Data, Research, and Analytics: Career Education as Exemplar

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Nebraska Department of Education
2013 Data Conference
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Presentation Objectives

1. Realize the challenges in relying solely on federal accountability analyses
2. Identify the value in adopting and utilizing a CTE data diversification strategy
3. Gain practical analytic suggestions for diversifying CTE data analysis
The Power of Data

• “If the quality of life is to be improved in this modern world, its citizens must understand how to make sense out of numbers.”

– David A. Kenny

Statistics for the Social and Behavioral Sciences
The Power of Data

• Numbers are not important in and of themselves. (Kenny 1987)

• They are important because they help us make decisions. (Kenny 1987)

• Decisions can be made without numbers, but if the right numbers are used, in the right way, the quality of decisions can be improved. (Kenny 1987)
Perkins IV Secondary Accountability Performance Indicator Framework

This graphic represents the relationship between the Perkins Secondary Performance Indicators and the CTE Participants and CTE Concentrators.
Fractions of Subpopulations (6S1)

**Numerator:** Number of CTE participants from underrepresented gender groups who participated in a program that leads to employment in nontraditional fields during the reporting year.

**Denominator:** Number of CTE participants who participated in a program that leads to employment in nontraditional fields during the reporting year.
Fractions of Subpopulations (6S2)

**Numerator:** Number of CTE concentrators from underrepresented gender groups who completed a program that leads to employment in nontraditional fields during the reporting year.

**Denominator:** Number of CTE concentrators who completed a program that leads to employment in nontraditional fields during the reporting year.
2009-2010 Nebraska Career Education

12th Grade
Total Membership: 22,161

Grades 7-12
Total Membership: 129,759

Nebraska Fall Membership
6S2: Nontraditional Completion

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6S2 Numerator
6S2 Denominator
10-11 Postsecondary Average Performance Performance

- Average Performance Level
- State Goal
Challenges

1. Like many accountability frameworks, this system *becomes* the mechanism for understanding and evaluating CTE student performance/learning
   - “Performance” indicators
   - But, performance relative to what?
     • an arbitrary state goal
   - Tail wagging the dog?
Challenges (continued)

2. Force an accountability system into a dual-purpose role:
   – Accountable for a federal investment
   – Assessment of student learning/outcomes
     • But these are not the same thing – or at least it is quite challenging and costly to develop such a system
Challenges (continued)

3. Thus, we judge the success or failure of CTE student learning/outcomes based on an *accountability* system designed by policymakers for, perhaps, a very different purposes

– And, because Perkins IV is the product of a legislative process, these policy objectives – while well intentioned – may not be fully coherent in practice
Data as Power?

• Do these accountability measures help us:
  – Make decisions about CTE?
  – Improve the quality of our decisions?

• Too often, we limit our use of education data to accountability purposes only.

• To enhance the quality of our decisions - more than numbers - diversify analytic strategies beyond the federal accountability framework.
Data Use Beyond Accountability

• Descriptive Analyses
  – Measures of Central Tendency
    • Mean, Median, Mode
  – Measures of Dispersion
    • Variance, SD, IQ Range
  – Measures of Association
    • Correlations
    • Probabilities
    • Odds Ratios
    • Relative Risk Ratios

• Inferential Analyses
  – Testing of Models
    • Linear Regression
    • Generalized Linear Model
    • Path and Structural Equation Models
Descriptive Analyses

• Measures of Central Tendency
  – Mean, Median, Mode
  – Used to identify the “typical” value and represents all numbers
  – Two major uses:
    • Simplification
      – knowing the average number as opposed to all numbers in a data vector
    • Prediction
      – Knowing the average score for previous years for next year
Descriptive Statistics: Average ACT Composite Score
By Participation | Career Field Status

2010-2011 Nebraska Career Education

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Descriptive Statistics: Average ACT Composite Score
By Concentrator | Career Field Status

2010-2011 Nebraska Career Education

Non-Concentrators
Concentrators
AGFNRS
ARCCON
AVCOMM
BUSMGT
EDUCAT
FINANC
GOVTPA
HEALTH
HSPTOR
HUMAN
INFOTE
LPSSC
MANUFA
MARKET
STEM
TDWL

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Descriptive Analyses

• Measures of Association
  – Is there a relationship between two variables?
    • For our purposes, often these are nominal variables
    • That is, a situation where each person is a member of a discrete category as opposed to each person receiving a numeric score
      – Is Career Education Status related to dropout status?
        » Participant – Non-Participant
        » Concentrator – Non-Concentrator
        » Dropout – Non-Dropout
Hypothetical Example

• The Contingency Table
  – AKA cross tabulation or “cross tabs”
  – For example, consider 100 students and their dropout statuses

<table>
<thead>
<tr>
<th></th>
<th>Non-Dropout</th>
<th>Dropout</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Concentrator</td>
<td>20</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Concentrator</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>
Risk or Probability

*But, the probability of dropout varies as a function of CTE Concentration status*

<table>
<thead>
<tr>
<th></th>
<th>Non-Dropout</th>
<th>Dropout</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Concentrators</td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td>Concentrators</td>
<td>c</td>
<td>d</td>
<td>c+d</td>
</tr>
</tbody>
</table>

**Probability that a student drops out**

\[
\text{Probability that a student drops out} = \frac{b + d}{n} = 0.60
\]

**Probability a Concentrator drops out**

\[
\text{Probability a Concentrator drops out} = \frac{d}{c + d} = 0.50
\]

**Probability a Non-Concentrator drops out**

\[
\text{Probability a Non-Concentrator drops out} = \frac{b}{a + b} = 0.67
\]
*Again, the odds of dropout varies as a function of CTE Concentration status.*

<table>
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<td>c</td>
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\[
\text{Odds a student drops out} = \frac{b + d}{a + c} = 1.5
\]

\[
\text{Odds a Concentrators drops out} = \frac{d}{c} = 1
\]

\[
\text{Odds a Non-Concentrators drops out} = \frac{b}{a} = 2
\]
Interpretation

• The difference is in the denominator
  – As a result, this influences the interpretation of these statistics

• Risk Interpretation
  – On average, concentrators drop out of school about 50% of the time
  – On average, non-concentrators drop out of school about 67% of the time
  – On average, students drop out of school about 40% of the time
Interpretation (cont.)

• Odds Interpretation
  – The odds of a concentrator dropping out of school is 1:1
  – The odds of a non-concentrator dropping out of school is 2:1
  – The odds of a student dropping out of school is 1.5:1

• Probabilities are relatively straightforward to understand while odds can be a bit more tricky
The Value of Ratios

• We are generally interested in ratios as opposed to probabilities or odds alone
  – Relative Risk (Probability) Ratios
  – Odds Ratios

• Hypothetical research question:
  – Are concentrators at greater risk of dropping out of school than non-concentrators?
    • Relative Risk – divide probability of concentrators by non-concentrators
    • Odds Ratio – divide odds for concentrators by non-concentrators
### Risk or Probability Ratios

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<td>c</td>
<td>d</td>
<td>c+d</td>
</tr>
<tr>
<td>a+c</td>
<td>b+d</td>
<td>n=a+b+c+d</td>
<td></td>
</tr>
</tbody>
</table>

Risk (Probability) Ratio of concentrator dropping out

\[
\frac{\frac{d}{c + d}}{\frac{b}{a + b}}
\]

= 0.75 or 1.34 (reciprocal)
### Odds Ratio

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<td>b+d</td>
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**Odds Ratio of concentrator dropping out**

\[
\text{Odds Ratio} = \frac{d}{b} = \frac{a+c}{b+d} = 0.50 \text{ OR } 2 \text{ (reciprocal)}
\]
Interpretation (cont.)

- **Risk (Probability) Ratio**
  - Concentrators are 0.75 time as likely to drop out of school than non-concentrators, or put another way
  - Non-concentrators are 1.34 as likely to drop out of school than concentrators (reciprocal)

- **Odds Ratio**
  - But we CANNOT say that non-concentrators are 2 times as likely to drop out of school
  - More accurately, the odds of dropping out of school are 2 times greater for non-concentrators relative to concentrators
Interpretation (cont.)

- For every non-concentrator not dropping out of school, 1.34 times as many non-concentrators will drop out than the number of concentrators.

- For most, risk (probability) ratios tend to be more straightforward to interpret than odds ratios.

- A value of 1.0 means no difference between groups for both risk and odds ratios.
  - Ratios less than 1.0 mean that being in the selected group decreases the risk/odds of experiencing the outcome.
  - Ratios greater than 1.0 mean that being in the selected group increases the risk/odds of experiencing the outcome.
Descriptive Statistics: CTE Students
Participants and Concentrators

63% of Nebraska students Grades 7-12 are CTE Participants

34% of Nebraska High School Seniors are CTE Concentrators
Descriptive Statistics: Gender
Concentrators vs. All High School Seniors

+5%  -5%
Descriptive Statistics: Ethnicity
Concentrators vs. All High School Seniors

- American Indian or Alaska Native: 1%
- Asian: 2%
- Black or African American: 5%
- Hispanic/Latino: 6%
- Two or More Races: 2%
- Native Hawaii or Other Pacific Islander: <1%
- White*: 10%

*not shown

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Descriptive Statistics: Immigration Status
Concentrators vs. All High School Seniors

3% vs. 3.8%
Descriptive Statistics: Food Program Eligibility
Concentrators vs. All High School Seniors
17% of all High School Seniors and CTE Concentrators are eligible for Gifted Programs.

Descriptive Statistics: Gifted Eligibility
All High School Seniors vs. Concentrators

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Descriptive Statistics: Gifted Eligibility
Concentrators vs. Non-Concentrators

Odds Ratio = \frac{0.196}{0.206} = 1.1

The odds of being eligible for gifted programs are 1.1 times greater for CTE Concentrators than Non-Concentrators.
33% of CTE Concentrators take AP or Honors Courses

Whereas 26% of all High School Seniors take AP or Honors Courses

Descriptive Statistics: AP or Honors Courses
Concentrators vs. All High School Seniors
The odds of participating in AP or Honors Courses are 1.6 times greater for CTE Concentrators than Non-Concentrators.

\[
\text{Odds Ratio} = \frac{0.485}{0.295} = 1.6
\]

Descriptive Statistics: AP or Honors Courses Concentrators vs. Non-Concentrators
0.4% of students grades 7-12 participating in Career Education dropped out of school.

Compared to

2.9% of students grades 7-12 not participating in Career Education.

Overall, 1.3% of all Nebraska students grades 7-12 dropped out of school.

Descriptive Statistics: Dropouts
Non-Participants, All Students Grades 7-12, Participants
Odds Ratio = \frac{0.03}{0.004} = 7.4

Descriptive Statistics: Dropouts
Non-Participants vs. Participants

The odds of being classified as a dropout are 7.4 times greater for students not participating in CTE than CTE Participants.
0.98% of students in grade 12 concentrating in Career Education dropped out of school.

Compared to

4.83% of students in grade 12 not concentrating in Career Education.

Overall, 3.52% of all Nebraska students in grade 12 dropped out of school.

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Descriptive Statistics: Dropouts
Non-Concentrators, All Students Grade 12, Concentrators
The odds of being classified as a dropout are 5.1 times greater for students not concentrating in CTE than CTE Concentrators.

\[
\text{Odds Ratio} = \frac{0.051}{0.01} = 5.1
\]

Descriptive Statistics: Dropouts
Non-Concentrators vs. Concentrators
Descriptive Statistics: Completer with Diploma
All High School Seniors vs. Concentrators

82% of Nebraska high school seniors completed an approved program of study and met district/system requirements for a high school diploma.

99% of CTE Concentrators completed an approved program of study and met district/system requirements for a high school diploma.

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The odds of completing an approved program of study and meeting district/system requirements for a high school diploma are 25.6 times greater for CTE Concentrators than students not concentrating in CTE.

\[
\text{Odds Ratio} = \frac{72.09}{2.81} = 25.6
\]

Descriptive Statistics: Completer with Diploma Concentrators vs. Non-Concentrators
Data Use Beyond Accountability

- Descriptive Analyses
  - Measures of Central Tendency
    - Mean, Median, Mode
  - Measures of Dispersion
    - Variance, SD, IQ Range
  - Measures of Association
    - Correlations
    - Probabilities
    - Odds Ratios
    - Relative Risk Ratios

- Inferential Analyses
  - Testing of Models
    - Linear Regression
    - Generalized Linear Model
    - Path and Structural Equation Models
Inferential Analyses

• Binomial Logistic Regression
  – An extension of the generalized linear model
  – Used to predict a discrete, dichotomous (takes the form of two categories) dependent variable
    • Dropout – Not a Dropout
  – Utilizes the logit link function:
    • $g(x) = \log(x/(1-x))$
  – Parameter estimation produced via maximum likelihood estimation
Inferential Analyses: Dropouts

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTE Participant (No)</td>
<td>2.002***</td>
<td>0.0589</td>
<td>7.405</td>
</tr>
<tr>
<td>Constant</td>
<td>-5.520***</td>
<td>0.0528</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

Note: $n = 142,570$, LR chi squared = 1541.38***, df = 1, *$p < .05$. **$p < .01$. ***$p < .001$

Predicted Logit (Dropout=1) = $\alpha + \beta_1 \times $ CTE Participant Status

Relative to CTE Participants, the odds of being classified as a dropout are 7.405 times greater for students NOT participating in Career Technical Education.
<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef.</th>
<th>SE</th>
<th>OR</th>
<th>Predictor</th>
<th>Coef.</th>
<th>SE</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTE Participant (No)</td>
<td>0.577***</td>
<td>0.0781</td>
<td>1.781</td>
<td>Single Parent</td>
<td>0.517***</td>
<td>0.1478</td>
<td>1.677</td>
</tr>
<tr>
<td>Female</td>
<td>-0.330***</td>
<td>0.0635</td>
<td>0.719</td>
<td>Food Program</td>
<td>-0.422***</td>
<td>0.0671</td>
<td>0.656</td>
</tr>
<tr>
<td>Days Membership</td>
<td>0.02***</td>
<td>0.0013</td>
<td>1.02</td>
<td>Free Meals</td>
<td>-0.387**</td>
<td>0.1469</td>
<td>0.679</td>
</tr>
<tr>
<td>FTE Percent</td>
<td>0.036***</td>
<td>0.0064</td>
<td>1.036</td>
<td>Reduce Meals</td>
<td>-0.387**</td>
<td>0.1469</td>
<td>0.679</td>
</tr>
<tr>
<td>AP or Honors Participant</td>
<td>-0.983***</td>
<td>0.1697</td>
<td>0.374</td>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEP Eligible</td>
<td>0.410***</td>
<td>0.1483</td>
<td>1.507</td>
<td>Asian</td>
<td>-0.465</td>
<td>0.2726</td>
<td>0.628</td>
</tr>
<tr>
<td>Gifted Participant</td>
<td>-0.781***</td>
<td>0.2592</td>
<td>0.458</td>
<td>Black</td>
<td>0.231*</td>
<td>0.0992</td>
<td>1.26</td>
</tr>
<tr>
<td>Imigrant</td>
<td></td>
<td></td>
<td></td>
<td>Hispanic</td>
<td>0.331***</td>
<td>0.0828</td>
<td>1.393</td>
</tr>
<tr>
<td>&lt; 1 Year</td>
<td>0.277</td>
<td>0.2791</td>
<td>1.319</td>
<td>Multiple</td>
<td>-0.203</td>
<td>0.202</td>
<td>0.817</td>
</tr>
<tr>
<td>&lt;=1 Year &gt;= 3 Years</td>
<td>0.706**</td>
<td>0.2605</td>
<td>2.027</td>
<td>Pacific Islander</td>
<td>-0.268</td>
<td>0.752</td>
<td>0.767</td>
</tr>
<tr>
<td>&gt; 3 Years</td>
<td>0.222</td>
<td>0.1615</td>
<td>1.248</td>
<td>American Indian</td>
<td>0.085</td>
<td>0.1514</td>
<td>1.089</td>
</tr>
<tr>
<td>Homeless</td>
<td>0.611***</td>
<td>0.1603</td>
<td>1.843</td>
<td>Grade Level</td>
<td>0.6794***</td>
<td>0.0258</td>
<td>1.973</td>
</tr>
<tr>
<td>Days Attendance</td>
<td>-0.049***</td>
<td>0.0015</td>
<td>0.952</td>
<td>Constant</td>
<td>-12.338***</td>
<td>0.7035</td>
<td>4.383</td>
</tr>
</tbody>
</table>

Note: n = 137,478, LR chi squared = 6662.88***, df = 22, *p < .05. **p < .01. ***p < .001
Conclusion

• Understand the realities of the Federal CTE accountability framework, including the benefits and drawbacks
• Recognize the value in adopting diverse data analytic strategies
• Gain practical suggestions for diversifying CTE data analyses to include larger populations of students
For more information, please contact:

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http://www.education.ne.gov/NCE/DRAW/index.html