Getting Data-Intensive Experiences in Secondary Classrooms: Impacts of Professional Development and the Long and Interesting Road Ahead

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2018-19 University Scholar, RTI International

Partially supported by RTI International University Scholars program. Opinions and findings are those of the presenter.
RTI partners

John Vavricka, Center for Technology, EWD
Peter Baumgartner, Center for Data Science, SDS
1. Deconstruct and describe data science skills and ways of working for secondary school audience
2. Create online resources and micro-credentials for teachers to incorporate data science in schools
3. Design intelligent personalized pathways and dashboards for data-infused secondary teacher professional education
How can RTI be on the forefront in supporting data science education and personalized professional development?
HI-RiSE: A Hub for Innovation and Research in Statistics Education

Laying foundations for future data scientists and data literate citizenry

http://hirise.fi.ncsu.edu

- Collaborative in our work
- Connected to classrooms and teachers
- Committed to open educational resources
Creating Data Literate Citizenry

“Data are abundant, quantitative information about the state of society and the wider world is around us more than ever. ... In order to re-root public debate to be based on facts instead of emotions and to promote evidence-based policy decisions, statistics education needs to embrace two areas widely neglected in secondary and tertiary education: understanding of multivariate phenomena and the thinking with and learning from complex data.”

(Engel, 2017, p. 1)
The GOOD NEWS: Opportunities across Curriculum

SCIENCE: Analyze and interpret data

LITERACY: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible

SOCIAL SCIENCES: Define and frame questions about events and the world in which we live, and evaluate evidence...

MATHEMATICS: Make inferences and justify conclusions

COMPUTATIONAL THINKING: leverage the power of technological methods to develop and test solutions.
GOOD NEWS:
Interest in AP Statistics & Computer Science

# of AP Statistics Exams 1997-2018

AP Computer Science participation increased 135% since the launch of AP CSP in 2016

2007: 20,041
2016: 57,937
2018: 135,992

+135% from 2016
The BAD NEWS:
Rare to Have Meaningful Data Experiences

In MOST Math Classes

• Stats unit reduced
• 1-2 variables
• Maybe a context (but often uninteresting)
• Small data set
• Often graph by hand or with GC
• Taught “rules”
• Bivariate analysis is about computing

Example: The heights of players on the Washington High School’s Girls basketball team are recorded below:

A student transfers to Washington High and joins the basketball team. Her height is 6’ 2”

a. What is the mean height of the team before the new player transfers in? What is the median height?
b. What is the mean height after the new player transfers? What is the median height?

The model, represented by \( y = 0.15x - 1.5 \), is graphed with a scatter plot.

Use the graph and the table to answer the questions.

1. Player A had 154 hits in 2015. How many home runs did he have? How many was he predicted to have?
Instead

Get Kids Engaged and Excited with Big(ger) Data
Work of Data Scientists: An interview study

Develop and use programming, statistics, data wrangling, modeling, visualization skills

But also develop creativity, team work, and resilience in tackling open-ended problems with data
Are Data Science Opportunities in AP Statistics?

Survey says?
A closer look at AP Statistics

- A course that *could* introduce students to big(ger) data
- Survey of current AP Statistics Teachers, Fall 2018  n=445
# Data sets used in AP Statistics

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<th>Few</th>
<th>Half</th>
<th>Most</th>
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<td>8%</td>
<td>17%</td>
<td>62%</td>
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<td>70%</td>
<td>21%</td>
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<td>1%</td>
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<tr>
<td><strong>&gt;1000 cases</strong></td>
<td>35%</td>
<td>54%</td>
<td>9%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>2 - 10 variables</strong></td>
<td>2%</td>
<td>44%</td>
<td>28%</td>
<td>23%</td>
<td>3%</td>
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<td><strong>&gt;10 variables</strong></td>
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<td>43%</td>
<td>6%</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Multiple types of data</strong></td>
<td>4%</td>
<td>57%</td>
<td>24%</td>
<td>12%</td>
<td>3%</td>
</tr>
</tbody>
</table>

N=428
Content Analysis of AP Statistics

Preparing the workforce of tomorrow.....

Examined Career Profiles (developed by EDC’s ODI) of

• **Big Data Enabled Specialists**
• **Data Practitioner**

*How well does the AP Statistics curriculum offer opportunities for students to experience aspects of tasks and skills needed by BDES and Data Practitioner careers?*
**Big Data Enabled Specialist** is an individual who wrangles and analyzes large and/or complex data sets to enable new capabilities including discovery, decision support, and improved outcomes.

1. Defines the Problem (Skills 1A-1N)
2. Wrangles Data (Skills 2A-2N)
3. Manages Data Resources (Skills 3A-3K)
4. Develops Methods and Tools (Skills 4A-4I)
5. Analyzes Data (5A-5J)
6. Communicates Findings (Skills 6A-6K)
7. Engages in Professional Development (skills 7A-7J)

**Data Practitioner** in service of an organization and/or stakeholders, supports the data life cycle by collecting, transforming, and analyzing data, and communicating results in order to inform and guide decision-making.

1. Initiates the Project (Skills 1A-1I)
2. Sources the Data (Skills 2A-2I)
3. Transforms the Data (Skills 3A-3M)
4. Analyzes the Data (Skills 4A-4M)
5. Closes the Project (Skills 5A-5K)
6. Engages in Professional Development (Skills 6A-6I)
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Tasks & skills **Well Represented** in AP Stats

3 Skills well represented
Big Data Enabled Specialist is an individual who wrangles and analyzes large and/or complex data sets to enable new capabilities including discovery, decision support, and improved outcomes.

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5. Analyzes Data (Skills 5A-5J)
6. Communicates Findings (Skills 6A-6K)

17 Skills sparsely represented

Data Practitioner in service of an organization and/or stakeholders, supports the data life cycle by collecting, transforming, and analyzing data, and communicating results in order to inform and guide decision-making.

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16 skills sparsely represented
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3. Manages Data Resources (Skills 3A-3K)
4. Develops Methods and Tools (Skills 4A-4I)
5. Analyzes Data (5A-5J)
6. Communicates Findings (Skills 6A-6K)

49 Skills Absent

Data Practitioner in service of an organization and/or stakeholders, supports the data life cycle by collecting, transforming, and analyzing data, and communicating results in order to inform and guide decision-making.

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2. Sources the Data (Skills 2A-2I)
3. Transforms the Data (Skills 3A-3M)
4. Analyzes the Data (Skills 4A-4M)
5. Closes the Project (Skills 5A-5K)

35 skills absent

Tasks & skills Absent in AP Stats
But, there’s a difference between curriculum standards and instructional strategies to meet those standards.

Professional learning opportunities for teachers can make a difference.
Two MOOCs for Educators Aimed at Better Instructional Strategies

- Teaching Statistics Through Data Investigations
  - 4500+ registered
  - 2100+ in Unit 1
  - 800+ completed

Teaching Statistics Through Inferential Reasoning
Teaching Statistics Through Data Investigations  http://go.ncsu.edu/tsdi

• First launched Spring 2015
• FREE – funded through grant from Hewlett Foundation
• Designed for teachers of students age 12 through introductory college courses (focus on pedagogy)
• Goal is to equip teachers with tools, frameworks, resources, and skills to teach statistics as an investigative process with real data
All MOOC-Eds at FI use same Design Principles

Self-directed
Job-connected
Multiple voices
Peer supported

(Kleiman, Wolf & Frye, 2015)
Key Components of Each Unit

• **Engage with Essentials**: brief papers and short videos
• **Learn from Experts**: expert panel and interview videos
• **Dive into Data**: tasks using free open tools (TUVA, CODAP)
• **Investigate and Discuss**: pedagogy focused (assessment, task analysis, student work, confidence to teach)
• **Discuss Learning and Practices**: exchange of ideas on various topics initiated by participants
• **Extend your Learning**: content videos, readings, lesson plans
• **Demonstrate your Learning**: microcredential opportunities
Multimedia Learning Opportunities

Brief Papers

Click-on Diagram

Instructor Video with Explanations and Examples of Students’ Reasoning

Expert Panel Discussions

Using Technology to Make Sense of Real Data

Classroom Videos
Research Questions

How do participants engage?
• Data click logs

What impact do course learning opportunities have on educators’ perspectives and practices?
• Discussion forums
• End of course surveys
• Follow-up surveys
• Interviews
Professional Change Model and Triggers for Critical Reflection

- Change process includes reflection and enactment among external domain and teacher’s professional world (Clark & Hollingsworth, 2002)
- Mezirow’s (2009) theory of transformational learning to examine stimuli that act as triggers to evoke cognitive dissonance for teachers where they question their understandings & perspectives from prior experiences
How do participants engage?
TSDI Participants

- 7 sections (Fall 2015 to Fall 2018)
- 2,723 unique educators
  - 90 countries, 78.6% from US
- 66% female
- 61.5% identified as classroom teachers
- 54.6% masters, 19.3% doctoral degrees
- Mean of about 14 years of experience
  - 20.5% with 1-5 yrs and 21.6% with > 20 yrs
Unit Participation Across 7 Sections

TSDI Course Engagement Fall 2015-Fall 2018

2723 unique registrants
1744 enrollees (64%) showed up!

★ Some skipped orientation and went straight to Unit 1, others came to orientation and did nothing else.
★ 33% of those in Unit 1 made it to Unit 5!
★ 278 accessed a certificate
Better than Typical MOOC Participation

64% show up rate of unique registrants versus

- Median of 46% show up rate across 13 MOOCs (Perna et al., 2014)
- Mean of 50% show up rate across 59 MOOCs (Jordan, 2015)

32.8% completion rate (unit 1->end) versus

- median completion rate of 18% (range of 13-39%) across 13 MOOCs (Perna et al. 2014)
Discussion Forums

11 Forums: Introduction, and 2 per unit
• Discussion about course material
• User-driven discussion about issues in teaching statistics

Across the 7 sections, 1034 participants posted at least once.
• 2,372 discussion threads containing 6,899 posts
• Mean of 6.67 posts per forum participant, with a skewed distribution since some participants posted 30-50 times within a course.
• Many forum lurkers, read a lot, post none to little.
• Super-posters finish the course, are well connected in social networks, and almost all returned to take second course TSIR.
1 User returned and binge watched videos all day! 20 yrs. Exp, PhD, Math/CS K-12 teacher in Italy. Initially enrolled in Sum 16, enrolled in TSIR SPr18
Most view 8 or less days and have less than 90 resource views

Female, masters degree, 10 yrs exp, K-12 classroom teacher, NC
**5731**: 15 yrs exp, masters degree, female, college faculty, MD

**10215**: 10 yrs exp, male, doctoral degree, college faculty, MI

**9663 Super Visitor and Resource User**: 5 yrs exp, PhD, female, College faculty, Hungary, only 4 forum posts!
Unique Users Accessing Video Resources Spring 2017

Number of UserIDs who Accessed Video Resources

- 17-T3DI - Unit 1 - Expert Panel
- 41-T3DI - Unit 2 - Expert Panel
- 44-T3DI - Expert Panel Unit 3
- 45-T3DI: Development of the GAISE Document Unit 3
- 46-T3DI: Developing the concept of the mean Unit 3
- 52-T3DI: Unit 4 Expert Panel
- 59-T3DI - Unit 4 - Expert Panel #2
- 60-T3DI - Unit 4 - Expert Panel #3
- 61-T3DI - Unit 4 - Investigate - Pose/Collect
- 62-T3DI - Unit 4 - Investigate - Analyze/Interpret
- 64-T3DI - Working With A Dynamic Simulation Tool
- 65-T3DI - Unit 3 - Multiple Levels of Sophistication
- 66-T3DI - What are your hopes for the future of statistics education?
- 67-T3DI - Unit 5 Expert Panel - What is the one piece of advice that you would give to teachers?
What impact does the course have?
Self Efficacy for Teaching Statistics
(Harrell-Williams, et al. 2019)

- \( n = 163 \) participants took pre- and post-survey through Fall 17
- Pre-mean score = 3.90
  - SD = 0.43
- Post-mean score = 4.84
  - SD = 0.29
- Paired t-test supports increase in confidence
SETS Survey Responses

Increase in Confidence
I feel much more confident regarding statistics now. Prior to this course, I had very little to no familiarity with statistics. The videos and practice with the data sites like Census for School really made everything concrete for me. I'm looking forward to bringing these ideas into the classroom. -Spring 2016 participant

Decrease in Confidence
I think the biggest thing this MOOC did was to open my eyes. And, if the confidence scores are lower now, it might be due to me having a deeper understanding, and knowing more about what I DON'T know about. Like the "ignorance is bliss" quote.

-Fall 2017 participant
Impacts on Beliefs & Perspectives

What resources triggered these shifts?
Impact of different resources on teachers’ learning

● “From the second video [Multiple levels of sophistication] it is apparent that each group of students investigating whether the die was fair or biased were at different levels of the SASI framework. The ways in which each group collected and analyzed data and interpreted the results indicated their levels of statistical sophistication.”
● “I loved the video of Chris and HollyLynne talking about the mean [Developing the concept of mean]. It is helping me to get a big picture idea of the curriculum.”
● “The SASI framework and example of statistical tasks [Dive into Data] were very useful to design, initiate statistical inquiry in classrooms. The SASI framework helped in becoming more objective and observant in what is going on in the classroom, where each group/child is heading and what are gap areas to be worked upon.”
Impacts on Perspectives about Statistics and Teaching Statistics

Understanding of **key statistical practices** and how these **practices are connected** rather than perpetuating statistics as a set of tools and procedures.

Ability to **explore and learn from data**, impacting their perspectives on how **useful explorations with data** could be for students.

Awareness of how **instruction should engage students** in various aspects of a **statistical investigation cycle**.

Understanding of how **technology tools support learning** from **real**, sometimes **messy**, and **bigger data**.
Example: Understanding of key statistical practices and how these practices are connected rather than perpetuating statistics as a set of tools and procedures.

“The mooc prompted me to rethink what sorts of questions I ask students, shifting more to statistical reasoning questions and away from statistical processes” - Fall 2015 Participant
Example: Awareness of how instruction should engage students in various aspects of a statistical investigation cycle.

“Thinking of statistics as a cycle has really helped me have a stronger understanding of Statistical thought. Rather than just having students complete a page of computational type questions, it really needs to be an ongoing cycle of thinking, investigating, considering, and then rethinking. I am going to start using Pose, Collect, Analyze, and Interpret as prompts in the classroom.” -Spring 16 Participant
Triggers Influencing Changes in Perspectives

SASI Framework

Classroom Videos of Teachers & Students

Expert Panel Discussions

Engaging with Colleagues

Using Technology to Make Sense of Real Data
“What was the most valuable aspect of this course?”

From end-of-course survey in Unit 5, most commonly referred to learning experiences in decreasing frequency:

- Access to resources, technology tools, websites, and lesson plans
- Learning from videos of expert panel discussions
- Learning from videos of students and teachers work in classrooms
- Introduction to the SASI Framework
- Focus on improving questioning, exploration, engaging students, and active learning
- Engaging in discussions with colleagues
- Appreciation for flexibility and learning at own pace
- Being grateful for opportunity and inspired to learn more
“What was the most valuable aspect of this course?”

Self-directed learning

- Access to resources, technology tools, websites, and lesson plans
- Learning from videos of expert panel discussions
- Learning from videos of students and teachers work in classrooms
- Introduction to the SASI Framework
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- Engaging in discussions with colleagues
- Appreciation for flexibility and learning at own pace
- Being grateful for opportunity and inspired to learn more
“What was the most valuable aspect of this course?”

Job-connected learning

• Access to resources, technology tools, websites, and lesson plans
• Learning from videos of expert panel discussions
• Learning from videos of students and teachers work in classrooms
• Introduction to the SASI Framework
• Focus on improving questioning, exploration, engaging students, and active learning
• Engaging in discussions with colleagues
• Appreciation for flexibility and learning at own pace
• Being grateful for opportunity and inspired to learn more
“What was the most valuable aspect of this course?”

Learning from multiple voices

- Access to resources, technology tools, websites, and lesson plans
- **Learning from videos of expert panel discussions**
- **Learning from videos of students and teachers work in classrooms**
- Introduction to the SASI Framework
- Focus on improving questioning, exploration, engaging students, and active learning
- **Engaging in discussions with colleagues**
- Appreciation for flexibility and learning at own pace
- Being grateful for opportunity and inspired to learn more
“What was the most valuable aspect of this course?”

Peer-supported learning

• Access to resources, technology tools, websites, and lesson plans
• Learning from videos of expert panel discussions
• Learning from videos of students and teachers work in classrooms
• Introduction to the SASI Framework
• Focus on improving questioning, exploration, engaging students, and active learning
• **Engaging in discussions with colleagues**
• Appreciation for flexibility and learning at own pace
• Being grateful for opportunity and inspired to learn more
Teachers as Continuous Learners

Share resources and new ideas with colleagues in both informal and formal ways to create systemic change

**Informal ways**
- Shared resources with colleagues
- Leading reform-oriented discussions with school colleagues

**Formal ways**
- Designed new lesson plans, implemented and submitted to STEW
- Translated key resources into Spanish and Mandarin
- Authored a blog about her professional learning in TSDI
- Returned to take second Teaching Statistics MOOC (n=323)
How did TSDI participants learn from Micro-credentials?
Teaching Statistics Microcredentials

Understanding the SASI Framework

- Statistical Habits of Mind
  - 5 PD hrs
- Statistical Investigation Cycle
  - 5 PD hrs
- Levels of Sophistication in Statistical Thinking
  - 5 PD hrs

Statistics Task Design

- Evaluate a Statistics Task
  - 5 PD hrs
- Design a Statistics Task Given a Data Set
  - 5 PD hrs
- Choosing a Statistics Task for your Context
  - 7.5 PD hrs

place.fi.ncsu.edu
Focus on MC Submissions in the Understanding SASI Framework stack
Scores Earned by Question
through May 2019

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<td>43% n=6</td>
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SASI 1: Statistical Habits of Mind

Q3

3. Consider the task. Create two fictional students' responses to this task. The first should be an example that demonstrates the application of at least 3 statistical habits of mind and articulates how those habits of mind engage the student in thinking statistically. The second should demonstrate a non-example response that lacks evidence of a student's use of statistical habits of mind and describe how this limits the student's response.

Show/Hide Task
Show/Hide Rubric

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<th>Yes</th>
<th>Not Yet</th>
</tr>
</thead>
</table>

The response provides one fictional sample student response (example) that...

- Clearly illustrates student using at least 3 statistical habits of mind to answer the investigative question.
- Clearly articulates how student's use of those statistical habits of mind engages them in thinking statistically in this task.

AND

The response provides one fictional sample student response (non-example) that...

- Clearly illustrates student's work that lacks evidence of robust use of statistical habits of mind.
- Clearly articulates how not using statistical habits of mind limits the student's statistical thinking in their response to the task.

OR

The response does not provide one fictional sample student response (example) that...

- Clearly illustrates student using at least 3 statistical habits of mind to answer the investigative question.
- Clearly articulates how student's use of those statistical habits of mind engages them in thinking statistically in this task.

The response does not provide one fictional sample student response (non-example) that...

- Clearly illustrates student's work that lacks evidence of robust use of statistical habits of mind.
- Clearly articulates how not using statistical habits of mind limits the student's statistical thinking in their response to the task.
Implications

- Courses like TSDI can engage **many educators across grade levels**
- Even educators who did not complete the course were impacted by engagement with **specific course resources in early units**
- A course like TSDI can **increase confidence to teach statistics**
- **Well-designed resources and engaging with peers** matters
- Some educators **use resources beyond course time**
- **Low attraction to micro-credentials** as suggested opportunities
- Micro-credentials need redesigned to **integrate learning resources and improve scoring processes**
- Need **partnerships with districts/organizations** to promote online PD and micro-credentialing opportunities!
Summer Work
Teaching Statistics Micro-credentials
Analysis and Reorganization

MCs as professional learning that integrates resources and application to practice

Assessment:
- Train text analysis tools to autocode “simpler” responses
- Develop 4-pt rubric with details so that scoring gives some auto-feedback.

Conversation with FI about potential MC partnership
Proposal under review

InSTEP: Invigorating Statistics Teacher Education through Professional Online Learning

• Design and examine impact of personal online pathways for PD in teaching statistics with data
• 2.8 million, submitted to NSF (DRK-12) 4 yrs, partner,
• RTI’s John Vavricka and Center for Technology
Bringing Data Science into Schools

- NCDS webinar March 2019
- Webinar for LDMC math leads April 2019
- 5-min lightning talk at USCOTS May 2019
- Session at RTI’s Early College Summit next week!
- Articles--research and teacher audience
- Feedback on International DS project curriculum framework
- Development of DS resources for teachers’ learning and redesign MCs Sum19
How can RTI be on the forefront in supporting data science education and personalized professional development?
Contact me!

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HI-RiSE: A Hub for Innovation and Research in Statistics Education
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