NC 1:1 Learning Technology Initiatives: Multi-Level Modeling Analysis of End-of-Course Tests

Jenifer O. Corn, Ph.D.
Ruchi K. Patel
Elizabeth Halstead
Friday Institute for Educational Innovation
NC State University College of Education

1:1 Laptop Initiatives

- Focus on using laptops for teaching and learning to meet goals
  - Increased equity of access to technology
  - Increased economic competitiveness
  - Enhanced home-school connection
  - Improved academic achievement

Agenda

- 1:1 laptop initiatives
- NCLTI evaluation
- Research methods
- Results
- Implications

1:1 Laptop Initiative Outcomes

- Mixed results
  - Improved attendance (Lane, 2003; Mills, 2006)
  - Improved engagement (Bell & Kay, 2010; Great Maine School Project, 2005)
  - Decreased disciplinary problems (Bebell, 2005)

1:1 Laptop Initiatives

- Recently, schools across the United States have implemented 1:1 laptop initiatives with the aim to develop future-ready students by aiding in the development of skills needed for college and the workforce, or 21st century skills
- Aim: develop future-ready students
  - 21st century skills
- Every student and teacher with a personal digital wireless device
  - Up-to-date software

1:1 Laptop Initiative

- Mixed results for learning outcomes
  - Positive (Bebell, 2005; Campuzano, Dynarski, Agodini, & Rall, 2009; Goldberg, Russell, & Cook, 2003; Hunter & Grewer-Rice, 2007; Jerski, 2003; Lowther, Ross, & Morrison, 2003; Mokhtari et al., 2010; Sclater et al., 2006; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Suhr, Hernandez, Grimes, & Warschauer, 2010; Warschauer, 2006; Weston & Bain, 2010)
  - Negative (Bebell & Kay, 2010; Corn, 2009)
NC LTI Evaluation

- **Focus**
  - Examine extent to which schools implemented 1:1 initiative strategies and achieved 1:1 project objectives (objective-oriented)
  - Improve teaching practices
  - Increase student achievement
  - Better prepare students for work, citizenship, and life in 21st century
  - Inform local and state decision-makers on future technology policy and funding (management-oriented)

Participants

- 18 pilot high schools across NC
  - 8 Early College
    - Teachers: 3 to 13
    - Students: 61 to 243
  - 10 traditional
    - Teachers: 30 to 84
    - Students: 378 to 1611
- Geographically and culturally diverse
- Participating schools rolled out projects between March 2007 and November 2009
- Non 1:1 Comparison schools similar in type, size, student demographics, and student achievement on prior year English and Algebra I test scores

Research Questions

- **RQ 1:** Do variables associated with a 1:1 initiative predict differences in individual learning outcomes?
- **RQ 2:** Does having a 1:1 initiative affect the percent of students deemed proficient in core subjects at the school level?

Methods

Participants

- 18 pilot high schools across NC
  - 8 Early College
    - Teachers: 3 to 13
    - Students: 61 to 243
  - 10 traditional
    - Teachers: 30 to 84
    - Students: 378 to 1611
- Geographically and culturally diverse
- Participating schools rolled out projects between March 2007 and November 2009
- Non 1:1 Comparison schools similar in type, size, student demographics, and student achievement on prior year English and Algebra I test scores

Research Questions

- **RQ 1:** Do variables associated with a 1:1 initiative predict differences in individual learning outcomes?
- **RQ 2:** Does having a 1:1 initiative affect the percent of students deemed proficient in core subjects at the school level?

- **RQ 1: Measures**
  - Individual learning outcomes
    - EOC tests estimate students’ knowledge of content-specific concepts
    - Multiple-choice
    - Reported as scale scores, standardized across all tests
    - Scale scores range 120 to 180
    - Algebra 1, Algebra 2, Geometry, Biology, English 1, Civics/Economics, US History
  - Variables associated with 1:1 initiative
    - Length of implementation
    - Number of months students had laptops when they took EOCs; for comparison schools = 0
    - Quality of implementation
      - Rated by research team based on observations of numerous indicators (infrastructure and technical support, curriculum and instruction, leadership, administration and instructional support, professional development)
    - Principal score
      - Rated by teachers on 5-point Likert-type agreement scale for several dimensions of leadership (vision, advocacy, professional development, shared decision making, infrastructure)
RQ 1: Measures

• Covariates typically associated with student performance
  – School-level: school type (EC or traditional), ABC distinction, percent of minority students, percent of students with economic disadvantage
  – Student-level: minority status, economic disadvantage status, disability status, grade enrollment, sex, 8th grade math and reading achievement

RQ 1: Fully-unconditional Model

• To ensure sufficient variability at both student and school levels for all EOC scores
• No predictors present

Level 1: EOC score: $y_{ij} = \beta_{0j} + r_{ij}$
Level 2: $\beta_{0j} = \gamma_{00} + u_{0j}$

RQ 1: Analysis

• Multi-level modeling
  – Nested data, students within schools
  – Unbalanced data, different sample sizes
  – Research question addresses school-level variables and their relationship with student-level outcomes
  – Aggregation to school-level and disaggregation to student-level are both inappropriate

Non-randomly Varying Slopes Models

• Allows both student- and school-level predictors
• Student-level slopes will be constrained, no theoretical rationale for allowing them to vary

RQ 1: Analysis

• Two sets of analyses
  – Compare influence of 1:1 initiative on EOC scores between 1:1 and non-1:1 schools
  – Determine influence of variables associated with 1:1 environments in only 1:1 schools

RQ 1: 1:1 vs Non-1:1 Schools

• Level 1:
  – EOC score: $y_{ij} = \beta_{0j} + \beta_{1j}(minority) + \beta_{2j}(economic\ disadvantage) + \beta_{3j}(grade) + \beta_{4j}(sex) + r_{ij}$
• Level 2:
  – $\beta_{0j} = \gamma_{00} + \gamma_{01}(length\ of\ implementation) + \gamma_{02}(school\ type) + \gamma_{03}(ABC\ distinction) + \gamma_{04}(percent\ minority) + \gamma_{05}(percent\ economic\ disadvantage) + u_{0j}$
  – $\beta_{1j} = \gamma_{10}$
  – $\beta_{2j} = \gamma_{20}$
  – $\beta_{3j} = \gamma_{30}$
  – $\beta_{4j} = \gamma_{40}$
  – $\beta_{5j} = \gamma_{50}$
RQ 1: 1:1 Schools Only

• Level 1:
  – EOC score_{ij} = \beta_0_{ij} + \beta_1_{ij}(minority) + \beta_2_{ij}(economic disadvantage) + \beta_3_{ij}(disability) + \beta_4_{ij}(grade) + \beta_5_{ij}(sex) + \epsilon_{ij}
• Level 2:
  – \beta_0 = \gamma_0 + \gamma_01(length of implementation) + \gamma_02(quality of implementation) + \gamma_03(principal score) + \gamma_04(school type) + \gamma_05(ABC distinction) + \gamma_06(% minority) + \gamma_07(% economic disadvantage) + \epsilon_{0i}
  – \beta_1 = \gamma_{10}
  – \beta_2 = \gamma_{11}
  – \beta_3 = \gamma_{12}
  – \beta_4 = \gamma_{13}
  – \beta_5 = \gamma_{14}

RQ 1: Results

• 1:1 vs Non-1:1 schools
  – Length of 1:1 implementation nonsignificant for all EOC test scores

RQ 1: Conclusions

• 1:1 initiative did not influence EOC scale scores at the individual student level
  – EOC test scores are an estimate of students’ knowledge of content-specific concepts aligned to NC Standard Course of Study
  – Measure content knowledge, not student learning skills

RQ 1: Results

• 1:1 schools only
  – No significant effects on students’ spring 2010 EOC scores based on
    • Length of 1:1 implementation
    • Quality of 1:1 implementation
    • Principal scores

RQ 1: Conclusions

• Focus group data from teachers
  – Requirements to prepare students for EOC exams may be limiting how teachers use laptops
  – First priority is getting through course content, not finding new and creative ways to integrate laptops into curriculum
RQ 1: Conclusions

- From other evaluation analyses
  - More than half of all 1:1 students surveyed agreed that use of laptops at their school helps them develop key 21st century learning skills

RQ 2: Measures

- Level 1 predictor
  - Months of implementation
- Level 2 covariates
  - School type (EC or traditional)
  - % minority students
  - % students receiving free or reduced lunch

RQ 2

- Does having a 1:1 initiative affect the percent of students deemed proficient in core subjects at the school level?
- RQ 1: Students within schools
- RQ 2: Time within schools

RQ 2: Measures

- Outcome
  - Percent of students proficient (passing) EOCs from 2007 to 2010
  - Algebra 1, Algebra 2, Biology, Civics, English 1, US History

RQ 2: Fully-unconditional Model

- No predictors present

Level 1: % proficient = \( \beta_{0j} + r_{ij} \)
Level 2: \( \beta_{0i} = \gamma_{00} + u_{0i} \)

RQ 2: Non-randomly varying slopes model

- Level 1:
  - % proficient\_ij = \( \beta_{0i} + \gamma_{01}(\text{length of implementation}) + r_{ij} \)
- Level 2:
  - \( \beta_{0i} = \gamma_{00} + \gamma_{02}(\% \text{ minority}) + \gamma_{03}(\% \text{ FRL}) + u_{0i} \)
  - \( \beta_{1i} = \gamma_{10} \)
RQ 2: Results

• Overall, schools with longer participation in the 1:1 initiative had a higher percentage of students passing the EOC exams ($p < .0001$)
• On average, each additional month of participation in the 1:1 initiative by schools suggested .37% more students passing the EOC exams

RQ 2: Results

• EC high schools had 9% more students passing the EOC exams than traditional high schools ($p = .0007$)
• Schools with a higher % minority students had fewer students passing exams ($p = .03$)

RQ 2: Results

• Interaction: schools with a higher % FRL students had a greater increase in the percent of students passing EOC exams with longer participation in the 1:1 initiative than schools with lower % FRL students

RQ 2: Results

• EC high schools had 9% more students passing the EOC exams than traditional high schools ($p = .0007$)
• Schools with a higher % minority students had fewer students passing exams ($p = .03$)

Algebra 1

• Length of participation in the 1:1 initiative
  – No effect on the percent of students passing the exam ($p = .22$)
• EC high schools had 14% more students passing the Algebra 1 EOC exam than traditional high schools ($p = .001$)
• Schools with a higher % minority students had fewer students passing exams ($p = .01$)

Algebra 2

• Length of participation in the 1:1 initiative
  – No main effect on the percent of students passing the exam ($p = .40$)
• Interaction
  – Schools with higher % FRL students had a greater increase in % students passing the Algebra 2 EOC exam with longer participation in the 1:1 initiative than schools with lower % FRL students.
Algebra 2

• Length of 1:1 participation
  – On average, each additional month of participation in the 1:1 initiative by schools suggested .35% more students passing the Biology EOC exam ($p = .02$)
  
• Schools with higher % FRL students had a lower percentage of students passing the exam ($p = .006$)
  
• EC high schools on average had 10% more students passing the Biology EOC exam than traditional high schools ($p = .001$).

Civics

• EC high schools had 11% more students passing the Civics EOC exam than traditional high schools ($p = .001$)
  
• Schools with higher % minority students had fewer students passing the exam ($p = .04$)

Biology

• Length of 1:1 participation
  – On average, each additional month of participation in the 1:1 initiative by schools suggested .35% more students passing the Biology EOC exam ($p = .02$)
  
• Schools with higher % FRL students had a lower percentage of students passing the exam ($p = .006$)
  
• EC high schools on average had 10% more students passing the Biology EOC exam than traditional high schools ($p = .001$).

US History

• Length of implementation
  – On average, each additional month of participation in the 1:1 initiative suggested .55% more students passing the exam ($p = .02$)

Civics

• Length of 1:1 participation
  – On average, each additional month of participation in the 1:1 initiative suggested .34% more students passing the exam ($p = .03$)

• Interaction
  – Schools with higher % FRL students had a greater increase in the percent of students passing EOC exams with longer participation in the 1:1 initiative than schools with lower % FRL students ($p = .07$)
English 1

• Length of implementation
  – No effect on the percent of students passing the exam ($p = .19$)
• EC high schools had 14% more students passing the English 1 EOC exam than traditional high schools ($p < .0001$)

RQ 2: Conclusions

• Overall, schools benefited from the 1:1 initiative with more students passing EOC exams.
  – Especially true for schools that had a higher % of students receiving free or reduced lunches.
• These results provide limited support for one general goal of the 1:1 initiatives—to reduce the digital divide
  – Percent of students receiving free or reduced lunch is one indicator of the economic makeup of students in a school.
  – Schools with more students receiving FRL may have benefited more from the laptops because students had access to educational resources they may not otherwise have had.

Recommendation

• Need for high-quality, valid assessments of 21st century skills
  • Leadership
  • Ethics
  • Personal productivity
  • Self-direction
  • Social responsibility
  • Adaptability and flexibility
  • Initiative and self-direction
  • Creativity and problem-solving
  • Cross-cultural skills
  • Communication
  • Information literacy
  • Collaboration

Selected References


Selected References


Selected References
