Using Stata for Educational Accountability & Compliance Reporting

Stata Conference 2014
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July 31, 2014
Overview

1. Background
   - New Legislation
   - Old System

2. The Challenge
   - Development Timeline
   - Evolving Requirements/Rules
   - Data Management/Architecture

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   - MegaReporting = \( \LaTeX \) + Bash

4. The Outcome

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The catalyst for the work

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- The State Board of Education (SBE) convened a task force to define the components of the accountability system model, weighting of the components, how student growth would be determined, and to set thresholds for performance labels
The catalyst for the work
(continued)

- This led to two distinct scales:

- A scale for schools/districts without a secondary/high school graduating class,
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  - A scale for schools/districts with a secondary/high school graduating class
- And started a process of programming a new system from the ground up as well as reverse engineering parts of the legacy code base
- In order to provide information to the public, a “prototype” had to be developed in a period of roughly 30 days
In the beginning... there was some other analytic software

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- First accountability system development occurred from 1985–1991 with four dedicated staff
- From that point until 2012, there was always a dedicated team of four or more staff that was a blend of information systems (e.g., SQL developers), information tech (e.g., networking/server maintenance), and 1 SAS user
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- In 2013 there were no staff available/able to run the myriad SAS scripts and manage the numerous output files; the original designer was contracted to run the former system.
In the beginning... (continued)

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<tr>
<th>Area</th>
<th># Scripts</th>
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<tbody>
<tr>
<td>Growth</td>
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- Data acquisition involved processing raw assessment files from test vendors, running a variety of stored procedures/function calls on a large Oracle database, and retaining/using archived SAS datasets.
Stata to the rescue

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Given the set of rules/operational definitions, it seemed like it would be fairly feasible; then we started working with the data and getting reminders about existing SBE and federal policies that also needed to be incorporated into the design.
Mutually Exclusive Completely Exhaustive (MECE) operational definitions

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Additional challenges regarding the handling of special cases of student scores would have reduced sample sizes to the point where any estimates would have been highly unstable.
MECE (continued)

Student ID | District ID | School ID | Date       | Code
-----------|-------------|-----------|------------|-----
000123456  | 0001        | 020       | 09aug2013  | E1  
000123456  | 0001        | 024       | 19aug2013  | E1  
000123456  | 0001        | 020       | 10sep2013  | T2  
000123456  | 0002        | 016       | 20oct2013  | E4  
000123456  | 0001        | 024       | 20oct2013  | T3  
000123456  | 0002        | 016       | 13apr2014  | T8  

- Codes beginning with an E represent different classifications of enrollments
- Codes beginning with a T represent different classifications of transfers
- For the original prototype, these data were originally stored in a wide format in the same flat file/table as the assessment data
- In cases like the first three observations, there was no way to determine when to close the enrollment window without making assumptions about which data were “true” and/or “correct” and which were not
- Since the first file submission from districts covers August and September, there isn’t a good/clean way of reconciling the records when they enter the data system without substantial time/effort that would have a negative effect on system performance
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Dealing with Time Variant and Time Invariant Data simultaneously

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- To work around this, many states have adopted a “banking” model where the associated score on the high school assessment is “deposited” until the student is in the 10th grade and “withdrawn” for application.
- Some data elements (e.g., enrollment/transfer records, monthly enrollment histories, etc...) were best suited for a “long” file format, while the assessment data were easier to store in a “wide” format.
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- Full Academic Year data was originally stored in wide format as part of the dataset that contained student assessment data; now this part of the process can be implemented independently of the other data.
- Graduation rate computations were included; this includes managing the 150+ files distributed to each of the school districts to validate and verify the data and make any appeals/submit documentation to update records (made easier by the UCLA Stats Consulting Group’s FAQ pages).
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  - Since the information systems office began sharing their code, I’ve been able to modify the SQL queries to implement the naming conventions and type casting on the back-end; unfortunately date and datetime fields imported from odbc load still need a little clean up
How Things Look Now

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EdAccountability
How Things Look Now

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mde_import
Data System Connectivity

- A utility program that uses odbc to pull data from a large student information system
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More importantly, however, is that this program labels all of the variables, adds value labels where appropriate/necessary, and creates a checksum that can be used to ensure the estimates can be replicated and validated independently
mde_fay
Calculating Full Academic Year Status

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  `ted(28apr2014) fbed(01dec2013)`
  `sbsd(01feb2014)` and 2 minutes later and full academic year (FAY) determinations were made for 500,000 + students at the state, district, and school levels for full year, fall semester, and spring semester
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Creating Rule-Based Composite Variables
mde_page, mde_fayvars, & mde_growvars

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Additionally, because students can take concurrent courses on differing schedules (e.g., full year, fall/spring semester), we needed a way to correctly determine whether FAY was satisfied for the individual subject areas.
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**mde_fayvars** checks student course schedule types and builds new variables that select the appropriate FAY district and school ID values for each subject area.
Creating Weights
mde_profvars & mde_onepercent

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- **mde_onepercent rla mth sci, district(dist)**
  - estimates the proportion of these students scoring proficient or above and defines a weight \( \frac{1}{\%\text{Proficient/Above}} \times 0.01 \) to impose a ceiling of 1%
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Weighted Transitional Probabilities

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- mde_growvars builds a dataset containing scaled score cut points and uses a combination of `merge m:1` and the `cond()` function to recode proficiency levels from 4 to 6 values.
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To identify the lowest quartile in literacy and numeracy domains, the state adopted a definition that would combine ranking and proportion methods to define the students in the lowest 25% in academic performance in the school.

\[ \text{ceil}(N \times 0.25) \]

is used to identify the position of the student within a subject, grade, and school/district whose score is used for the membership threshold.

mde_low25 rla mth, district(dist) school(sch) implements these rules and creates indicator variables for the students.
Proportion/Order-Based Classifications
mde_low25

- As the US Department of Education’s policy focus shifted under President Obama’s administration, an increase emphasis on defining sub-group membership based on performance emerged.
- To identify the lowest quartile in literacy and numeracy domains, the state adopted a definition that would combine ranking and proportion methods to define the students in the lowest 25% in academic performance in the school.
- \( \text{ceil}(N \times .25) \) is used to identify the position of the student within a subject, grade, and school/district whose score is used for the membership threshold.
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ADO Files !!!
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Data Management and Rule Implementation
Calculations
MegaReporting = \LaTeX2ε + Bash

The Outcome

Where to go from here

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`ceil(N * .25)` is used to identify the position of the student within a subject, grade, and school/district whose score is used for the membership threshold.

`mde_low25 rla mth, district(dist) school(sch)` implements these rules and creates indicator variables for the students.

EdAccountability
Status
mde_proficiency

- The proficiency calculations are a combination of weighted/unweighted proportions based on the weights created by the mde_onepercent program.
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mde_proficiency rla mth sci his, district(dist) school(sch) disfile(district_proficiency) schfile(school_proficiency) would generate all of the proficiency values for each of the four subject areas at the state, district, and school levels.
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- Although not included in the original design/build, the current version of the program includes an option amovars that is used to create all of the result sets require for federal reporting of Annual Measurable Objectives
The growth program is structured similar to the proficiency program, but includes a substantial increase in the number of available options.
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Because the lowest 25% membership is only used in growth calculations, this program includes options to specify each of the group identifiers for their respective subject areas, as well as state, district, and school identifiers to aggregate the data properly.
Files are distributed to each of the 150+ districts across MS to verify and validate students’ final status as graduates, still enrolled, dropouts, or other completers.
Graduation & Dropout Rates
mde_grads & mde_gradfiles

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- mde_gradfiles builds a file list of these files and automates importing, converting, and combining them into a single Stata dataset; it also adds variable and value labels and does some other associated housekeeping along the way.

Where to go from here
Graduation & Dropout Rates
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- mde_gradfiles builds a file list of these files and automates importing, converting, and combining them into a single Stata dataset; it also adds variable and value labels and does some other associated housekeeping along the way
- Even with the file created from the output of the program above, we still need to manage monthly enrollment records and the official information stored in the information systems

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Even with the file created from the output of the program above, we still need to manage monthly enrollment records and the official information stored in the information systems.

mde_grads can call mde_gradfiles to build the file above; import, clean, and merge the two other distinct data sources; compute the rates; and accept a do file as an argument to implement changes from the appeals process as well as adding characteristics into the dataset to document the change to each variable for each appeal and add a label identifying the school the filed the appeal.
Combining the results and assigning letter grades
mde_grades

- The final step before creating the reports is the assignment of performance classifiers to schools and districts.

Where to go from here
Combining the results and assigning letter grades

mde_grades

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- This phase in the overall workflow is also where “pseudo-imputation” is used to provide component scores for schools without sufficient data (e.g., < 10 Students) using the results for the district.
Combining the results and assigning letter grades

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In this phase a scale linking occurs for special cases of primary grade schools that do not have science assessment results.

A recent addition to this program — at the request of a district superintendent — is adding percentile rankings for each component score to the output file; the results are also classified into quintiles which are used to define fill colors for cells in the reports.
Visualizing Comparisons for Schools, LEAs, & the Public

mde_graphs

- Anyone who has looked at data viz in educational reporting has almost definitely witnessed massive abuse of bar graphs for longitudinal data.
Visualizing Comparisons for Schools, LEAs, & the Public

mde_graphs

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And when we solicited feedback from a group of district administrators, added to the number of graphs to meet the requests.

However, some folks weren’t immediately comfortable with scatter plots, so I also created a short animated graph using Stata and ffmpeg (thanks to the tutorial developed by R. Grant) that provides an over simplified way of reading scatter plots.
Visualizing Comparisons for Schools, LEAs, & the Public
Proficiency Example

Reading Language Arts and Mathematics Proficiency

- Other MS Schools
- Other Schools in District
- School of Interest

Red Lines Indicate the State's Performance.
For Example Purposes Only
All Data Are Simulated for Illustration Only
Visualizing Comparisons for Schools, LEAs, & the Public

Growth Example

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The Outcome

Where to go from here

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Visualizing Comparisons for Schools, LEAs, & the Public
Low 25% Student Growth Example

2012-2013 Growth:
Low 25% Students

- Other MS Schools
- Other Schools in District
- School of Interest

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Visualizing Comparisons for Schools, LEAs, & the Public
Proficiency v Growth Example

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Proficiency vs Growth:
Reading Language Arts

- Other MS Schools
- Other Schools in District
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Proficiency vs Growth:
Reading Language Arts

Other MS Schools
Other Schools in District
School of Interest

Reading Language Arts:
Proficiency Points

Reading Language Arts:
Growth Points Low 25% Students

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EdAccountability
July 31, 2014
Due to a combination of limited access and familiarity with Crystal Reports, I also had to develop a solution for our reporting needs.
Homemade \LaTeXMail Merge

mde_reports

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- To make the values of the component scores more informative, we created quintiles for each component score and used the quintiles to define the fill colors for the cells.
- mde_reports reads the result set data file and uses a Bash script that is optionalled called by \LaTeX to compile the .tex files and remove all of the ancillary files after compilation.

Where to go from here...
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\texttt{mde\_reports} reads the result set data file and uses \texttt{file} to write the \LaTeX\ and write a Bash script that is optionalled called by \texttt{shell} to compile the .tex files and remove all of the ancillary files after compilation.
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Data Architecture for Stata

The Outcome
Where to go from here

The colors above indicate in which quintile the individual component is in compared to other schools in the MS Statewide Accountability System.
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Where to go from here

Homemade $\LaTeX$Mail Merge
Schools/Districts without a 12th Grade Example

<table>
<thead>
<tr>
<th>SCHOOL NAME HERE</th>
<th>DISTRICT NAME HERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade: <strong>C</strong></td>
<td></td>
</tr>
<tr>
<td>Total Points: <strong>418</strong></td>
<td></td>
</tr>
<tr>
<td><strong>READING</strong></td>
<td><strong>MATHEMATICS</strong></td>
</tr>
<tr>
<td>PROFICIENCY</td>
<td>49.5</td>
</tr>
<tr>
<td>GROWTH ALL STUDENTS</td>
<td>65.9</td>
</tr>
<tr>
<td>GROWTH LOW 25%</td>
<td>74.1</td>
</tr>
</tbody>
</table>

The colors above indicate in which quintile the individual component is in compared to other schools in the MS Statewide Accountability System.

EdAccountability
July 31, 2014
Efficiency Gains from Stata
Comparing the code bases

<table>
<thead>
<tr>
<th>Area</th>
<th># Scripts</th>
<th># Data Files</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>32</td>
<td>80</td>
</tr>
<tr>
<td>Graduation Rates</td>
<td>23</td>
<td>75</td>
</tr>
<tr>
<td>AYP†</td>
<td>81</td>
<td>119</td>
</tr>
<tr>
<td>ESEA (Federal Law)</td>
<td>16</td>
<td>22</td>
</tr>
</tbody>
</table>

† Various aggregated proportions of achievement levels/participation rates on standardized tests

- The process of estimating growth previously required the use of 32 static SAS Scripts; Now ... it is completed with 1 .ADO file.
- Graduation Rates previously used 23 static SAS Scripts; Now ... it can be completed with 2 .ADO files.
- Proficiency/Participation Rate Measures used > 50 Scripts previously. Now ... it is completed with 2 .ADO files.
Efficiency Gains from Stata  
(continued)

- In addition to reducing the code base, the use of ADO files should also reduce long term maintenance (so long as the rules don’t change)
- The migration also gives the agency the flexibility to deploy open sourced toolkits developed by the Strategic Data Project http://www.gse.harvard.edu/sdp/resources/toolkit.php for measuring and leveraging existing data to drive human capital policies/practices as well as inform policies, practices, and program development to support college and career readiness goals
Ease of use for additional end-users
Menu/Dialog Driven Interface

- Although Stata may be user friendly to folks accustomed to working in the Stata environment, scripting languages can often be intimidating for many folks in the education sector whose only experience with analytic software is Some Program for Some Statistics and/or spreadsheet-based programs.

- While dialog programming in Stata may not be the easiest, creating menu driven systems can make the interface more welcoming to novice users.

- Stata is also still fairly new to the education sector in general and many graduate training programs in education tend to favor Some Program for Some Statistics even though it is a less robust platform for analysis and development.
Since a few of the operations take several minutes to run, it would be great to push some of the computations into Mata

Currently working on refining the SQL codebase to force queries to return SIF values for date fields (e.g.,
\[
\text{TO\_NUMBER(TO\_DATE('09012014', 'MMDDYYYY') - TO\_DATE('01jan1960', 'DDmmmYYYY'))} = 19967
\]
) to reduce cleaning/formatting operations on the Stata side of things

Because of the tight development timeline, the majority of the code took the “brute force” approach so there are likely to be numerous opportunities for code optimization
One of the biggest runtime efficiency challenges is in graph creation

Currently all of the graphs are static, but I’m hoping that I’ll learn enough about `stata2d3` during the conference to change that a bit more

I also hope to better integrate tools like QGIS and/or `spmap` (Available from SSC) to develop data products for public consumption
Training additional end-users

- Used some of the existing examples of building .smcl-based presentations as a starting point
- Replaced nearly all code with hypertext to reduce end-users’ anxiety of script-based software and allow them to get an idea of what the software is capable of without having to learn to code first
- After some initial participant feedback, added two sub-routines that would allow users to fetch data sets created with aisa (Written by S Kolenikov) and a routine that would launch video tutorials in Stata