Use of Computer Programs and Mathematics Achievement of Students in Puerto Rico Using 2015 NAEP Data (Unrestricted Presentation)

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Presentation Guideline

1. Introduction
2. Literature Review
3. Methodology
4. Conclusions

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Purpose of the study

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- Investigate the relationship between the use of computer software to do mathematics and the mathematics achievement of students in Puerto Rico measured by the 2015 National Assessment for Educational Progress (NAEP).
- Uncovering this relationship will provide guidance on educational practices and policies for schools in P.R.

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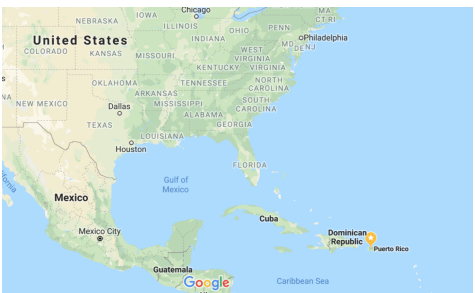
Puerto Rico Demographic Information

Population: 3,725,789

Education in Puerto Rico (2015):

- 379,818 students
- 99.7% Hispanics
- American educational model
- Spanish language
- Mathematics P.R. Core Standards
- Standardized assessments



Google Maps

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Statement of the Problem

Alarming mathematical achievement levels for 8^{th} grade students in 2011-2015 Math NAEP reports:

- Proficient or advanced levels: Less than 1%
- Below basic level: 94%

National Assessment for Educational Progress (NAEP)

Levels of mathematical achievement

- *Basic*
- *Proficient*
- *Advanced*

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Research Question

- Researchers have shown that the use of computer programs might affect positively mathematics achievements.

- The mathematics achievement of students in Puerto Rico and the relationship with the use of computer programs haven't been explored.

RQ:

How does the use of computer software application programs to do mathematics by students relate to the 2015 NAEP Math scores of 8^{th} grade students in Puerto Rico?

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Mathematics Achievement of Students in P.R.

- The 80's (Rivera, 1987)
  - planning the class, presenting the content, managing the classroom, and students' behavior
- Reports by the National Center for Education Statistics [NCES]:
  - gender
  - absenteeism
- Perspectives of Teachers (Álvarez-Suarez, 2014) - Puerto Rican Test of Academic Achievement (PPAA)
  - parental support
  - missed school days
  - absenteeism
  - school disciplinary climate
  - apathy toward mathematics

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Computer Software Application Programs to Do Mathematics

Computer Software Application Program (CSAP)

A CSAP is an information technology that tells the computer how to perform a task, specifically as an application.

To Do Mathematics

- The *doing of mathematics* is increasingly coming to be seen as a social and collaborative act (Schoenfeld, 1992), it is used for making sense of mathematics and developing a mathematical point of view.
- A technology is used to do mathematics when it is outsourcing work that could be done by hand (Drijvers, 2013)

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Common Core State Standard - Mathematical Practices

Standard 5: Use Appropriate Tools Strategically:
Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, **a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software**. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations... (NGACBP & CCSSO, 2010, p. 7)

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Geometric, Spreadsheet, Graphic, and Statistic CSAPs to Do Mathematics

Geometric CSAP

- geometry, statistics, and complex analysis courses
- visualization, exploration, and enthusiasm to learn geometry and statistics

Spreadsheet CSAP

- algebra and statistic courses
- transition (specific to general thinking), conceptual understanding, graphing, motivation to learn algebra and reduction of anxiety to learn statistics

Graphic CSAP

- precalculus, modeling and problem solving courses
- conceptual understanding, motivation, and reduction of tedious procedures

Statistic CSAP

- probability and statistics courses
- data manipulation, visualization, exploration, and discussion

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Research Gap

Research Gap

1. The CCSS recommends the use of *appropriate tools* to learn mathematics, and research has shown that the use of CSAP to do mathematics positively affects the mathematics achievement of students.
2. Little research has been done to explore the mathematics achievement of K-12 students in P.R. and no one have explored the relationship of the use of CSAP and mathematics achievement in P.R.
3. This study sheds light on the understanding of this relationship

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Design of the study

RQ:

How does the use of CSAPs to do mathematics by students relate to the 2015 NAEP Math scores of 8^{th} grade students in Puerto Rico?

- Large scale (Middleton, Cai, & Hwang, 2015)
- Non-experimental (Johnson, 2001)
- Quantitative (Creswell, 2011)

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NAEP Overview & Study Sample

- NAEP - Puerto Rico
  - Scale (0-500)
  - Variables
  - Spanish version of Math NAEP
  - 4^{th} & 8^{th} grades
  - Three time periods: 2003-2007, 2011-2015, & 2017-present
- NAEP Sampling
  - Multistage sampling
  - Nested structure of students within schools
- 2015 PR NAEP 8^{th} grade
  - Sample: 5100 - 8^{th} grade students from 120 public schools
- Restricted NAEP data

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Variables of Interest: Student Reported Variables

Output variable (dependent variable):

1. NAEP mathematics composite score (scale 0-500)

Input Variables (independent variables):

1. Variable of interest
   - use of CSAP
2. Controlling variables:
   - socioeconomic status
   - absenteeism

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Variables of Interest: Use of CSAP Reported by Students

When you are **doing math** for school or homework, how often do you use these different types of **computer programs**?

1. A spreadsheet program.
2. A graphing program to make charts or graphs.
3. A statistical program to calculate patterns such as correlations or cross tabulations.
4. A program to work with geometric shapes for math class.

Scale for use of CSAP questions

- Never or hardly ever
- Once every few weeks
- About once a week
- 2-3 times a week
- Every day or almost every day

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Controlling Variables

Socioeconomic status (SES)

Home possessions

- access to internet, clothes or dryer, dishwasher, more than one bathroom, and your own bedroom

Highest level achieved by either parent

- did not finished high school
- graduated high school
- some education after high school
- graduated college
- unknown

Absenteeism

Days absent at school during the last month

- none
- 1-2 days
- 3-4 days
- 5-10 days
- more than 10 days

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Data Analysis

1. Descriptive analysis
2. Data preparation
3. Check if there is a need for multilevel modeling
4. Use a two level cross-sectional multilevel model
   - Conditional models: (1) check the variation explained by the IUCP, and (2) add other control variables and check if they are reducing the variance of the model
   - Finalized model
   - Interpret final model

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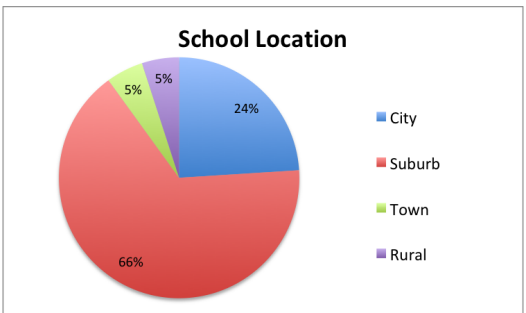
Results: Descriptive Analysis - Demographic variables

Puerto Rico characteristics:

- Race/ethnicity: Hispanic
- NSLP: Eligible
- School type: Public

Gender	%
Female	50
Male	50



SOURCE: U.S. Department of Education, National Center of Education Statistics, National Assessment for Educational Progress (NAEP) 2015 Mathematics Assessments, NAEP Data Tool.

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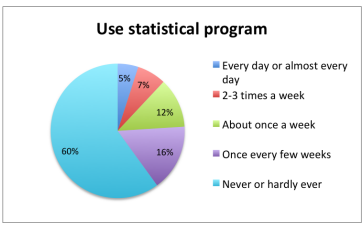
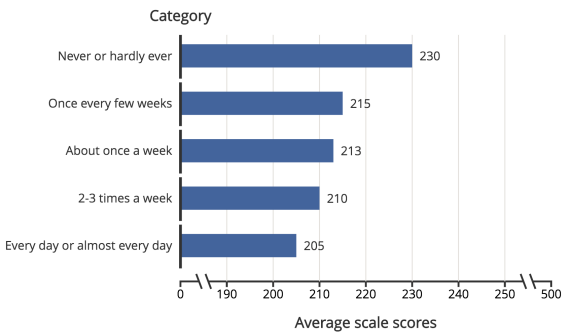
Results: Descriptive Analysis - Statistic CSAP



Average scale scores for grade 8 mathematics, by Use statistical program for math class [M816601] for jurisdiction: 2015, Puerto Rico



SOURCE: U.S. Department of Education, National Center of Education Statistics, National Assessment for Educational Progress (NAEP) 2015 Mathematics Assessments, NAEP Data Tool.

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Two-level Cross-sectional Multilevel Modeling: The Null Model

Null model (m_0)

student level: $NMS_{ij} = \beta_{0j} + e_{ij}$,

school level: $\beta_{0j} = \gamma_{00} + u_{0j}$,

where NMS_{ij} is the NAEP composite mathematics score and e_{ij} is the residual error for student i in school j. And u_{0j} is the residual error for the school j.

Intraclass correlation coefficient (ICC)

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Two-level Cross-sectional Multilevel Modeling: Conditional Models

Random intercept model (m_1)

student level: $NMS_{ij} = \beta_{0j} + \beta_{1j} IUCP_{ij} + e_{ij}$,
school level: $\beta_{0j} = \gamma_{00} + u_{0j}$,
$\beta_{1j} = \gamma_{10} + u_{1j}$,

Effect size of $IUCP$

Conditional model with all level one predictors (m_2)

student level: $NMS_{ij} = \beta_{0j} + \beta_{1j} IUCP_{ij} + \beta_{2j} IHP_{ij} + \beta_{3j} PARED_{ij} + \beta_{4j} IDAS_{ij} + e_{ij}$,
school level: $\beta_{0j} = \gamma_{00} + u_{0j}$,
$\beta_{1j} = \gamma_{10} + u_{1j}$,
$\beta_{2j} = \gamma_{20} + u_{2j}$,
$\beta_{3j} = \gamma_{30} + u_{3j}$,
$\beta_{4j} = \gamma_{40} + u_{4j}$,

Two-level Cross-sectional Multilevel Modeling: Finalized Model

Finalized model (m_3)

student level:

$$NMS_{ij} = \beta_{0j} + \beta_{1j} IUCP_{ij} + \beta_{2j} IHP_{ij} + \beta_{3j} PARED_{ij} + \beta_{4j} IDAS_{ij} + e_{ij},$$

school level:

$$\begin{aligned}
\beta_{0j} &= \gamma_{00} + \gamma_{01}\overline{IUCP_j} + \gamma_{02}\overline{IHP_j} + \gamma_{03}\overline{PARED_j} + \gamma_{04}\overline{IDAS_j} + u_{0j},\\
\beta_{1j} &= \gamma_{10} + \gamma_{11}\overline{IUCP_j} + u_{1j},\\
\beta_{2j} &= \gamma_{20} + u_{2j},\\
\beta_{3j} &= \gamma_{30},\\
\beta_{4j} &= \gamma_{40},
\end{aligned}$$

where NMS_{ij}, $IUCP_{ij}$, IHP_{ij}, $PARED_{ij}$, $IDAS_{ij}$, and e_{ij} are the NAEP scores, index for use of computers, index of home possessions, parental education, index for days absent at school, and the residual error respectively for student i in school j. And u_{kj} are the residual errors for school j.

Level one variable are group centered and level two variables are grand centered.

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Discussion of Results

Descriptive analysis:

- half of the students never or hardly ever used any CSAP to do mathematics

Multilevel modeling:

- IUCP and controlling predictors were significant in the model
- negative correlation (Kim & Chang, 2010)

NAEP variables:

- self-reporting on doing mathematics

NAEP policies for students:

- time and collaboration constraints during NAEP
- use of technology during NAEP

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Conclusion and Recommendation for Researchers

Conclusion:

- The use of computer programs and mathematics achievement of students in Puerto Rico is related: The average score of a school that has about one point of average above the overall average of $IUCP$ will have an average of NAEP math score less than schools meeting the average overall $IUCP$.

Recommendation for researchers:

- Quantitative research using different
  - factors
  - standardized assessment
  - grade level
  - populations
- Explore the “why” - quantitative or qualitative

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THANK YOU.

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