Elementary Education Students' Data Science Attitudes and Experiences

Dr. Jennifer Clinkenbeard
Associate Professor of Mathematics
California State University Monterey Bay
jclinkenbeard@csumb.edu

Background and Motivation

- The July 2023 Mathematics Framework for California Public Schools recommends that all students learn introductory data science.

  "Data science can and should be integrated into math instruction across the grade levels, from elementary school through high school, regardless of which pathway a school has selected." (see Chapter 8).

- Based on this recommendation, we redesigned an existing mathematical methods course for undergraduate students who plan to become K-6 teachers to include a 5-week unit on data science and statistical reasoning.

Learning Outcomes for the Data Science Unit

- Pose statistical investigative questions and identify appropriate data types.
- Represent, analyze, and interpret data using tables, graphs, and measures of center.
- Identify patterns and associations in bivariate data and interpret trends in context.
- Apply the stages of the data life cycle to real-world datasets.
- Use digital tools to organize and visualize data and evaluate claims based on data.

Data Science | K-10

BIG IDEAS

A Selection of Big Ideas from Data Science – from GAISE II (2021).

Formulate statistical investigative questions	Collect/consider data	Analyze data	Interpret and communicate

CODAP

Common Online Data Analysis Platform (CODAP)

CODAP is a free, web-based app for learning and doing data science, used by students, curriculum developers, and education researchers.

Learn More

When you go to a playground…what do you notice and wonder about **quality**?

Data Science “Playgrounds” project

- Students drafted and revised statistical investigative questions, as well as survey questions.
- Questions were designed to be something that could be observed from visiting a local playground.
    - Students chose to focus on cleanliness, safety, accessibility, and equipment available.
- Students each went to a local playground and recorded their data on a Google form to create a class data set.
- The class cleaned the data set and the instructor loaded it in CODAP.
- Students engaged in data analysis using the class data set.
- Students worked in pairs to write a report of their findings about local playground quality.

Student Work Sample #1

Is there an association between how accessible a playground is for users with mobility devices and how likely people are to recommend that playground?

About 27 percent of the variation in accessibility ratings can be explained by recommendation ratings. This shows that there is a moderate relationship between the two variables. However, since 27 percent is not very high, it also means that accessibility does not fully determine how people rate playgrounds overall. Some playgrounds with high recommendation ratings still have lower accessibility ratings. This shows that while accessibility is important, people may also consider other factors when recommending a playground.

Student Work Sample #2

I live near this park and drive by it almost every day, I noticed that there are parties here almost every weekend and the park is often pretty dirty in areas where the tables and barbecues are.

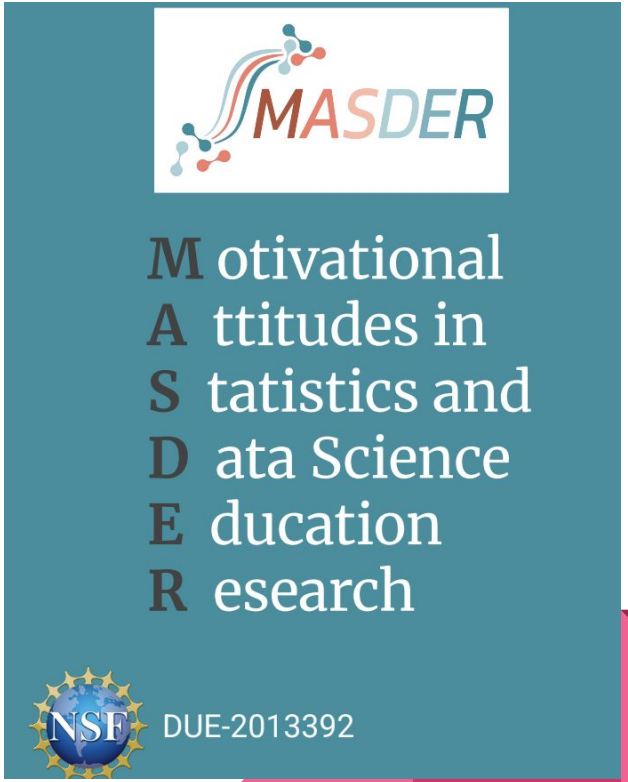
My question is, is there a relationship between the number of trash cans in different areas of the park and the cleanliness of those areas?

Research Question

How do preservice teachers' attitudes, beliefs, and experiences with data science change following a 5-week unit on data science and statistical reasoning?

Developing our questionnaire

Adapted questions and scales from survey instruments developed by MASDER (Motivational Attitudes in Statistics and Data Science Education Research) for a preservice elementary school teachers audience.



Construct (No. of items)	Definition
Global items (6)	Broad measures of students' overall experiences, confidence, perceptions, and interest related to mathematics and data science.
Interest/Enjoyment (6)	The interest a student has in data science, or their enjoyment from it
Difficulty (6)	How difficult the student perceive data science to be
Utility (4)	(Student) How much the student values data science for serving or achieving their goals (Instructor) The value of teaching data science because it meets some future goal
Expectancy (10)	(Student) How the student thinks they will perform in the field of data science (Instructor) How the student thinks they will perform as a teacher of data science
Academic Self-Concept (6)	Student perceptions about academic achievement (general)
Experiences (4)	Open ended items about students' experiences with data science

Methods

- Pre- and post- survey model, at the beginning of the semester and end of the data science unit (about Week 6 of a 15 week semester).
- N = 52 pre and post matched responses across four course sections (54% response rate)

- 7 point Likert scale items
- Reverse coded negative items
- Used mean as a composite measure for each construct scale

Results

Construct	Pre: Mean (SD)	Post: Mean (SD)
Global items	4.70 (0.87)	5.03 (0.84)
Interest/Enjoyment	4.97 (0.90)	4.98 (0.99)
Difficulty	4.09 (0.85)	4.18 (0.95)
Utility	5.00 (0.98)	5.24 (0.96)
Expectancy	4.57 (1.06)	5.14 (0.98)
Academic Self-Concept	5.31 (1.01)	5.29 (1.14)

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Results

Construct	Sample questionnaire item(s) and mean difference (pre to post)
Global items	As an elementary school teacher, how much will you use data science? (0.40) How confident are you that you can master introductory data science material? (0.54) How confident do you feel in your ability to learn mathematics in general? (0.58)
Utility	I need to know data science because it will be expected of me in the future. (0.35)
Expectancy	I can create appropriate data visualizations (0.75) I feel prepared to teach my future students how to explain results that use data (0.85) I feel prepared to teach my future students how to identify appropriate data science techniques (0.79)

Open-Ended Questionnaire Item Analysis

Think back to your own elementary school days. Did you learn about data science? If so, describe a memorable experience. (Pre)	What was your most memorable experience learning about data science in this course? (Post)
● Few participants recalled memorable experiences at all ● Primarily procedural activities (graphs, charts, tallies, probability) ● Few memories connected to real-world contexts	● Hands-on, applied learning via Playgrounds project ● Learning and experimenting with CODAP ● Collaboration with peers

Key Findings

- Attitudes across the six measured domains were generally stable or showed positive movement from pre- to post-survey.
- The largest changes were found in expectancy-related beliefs, including:
  - participants' expectations for their own success and engagement as learners
  - expectations about future students' success and engagement from an instructor perspective
- Findings suggest the experience may have strengthened both:
  - participants' confidence in data science, and
  - their beliefs about supporting future student success.
- Providing authentic data science experiences in undergraduate coursework is important because many future teachers may not have experienced inquiry-oriented data science learning themselves.
- Experiencing collaborative, applied, and reflective data investigations as learners can help future teachers build confidence,and better support meaningful data science learning in their own classrooms.

Future Work

- Iteration of course materials, including different options for the culminating data science project.
- Repeated data collection over time.
- Dissagregate results to better understand students' experiences and learning.
- Iterate questionnaire tool in collaboration with MASDER team.
- Collaboration with other institutions with similar courses to collect questionnaire data.

Thank You and Acknowledgements

- “Playgrounds” project and course curriculum adapted with permission from materials developed by Dr. Bridget Druken, California State University Fullerton, for the Fullerton Math Project.
  About - Dear IDEEM | Fullerton Math Project

- Questionnaire adapted with permission from Motivational Attitudes in Statistics and Data Science Research (MASDER) family of instruments, in consultation with Dr. Alana Unfried, California State University Monterey Bay.
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