Updated Proposal: Request for Funding to the Center for Science of Information's Frontiers Education Program

September 24, 2019

Project Title: Implications of teacher knowledge and attitudes: A cross-national exploration of secondary math teacher preparation

Total Funds Requested: $7,469

Co-Project Investigators:

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Problem Statement

As revealed by recent test scores, students in the United States continue to struggle with the math discipline and lag behind other industrialized nations (e.g., Canada, Japan, The Netherlands, etc.). The 2015 Programme for International Student Assessment (PISA) which measures academic achievement of 15-year-olds every three years, ranked U.S. students in thirty-first place on the composite measure for math, science and reading, but in thirty-ninth place world-wide in math achievement (Organization for Economic Cooperation and Development, 2015).

Further, the National Association of Education Progress (2017) published a report card highlighting that only 34% of eight graders met the math achievement level of *proficient* or higher, 30% were *below basic*, and the average scale score on the measure was 283, on a scale of 0 to 500. Finally, a Pew Research Center report found that less than a third of Americans held U.S. K-12 education in the science, technology, engineering and math (STEM) disciplines in esteem by ranking it as above average or the best in the world.

However, some studies have shown positive relationships between teachers' attitudes towards math, math ability, and students' math performance (Hill, Rowan, & Ball, 2005; Mensah, Okyere, & Kuranchie, 2013). To date, this important research lacks visualizations that highlight these relationships, particularly across countries that span the spectrum of math achievement. Graphical representations such as maps and graphs can elucidate statistical analysis, making research findings clearer for a wide range of stakeholders from policy makers, school district administrators and leaders, to curriculum developers, consultants, principals, and classroom teachers.

Intellectual Merit & Broader Impacts

We believe that our initial inquiries of the NSF dataset through data visualizations will allow our team to continue a data-driven exploration of potential policy and practice differences in the project countries that may have potential for improving the outcomes for high school students here in the United States.

By making the data analysis more accessible, we hope to inspire a reinvigorated conversation on teacher preparation in STEM which may lead to numerous positive outcomes for secondary students in the immediate future. Additionally, any findings that may lead to improvements in STEM teacher training and preparation, will have positive implications for the country as a whole.

Proposed Activity

This data visualization project will employ the use of the NSF funded Mathematics Teaching in the 21st Century (MT21) data which is currently hosted on the Inter-University Consortium for Political and Social Research. Six countries are represented in the data (South Korea, United States, Taiwan, Mexico, Bulgaria, and Germany).

Within those countries, teacher-level data at the early and late stages of their preparation are available across domains of math knowledge, attitudes and pedagogical beliefs. The availability of these identifiers at the country, individual, and institutional level will lend itself to a wide array of meaningful visualizations.

Specifically, we seek to visually explore several general differences among the six participating countries, including 1) perceptions about how students best learn math; 2) ability to communicate mathematical ideas; 3) prioritization of math curriculum, and; 4) positive attitudes towards math and its uses in life. Where possible, we would also like to cross reference this data with the results from reports such as the Trends in International Math and Science Study (TIMSS) which provides snapshots of student performance in various domains at the international level.

Goals & Outcomes

1) *(Primary Goal) Present Visualizations at Two Conferences*:
    a. *Conference #1*: Because the state of Texas has had an influential voice in public school education in the United States, we selected the Texas STEM Conference 2020 (https://txstem.org/stem-conference/) as our first choice for a platform to share our visualizations. The conference will be held from January 22-24, 2020 in Austin, Texas. The form of this presentation would take the form of a 45-minute interactive workshop soliciting discussion around the visualizations.
    b. *Conference #2*: We will also submit a proposal to present a poster at the National Council of Teachers in Mathematics, to be held in Chicago, Illinois from April 1-4, 2020.
    c. *Alternative Option:* Finally, we understand that acceptance to present at these conferences is competitive. So, in the event that our presentation is not accepted for the Texas STEM Conference, we will submit a proposal to present a poster at the 45th Annual Conference for the Association for Education Finance and Policy which will be held in Ft. Worth, Texas from March 19-21, 2020.

2) *(Secondary Goal) Manuscript Preparation:* Under the circumstances that the MT21 data set meets certain estimation criteria for multi-level modeling, the corresponding applicant will also assemble a team of interested co-authors from this current project (schedules permitting) and select PhD students enrolled in a Fall 2019 course in Hierarchical Linear Modeling (a statistical method suited to analyzing multiple levels of data with less error than simple multiple regression) at the University of North Texas to execute a manuscript that will be submitted to an education related journal within the 2019-2020 academic year. This paper will incorporate the statistical method of hierarchical linear modeling, along with relevant visualizations to expand on previous literature on these topics.

Proposed Work Statement

- Team meeting format:
    - Our team has decided to remain on Google Drive due to the ease of communication via Google Docs.
    - Due to a limited common available meeting times and diverse geographic locations, our larger team of six is now broken into partnerships that will primarily work with each other on an ongoing basis create and refine at least 2 visualizations to be used in our presentations. Where possible, we will reconvene as a larger group. These pairings were formed by the corresponding applicant based on disciplinary expertise, shared interests, and previous working relationships. They are:

        - Genéa and Tessa
        - Cary and Debjani
        - Milushka and Dinuka

    - Again, because our team is spread out across different geographical locations with different schedules, most of the work will take place within the interdisciplinary pairings. This work will be shared with our group on an ongoing basis via the Google Drive. Draft visualizations will be posted by each pair by November 15th, 2019 so that we may refine and update visualizations multiple times prior to the first conference. While the initial visualizations produced by each pairing can be generated through any means (e.g. Excel, R, Tableau, etc). Our goal is for the collection of visualizations to look similar and tell a cohesive story, so we aim to create all final visualizations in Tableau.
    - Additionally, each semester we will meet in larger group configurations (1-2 hours) via video conference to discuss progress, synthesis of visualizations, and conference prep.
    - The team will host a workshop at the Texas STEM conference (January 2020) to stimulate dialogue based on visualizations and present the final poster of visualizations at the NCTM national STEM education conference (Spring 2020).

- Team member contributions:
    - **Genéa**- Her research area is in research, measurement and statistics. She will serve as project coordinator and corresponding applicant; contribute to data analysis and visualization, poster preparation and the final presentation. She will also coordinate future manuscript preparation to address knowledge gaps in the field of educational psychology.
    - **Milushka**- Her substantive background in STEM education research will allow her to contribute unique insights to data analysis, poster preparation and the final presentation (this project will inform her focus on concrete steps that can be taken to support underserved populations in STEM).
    - **Cary**- Her academic and research preparation were in the area of science & math education research and teacher training. Her prior experience as a middle school science teacher and district administrator will inform the relevancy of the research

objectives and outcomes to practitioners in K-12 education. Due to her expertise, she will guide the team's visualization efforts and contribute to data analysis of the project.

- **Dinuka**- His extensive experience with critical software (i.e. such as R and Tableau) will support his contribution to the team's data analysis and visualization, poster preparation and the final presentation (this project will support his ability to communicate academic findings to lay audiences).
- **Tessa**- Her background and interest in computer science will inform the substantive thrust of our investigation. She will guide the team's poster preparation efforts, contribute to data analysis and visualization, and assist in both final presentations (this project supports her goal of exploring data science, which is within the scope of her fellowship with CSoI).
- **Debjani-** Her experience with statistical software will contribute to data analysis and visualization (this project will support her ability to communicate academic findings to lay audiences).

Diversity Statement

The benefits of this research project will address long-standing inequities in math education where underserved groups in the United States K-12 public education system are disproportionately affected by the quality of math instruction. Additionally, makeup of this team is itself diverse, including five ethnicities, four women, and four distinct disciplines across the social sciences, natural sciences, and computer science. Thus, this project directly supports CSoI's mission to recruit, retain and promote women and other underrepresented groups in the science of information.

Budget & Justification FY 2019-2020

Item	Description	Approximate Cost
Airfare/Regional Travel	(2) Round-trip airfare for 1undergraduate and 1 graduate student	3 x $500= $1,500
	Regional train or bus for 1 graduate student	1 x 2 x $80 = $160
Local/Ground Transportation	Shuttles, Lyft/Uber to pickup/drop-off, taxis to and from airport, gas and parking for 1 etc.	5 x $250= $1,250
T-STEM Lodging	One-night stay in hotel for 2 graduate students (at Austin, TX 2019 per diem rate)	4 x $145= $580
	Two-night stay in hotel for 1 undergraduate student (at Austin, TX 2019 per diem rate)	
NCTM Lodging	Two-night stay in hotel for two graduate students and one undergraduate (at Chicago, IL 2019 per diem rate)	3 x 2 x $219= $1,314
Meals & Incidentals	3 full days for 5 people	3 x 5 x $61= $915
Conference	Registration fees for 5	5 x $350= $1,750
Project Total		**$ 7,469**

*Note: Funds will go toward two graduate students (driving together) and one undergraduate student flying to the 2020 Texas STEM Conference in Austin, Texas (**https://txstem.org/stem-conference/**) to present the results of their research. [Presenters: Genéa, Cary, Tessa.]*

*Two graduate students and one undergraduate student will be flying or taking regional transportation to the NCTM Conference in Chicago, Illinois (**https://www.nctm.org/100/**). All six team members will meet virtually throughout Fall 2019 and Spring 2020 in order to prepare the presentations. [Presenters: Milushka, Dinuka, Tessa.]*

References

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