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Using School Choice to Connect to Mathematics Learning in a Statistics and Probability Course for K-8 Pre-service Teachers

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Using School Choice to Connect to Mathematics Learning in a Statistics and Probability Course for K-8 Pre-service Teachers

Abstract
This pilot qualitative study explored K-8 pre-service teachers (PSTs)' learning experience in a Statistics and Probability course and their ability to make connections between mathematics and their everyday lives when given opportunities to investigate mathematics through a social issue. Data from student surveys, assessments, and written reflections will be reported, analyzed, and discussed. The researchers also describe approaches and reflect upon experiences for PSTs while studying school choice voucher programs.

Keywords
School choice, social justice, teacher education, teacher practices, probability, statistics

How often do your students watch, listen to, or read about current events? Do they get their news from social media or reliable news sources? What are your students' thoughts on relocating public funding to charter and private schools? Or, are they even aware of the ongoing debate over school choice voucher programs? What about the people in their community? Observations and interactions with the researchers' students suggest that several pre-service teachers (PSTs) may not be aware of certain social issues, including those that may impact their lives and career choices. To engage their students in mathematics and social issues, the researchers incorporated learning about the school voucher programs with concepts in a Statistics and Probability course for K-8 PSTs.

Background

Integrating current events into the classroom allows teachers to give students a context to connect real-world events to classroom content, which makes learning more meaningful (Gutstein, 2003). Incorporating social justice in the classroom can promote students' understanding of current events and how knowledge of mathematics can help bring injustices to light, which may in turn lead to change (Gonzalez, 2009). Additionally, research supports the idea of including social justice issues into today's classroom because it increases student engagement, raises student motivation levels, and eventually improves students' academic achievement (Gareth, 2013). One framework for social justice theory (Gonzales, 2009; Gutstein, 2006) included two components: mathematics goals such as succeeding academically, and social justice goals such as developing a social or cultural identity. These two goals can be achieved by connecting mathematics to real-world contexts during lessons (Chapman & Hobbel, 2010; Gonzales, 2009).

This research follows the work of Bartell (2013) and Gutstein (2003), which suggested that students should be given opportunities to investigate mathematics through current issues, such as politics and education, which affected their own lives. Furthermore, Gutiérrez (2013a, 2013b) recommends that mathematics teachers must be able to expand their political knowledge to transform learning and support learners. The researchers' students were future educators, and at the time of this study school choice was a "hot topic," so the researchers chose the context of school choice voucher programs to engage their PSTs in learning about sampling issues and two-way frequency tables.

In addition to framing this current study in previous social justice research, the researchers utilize previous work on Scholarship of Teaching and Learning (SoTL) (Boyer, 1990; Cross, 1986) to reflect upon and share experiences from their

class to inform how they may change teaching lessons in the future. The researchers used Hutchins, Huber, and Ciccone (2011)'s idea that SoTL should focus on student learning to frame this research. By intertwining social justice and SoTL, the researchers created a project that not only informed their students about school choice voucher programs and how they may impact the students' future in education, but also shared with other teacher educators how a project like this may be implemented, changed, and incorporated to future classes.

Planning

This qualitative research was implemented in a Statistics and Probability course for K-8 Teachers. Classes met twice a week, and each class meeting was 75 minutes long. An overview of the included topics for this course follows:

Table 1
Course Overview

Unit 1	• Sampling Design: Types of sampling designs, sampling errors, non-sampling errors, margin of errors, confidence statements • Surveys and How to Critique them • Experiments vs. Observational studies
Unit 2	• Data Analysis: Graphical; Measures of Central Tendency and Variation • Two-Variable Data: Scatterplots, Correlation, and Regression
Unit 3	• Probability: Counting methods (Fundamental Counting Principle, Combinations, and Permutations), Using counting methods for probability and multi-stage experiments, Two-Way Tables, Odds, Expected Value

The participants in the study were 36 K-8 PSTs, mostly juniors or seniors, and enrolled in the Statistics and Probability course described above (see Table 1) at a university in the Southeast United States. Since their students are future teachers, the researchers anticipated that topics relating to the educational system such as school choice would pique their interest. Additionally, quiz and test results from previous semesters show that students in this course tend to incorrectly classify sampling errors and find questions involving two-way frequency tables challenging. Feedback from past student evaluations indicated that students enjoyed the material more when they could make connections between mathematics and real-world contexts. Thus, this study was designed with two goals in mind: to increase awareness of the social issue (the social justice component) and to increase understanding of sampling issues and two-way frequency tables (the

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mathematical component). This study is focused on the following research questions:

1. What is the PSTs' prior knowledge about school choice voucher programs?

2. What is the PSTs' perception of school choice voucher programs after their learning?

3. What are the PSTs' learning experiences through the context of school choice voucher programs?

To investigate those above research questions, the study was developed and comprised of three parts: (i) Part 1 focused on learning about students; (ii) Part 2 focused on students' perception of school choice voucher programs after their learning; and (iii) Part 3 focused on students' learning experiences after they collected data from participants in their community.

Implementing

The research was implemented the first day of Unit 3 on Probability (see Table 1). Table 2 outlines the implementation of the study, where students completed the majority of the assignments outside of class.

Table 2
Implementation of the Study

Parts of the study	Assignments and Data Collected
Part 1: Learning about students	• Survey
Part 2: Students' perception of school choice after their learning	• Assignment 1: Reading • Assignment 1: Reflections ** (Focus of our project)
Part 3: Students' experiences after conducting surveys in their community	• Assignment 2: Survey activity • Assignment 2: Reflections: Relate survey activity to statistics concepts & construct a two-way table ** (Focus of our project) • Assignment 2: Students enter data in a Google Form • Survey ** (Focus of our project)

Part 1: At the end of the first lecture on counting methods in Unit 3 (see Table 1), students used their phones to answer a survey created with Google Forms,

which was convenient for data collection and fun for them to learn about this teaching tool. For those who were not able to access the form with their personal devices, a paper version of the survey was given to them. Completion of the questionnaire took place in class and lasted approximately five minutes. Survey questions were designed to inform the researchers of how often and where their PSTs get updated about current events, and whether the PSTs were aware of school-choice voucher programs prior to this study.

Part 2: Following the completion of the survey and pre-assessment, students were given Assignment 1 (see Appendix A) as homework, where they read two articles. It is important to note that each selected article analyzes both the advantages and disadvantages of school choice voucher programs. After that, students answered questions about school choice and reflected on what they learned from reading the articles. These assigned articles served as a starting point, and students were free to explore other resources but asked to cite any references they used. Assignment 1 was completed outside of class, and their written responses were submitted in class.

Part 3*:* Once students learned about different reasons to support or oppose school voucher programs, they were given Assignment 2, which consisted of multiple parts. First, students surveyed people in their community on school choice issues. After completing the survey, students reflected on how the survey activity was related to the material learned in class and their everyday lives. They were also asked to create one two-way table to summarize any two categorical variables from the data they collected. The written responses were completed outside of class and submitted in class. Next, students entered the data they collected in Google Forms, which gave them experience in data entry as part of conducting research. Upon completion of Assignment 2, students participated in a survey created with Google Forms that took the last five minutes of class, explaining whether or not they enjoyed learning sampling issues and two-way frequency tables through a focus on school voucher programs.

Due to the social issue and mathematics components of the study, students' reflections on their learning in both assignments and the survey results were the focus of this project. Triangulation was used by collecting multiple data sources (reflections, class activities, and discussion) to determine how students were interpreting this project, and how researchers planned to make changes for the next semester. Data from surveys were automatically collected and generated by Google Forms. Data from students' written assignments were analyzed by two researchers, who independently coded students' responses first to find themes and then discussed and resolved any differences.

DOI: 10.20429/ger.2018.15101

Findings

Learning about Students (Part 1 of the Study)

Thirty-five out of 36 students completed the survey. On the question asking where students get updated on current events, they were given the following choices and asked to "check all that apply:" Facebook/Twitter/Social Media, Fox News, CNN, The New York Times, The Associated Press, or 'Other." Results revealed that students relied mostly on social media outlets (91.4%) or Fox News (45.7%) to stay informed (see Figure 1) and 77.1% of them read about current events between one and four times a week.

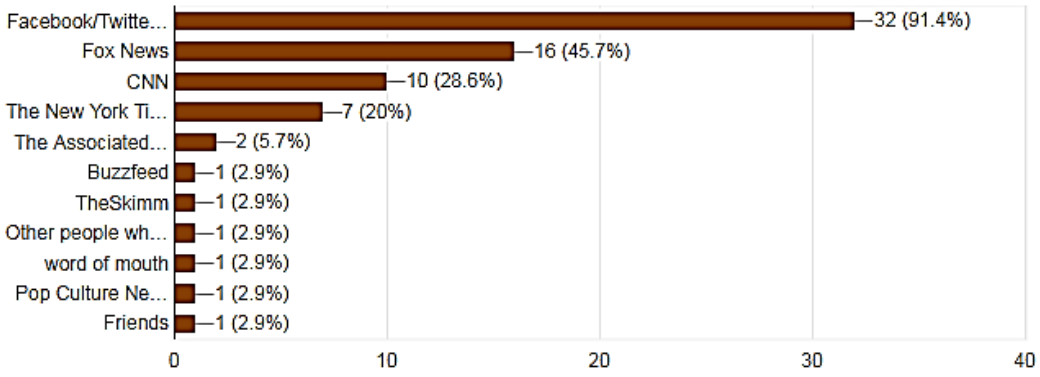

Figure 1. Where students get their news.

Furthermore, although students in this course are education majors, 71.4% were not aware of the school choice voucher system at the time of the survey.

Student's Perception on School Choice Voucher Programs after Their Learning (Part 2 of the Study)

Thirty-four of 36 students submitted their written Assignment 1 (Appendix A), answering the following three questions:

1. Name three pros of school choice voucher programs.

2. Name three cons of school choice voucher programs.

3. What did you learn from reading these two articles and/or any other resources? Does this change the way you feel about implementing school choice voucher system? Please explain.

Results from PSTs' Assignment 1 are reported below.

1. Themes for Pros of School-Choice Voucher Programs

As shown in Table 3, four themes emerged from the responses about pros of school choice voucher programs and were grouped into the following categories: (i) competition; (ii) financial relief; (iii) education boundaries; and (iv) increase diversity in schools.

Table 3
Themes for Pros of School-Choice Voucher Programs

Description	Frequency	%
Competition	42	41.18%
Financial relieve	36	35.29%
Education boundaries	22	21.57%
Increase diversity in schools	2	1.96%
Total	102	100.00%

Competition in education was identified 42 times (or 41.18%), since allowing parents to choose among schools may lead to better educational system. Financial relief such as scholarships and government subsidies was identified 36 times (or 35.29%). Education boundaries were mentioned 22 times (or 21.57%) and included comments regarding more rigorous curricula, more prone to new approaches in teaching, academic gains for children, and quality college-prep education. Finally, increase diversity in schools was listed twice (or 1.96%). Students realized that the social issue of economics also influenced decisions about school choice. A student wrote, "*I am learning in cultural issues class that schools are becoming more segregated because of economic status and this would help*."

2. Themes for Cons of School Choice Voucher Programs

As displayed in Table 4, six themes emerged from the responses about cons of school choice voucher programs and were grouped into the following categories: (i) financial concerns; (ii) academic concerns; (iii) violating separation of church and state; (iv) concerns about school system; (v) not popular (or "only offered in 14 states"); and (vi) "*How to decide who qualifies?*"

DOI: 10.20429/ger.2018.15101

Table 4
Themes for Cons of School-Choice Voucher Programs

Description	Frequency	%
Financial concerns	38	37.25%
Academic concerns	25	24.51%
Separation of **c**hurch and **s**tate	18	17.65%
Concerns about school system	14	13.73%
Not popular (or "Only offered in 14 states")	6	5.88%
"*How do you decide who qualifies?*" (criteria)	1	0.98%
Total	102	100.00%

Financial concerns such as funding taken from public schools, expensive cost, and funding students already in private schools with public money, were named 38 times (or 37.25%). Academic concerns, which included comments about voucher students not having any sustainable academic gains, closure of charter schools, and the concern over whether or not voucher programs would work, were listed 25 times (or 24.51%). Violating the separation of church and state was mentioned 18 times (or 17.65%), including statements such as, "*Majority of states don't offer traditional vouchers because of the Blair amendment, which prohibits spending public dollars on religious schools*." Concerns about school system were identified 14 times (or 13.73%) and consisted of comments such as the unavailability of school choice to all students, harming our failing public school system, making it harder for failing schools to get help, overcrowding schools, affecting rural town schools, and not meeting the requirements of students with special needs. Not popular ("Only offered in 14 states") was cited 14 times (or 5.88%). Additionally, a question, "*How do we decide who qualifies?*" was asked once (or 0.98%).

3. Students' Learning from Reading These Two Articles and/or Any Other Resources

Table 5 summarizes whether students learned something new from reading these two articles and/or any other resources and whether they considered only one or both sides of an issue.

Table 5
Students' Learning from Reading These Two Articles and/or Any Other Resources

Description	Frequency	% (*n* = 34)
Indicated that they learned something	28	82.35%
Considered two sides of an issue	29	85.29%
Considered one side of an issue	5	14.71%

Among 34 students submitting their reflections, 28 students (or 82.35%) explicitly indicated that they learned something from reading about the school choice issue. Twenty-nine students (or 85.29%) included both positive and negative impacts of school choice voucher programs in their responses, whereas only five students (or 14.71%) examined only one side, either in favor or against but not both, on this matter.

One student considered both sides of school choice, but did not specify whether he learned something. The rest of students' responses regarding their learning from reading articles about school choice falls into one of the following cases:

Case 1: If students indicated that they learned something from reading about school choice voucher programs, then they considered both the advantages and disadvantages of the issue in their reflections. One student wrote:

> *I learned that Georgia is among the list of states that participate in the voucher programs. I was not aware of vouchers until reading this set of articles, however, I am all in as although it may not guarantee success it at least gives a chance to all students for the best education they can obtain.*

Another student reflected:

> *From reading these two articles, I learned more about what Trump's school voucher plan entails. I also learned what some of the positives and negatives are of offering families school choice. The way I feel about school choice is very mixed. I can see how it can be beneficial to students, but I can also understand the downsides like how much it costs and how it might destroy some schools. After reading the articles and comparing the pros and cons, I feel as though it might do a lot of harm, and not as much good*.

Case 2: Those who only considered one side of this issue, either the advantage or disadvantage but not both, did not explicitly state that they learned something. A sample comment from one student is:

DOI: 10.20429/ger.2018.15101

I do like the voucher programs because they give underprivileged children a chance to get an education. Some families may live where the schools are not good or even closing its doors due to money and Donald Trump wants to set money aside to keep vouchers possible.

Another student voiced her opinion:

I already read both of the articles and still feel strongly that the voucher system will suffocate our public schools. I intend to teach in public schools with low-income demographics and the idea of that school's funding being taken away and redistributed in the form of a voucher is upsetting. Public schools need improvement, but vouchers are just a Band-Aid and they will worsen the situation.

Student Experiences after Conducting Surveys in Their Community (Part 3 of the Study)

Thirty-four out of 36 students submitted their written Assignment 2, answering the following three questions:

1. How does this activity (collecting information on 5 people) relate to material learned in class? Please explain.

2. How does this activity (collecting information on 5 people) relate to your everyday life and/or profession? Please explain.

3. From the data you collected, create one two-way table to summarize (any) two variables on your Survey Form.

Findings on PSTs' Assignment 2 are described below.

1. Students Related Conducting Surveys in Their Community to Material Learned

Table 6
Students Related Conducting Surveys in Their Community to Material Learned

Topics Stated	Frequency	%
Data collection	25	56.82%
Data analysis	7	15.91%
Probability	12	27.27%
Total	34	100%

As displayed in Table 6, among all mathematics topics stated in students' responses relating the survey activity to the material learned in class, data collection

was mentioned 25 times (or 56.82%), data analysis cited 7 times (or 15.91%), and probability stated 12 times (or 27.27%). This indicates that students were able to transfer the knowledge they learned from the material in Unit 1 and Unit 2 (see Table 1), specifically on sampling methods and how a sampling error may lead to biased results. One student noted:

> *Earlier in the semester we learned about different types of sampling and what makes a good sample vs bad sample. I sampled my roommates, which would be considered convenience sampling and it wasn't random and was also a small sample size. One of my roommates is an education major so this caused bias.*

Another student commented:

> *By collecting these types of data, we can find the probability that someone supports the voucher system through various different variables (age, gender, education, and how often they keep up with current events). This relates to the class notes by being able to use the formulas learned to find out what the probability is of a female aged 18-25 supporting the voucher system.*

2. Students Related Conducting Surveys in Their Everyday Lives and Professions

From in-class discussion after students turned in their Assignment 2 and evidenced in their written reflections, the researchers found that many students were able to make a connection between conducting surveys in their communities and their real lives or their professions. Twenty-four students (or 70.59%) related their survey activity to their future teaching careers. For example, one student wrote:

> *This would relate to my profession of teaching, in that you are always collecting and gathering data about test scores. Teachers have to be able to know how to help these struggling students by looking at their areas of weakness according to the tests given. Also, you could look at the school as a whole and correct data about male/female, race/background, parents' income, divorced families, etc.*

Three students (or 8.82%) linked surveying their communities on school choice with their everyday lives. One student noted:

> *Collecting a survey relates to our everyday lives because we often ask for others' opinions or feedback about certain things. Also, when eating out at*

DOI: 10.20429/ger.2018.15101

> *restaurants, they sometimes offer discounted or free items in order to get customers to go online and give feedback about the food or service*.

Seven students (or 20.59%) related the survey activity to both their everyday lives and professions. A student reflected:

> *Being an education major and a future educator, I am constantly collecting data from my students, in order to see how well they are understanding the content and understanding their level of comprehension. On a normal basis, I collect data of all sorts. I collect data from social media, the news, magazines, people, etc. to help make decisions about what to buy, eat where to travel, what to wear and so much more*.

3. Students' Two-Way Table Construction Results

When creating a two-way table, students were given flexibility to choose any two categorical variables from the data they collected. Table 7 shows three cases of students' two-way table construction.

Table 7
Students' Two-Way Table Construction Results

Types of Two-Way Table Construction	Frequency	%
Correct	26	76.47%
Missing some details (a total row/column/cell)	7	20.59%
Incorrect	1	2.94%
Total	34	100%

Twenty-six (or 76.47%) students correctly constructed a two-way table. Seven students (or 20.59%) gave a partially correct two-way table. Common reasons for the partially correct table included missing the totals of each column or omitting classifications of a categorical variable where there were no participants. Only one student (or 2.94%) incorrectly produced a two-way table by grouping classes from two different categorical variables into one category. This gives us an opportunity to address the misconceptions as potential errors their future students may make.

On the survey completed after students submitted their Assignment 2, 86.1% of students stated that they enjoyed learning about mathematics through the context of school choice voucher programs. Many used the words "relevant" and "informative" to identify why they enjoyed using this context. A student responded, "*It is a topic that education majors need to start really paying attention to, because it could affect us in the future*." Additionally, many students wrote that they were more interested in learning the material through the issue of school choice than

"other examples" because they could apply "classroom into a realistic situation." Another student commented:

> *I've never had to look into school vouchers so this assignment gave me the opportunity to look more into the data. I found it very neat to collect all of the data and find out people's opinions*.

For the students who did not enjoy learning mathematics in this context, they commented on the fact that too many participants in the survey they conducted did not know about school choice voucher programs. One student provided the following feedback, "*I feel like there might be too many people that are unaware of the school voucher programs for us to find anything valuable in this data*."

Implications, Extensions, and Conclusion

Implications for this study could relate to both current events and mathematical concepts. Even though universities are graduating education majors, many students may not be aware of the issues that will impact their career choices. While a few students maintained their original conceptions about the school choice voucher programs, most students indicated they learned something. Additionally, the researchers were encouraged by the positive feedback and the depth of responses from their students, and they intend to continue implementing similar projects in the future.

As this was the first time a study featuring social issues was implemented in the researchers' mathematics classes, they plan to make changes in their future classes. In the upcoming semesters, they aim to integrate learning about various social issues with other mathematics concepts such as percents, ways to display statistical graphs, areas of polygons, probability, etc. in lower-level mathematics education courses called "Foundations of Numbers and Operations" and "Foundations of Data and Geometry" so that they can make a broader impact by reaching more students and increasing awareness of different social issues. Based on the feedback from students who did not enjoy learning mathematics in the context of school vouchers, the researchers intend to incorporate a presentation component to their upcoming projects. Many students commented on the fact that they *wanted* to educate their participants, which suggested that they were excited to share what they learned with their community. Thus, in the future, the authors may ask their PSTs to present what they learn about an issue to their community, and then give a brief presentation in class on their experiences after conducting a survey on the issue in their community.

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The study reveals that even though at first the PSTs were not aware of social issues that may affect their future careers, their written reflections indicated that they did gain political and educational knowledge through examining pros and cons of school choice voucher programs. For this reason, teachers in different content areas and at different levels throughout K-20 should be encouraged to implement social justice projects into their content specific courses. All students should be better equipped to address changing issues in the real world, and giving them opportunities to explore these issues helps to make them better citizens by taking an active role in improving the world around them (Gutstein, 2006).

Overall, the authors found that connecting current events with mathematics engaged their students, which agrees with Bartell (2013) and Gutstein (2003)'s work. Students in this study learned about social issues that impact their lives and professions, and they were able to connect surveying their community with sampling issues and two-way frequency tables. Results (see Table 7) shows that most PSTs did in fact learn how to construct two-way tables from their collected data. Moreover, most students analyzed both the positive and negative factors before deciding whether to support or oppose the school voucher programs, which is important for developing critical thinking skills. Simic-Muller, Fernandes, and Felton-Koestler (2015) stated that many PSTs had limited experience with "controversial issues" in the context of teaching mathematics, and funding for schools is defined as one example of those issues. Thus, the researchers found it valuable that before their PSTs have their own classrooms, not only the PSTs gained an experience with teaching mathematics in a context of a social justice topic, but they were also able to make connections between the topic of school choice voucher systems and mathematics. Reflecting upon their experiences from this study, the researchers believe that students should be given similar opportunities as described in this research study to not only be engaged in content, but also to make connections between their mathematics knowledge to the real world. Using current issues to connect to mathematics learning can help students see the relevance of mathematics in today's world, which is how students should be prepared before they enter the workforce.

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Appendix A

Assignment 1

Direction: *You are to go to the following two websites to read about school vouchers and identify three pros and three cons for implementing school-choice voucher systems. Feel free to read more from other resources but write down any link you used*.

* Go to http://www.npr.org/sections/ed/2016/12/07/504451460/school-choice-101-what-it-is-how-it-works-and-does-it-work

* Go to http://www.cbsnews.com/news/education-nominee-expected-to-address-school-choice-charter-schools-at-confirmation/

1. Name three **pros** of school vouchers (bullet points are fine).

2. Name three **cons** of school vouchers (bullet points are fine).

3. What did you learn from reading these two articles and/or any other resources? Does this change the way you feel about implementing school choice voucher system? Please explain.