ANALYSIS OF STATE OF CS EDUCATION POLICIES, SUCCESS METRICS, AND ECEP CAPE FRAMEWORK
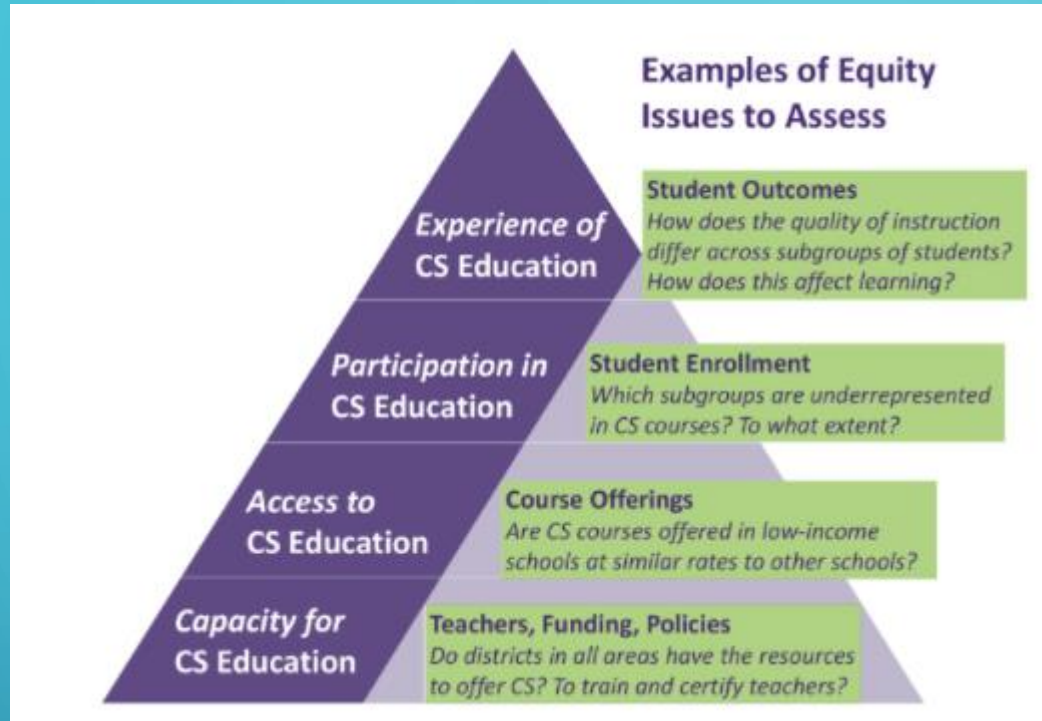
LAWRENCE TANIMOTO

ECEP CAPE Framework

Examples of Equity Issues to Assess
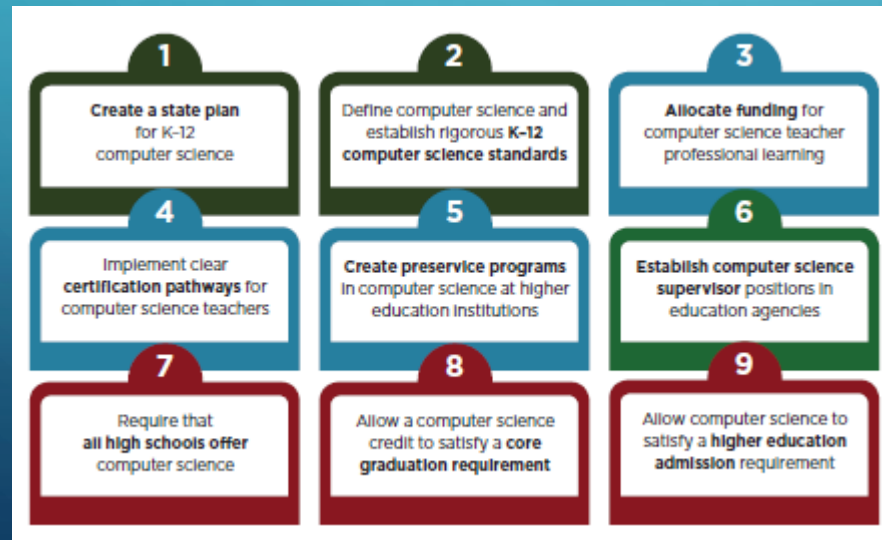
Experience of CS Education
Student Outcomes
How does the quality of instruction differ across subgroups of students? How does this affect learning?

Participation in CS Education
Student Enrollment
Which subgroups are underrepresented in CS courses? To what extent?

Access to CS Education
Course Offerings
Are CS courses offered in low-income schools at similar rates to other schools?

Capacity for CS Education
Teachers, Funding, Policies
Do districts in all areas have the resources to offer CS? To train and certify teachers?

Code.org Pro-CSEd Policies

1. Create a state plan for K–12 computer science
2. Define computer science and establish rigorous K–12 computer science standards
3. Allocate funding for computer science teacher professional learning
4. Implement clear certification pathways for computer science teachers
5. Create preservice programs in computer science at higher education institutions
6. Establish computer science supervisor positions in education agencies
7. Require that all high schools offer computer science
8. Allow a computer science credit to satisfy a core graduation requirement
9. Allow computer science to satisfy a higher education admission requirement

AP CS Info

% of Students Enrolled in Foundational CS

% of Students in HS with CS

% HS with Foundational CS

Number of Pro-CSEd Policies Implemented

OBJECTIVES

- Better understand of the success metrics in 2021 State of CS Ed Report

- Understand how success at lower layers in CAPE affect higher layers

- Understand which policies are most effective at improving success metrics

- Suggest improvements to what policies to promote, success metrics to track

2021 State of CS Education report focuses on what policies have been implemented by which states and the % of high schools have a foundational CS course success metric. This report analyze data collected for the report but not necessarily highlighted and tries to add value and understanding

SUCCESS METRIC SUMMARY

	# of Policies	% of HS with FCS	% Students in HS w/ CS	% Students Enrolled in FCS
State Avg	5.16	57.4%	77.6%	4.9%
State Std Dev	2.42	17.7%	11.9%	3.3%
National Avg	5.48	51.3%	77.7%	4.7%
States w/Data	51	51	51	36

State Avg is average where each state has equal weight
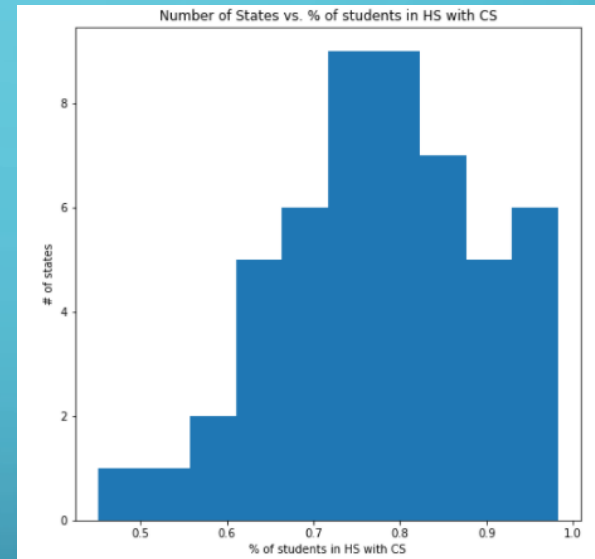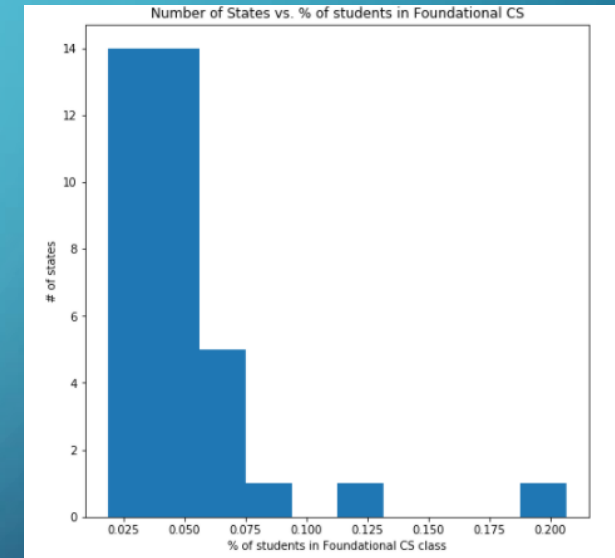National Avg is average weighted by number of schools or number of students

SUCCESS METRIC HISTOGRAMS
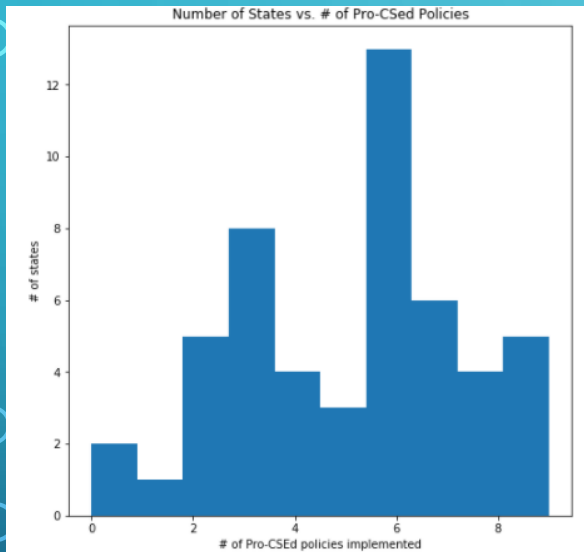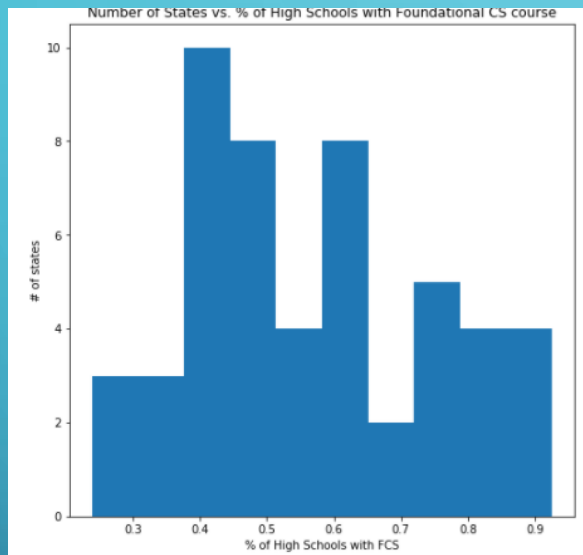
# of Policies   % of HS with FCS   % Students in HS w/ CS   % Students Enrolled in FCS

OBSERVATIONS

- CSEd Report focuses on # of policies implemented, % of HS with Foundational CS metrics

- Reported 51.7% of HS with Foundational CS is national average weighed down by large states; 57.4% is average over all states equal weighted.

- % of Students in HS with CS may include High Schools with a "Computer Science" class that do not have the 20 hours of coding to be considered "foundational"

- % of Students in HS with CS is roughly 40% - 50% higher than % of HS with Foundational CS; % of HS with Foundational CS is roughly 10 times larger than % Students in Foundational CS

OUTLIERS (MORE THAN 2 STDEV)

- # Policies (5.16 State Avg)
  - Oregon – 0

- % High Schools with Foundational CS (57.4% State Avg)
  - No Outliers

- % Students in HS with CS (77.6% State Avg)
  - District of Columbia (50.8%)
  - Louisiana (45.1%)

- % Students in Foundational CS (4.9% State Avg)
  - South Carolina (20.7%)
 - Maryland (12.5%)

SUCCESS METRICS RELATIONSHIPS

X Value	Y Value	Line of Regression	R2 Value
# of Policies	% of HS with FCS	0.047 x + 0.333	.404
# of Policies	% Students in HS with CS	0.028 x + 0.631	.328
% of HS with FCS	% Students in HS with CS	0.567 x + 0.451	.716
# of Policies	% Students in FCS	0.005 x + 0.021	.127
% of HS with FCS	% Students in FCS	0.115 x - 0.019	.363
% Students in HS with CS	% Students in FCS	0.158 x - 0.077	.295

# of Policies
vs.
% of HS with Foundational CS
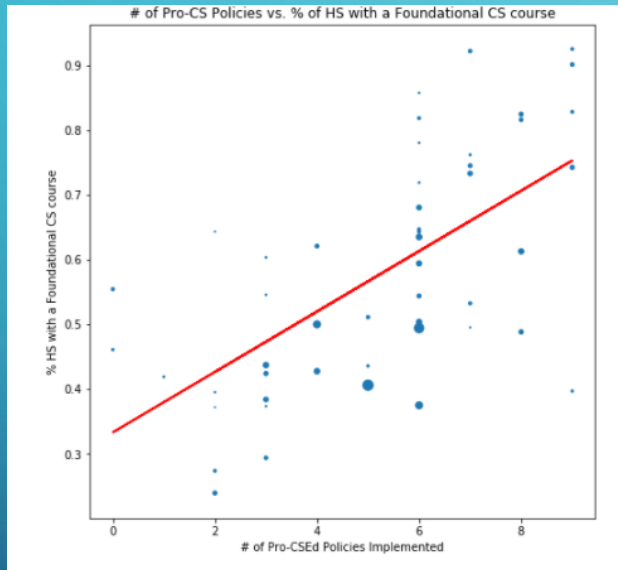
R2 = .404

Size of dots reflect # HS, # Students;
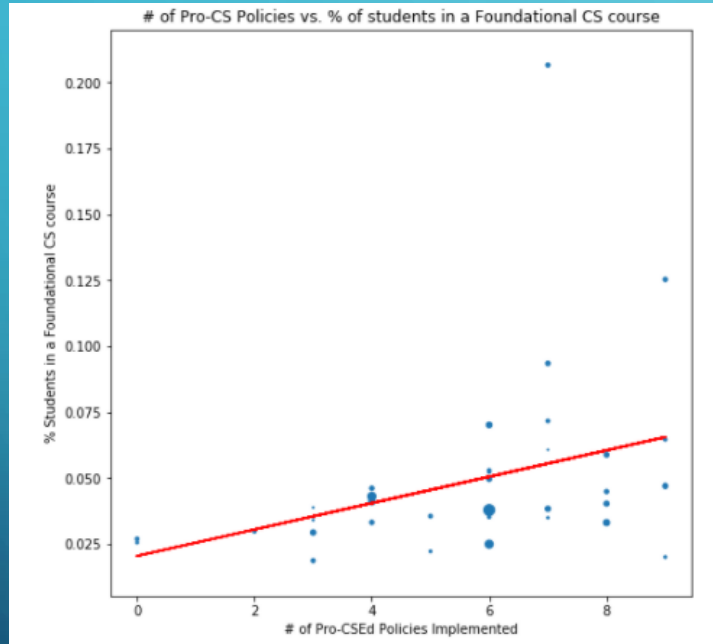not reflected in regression
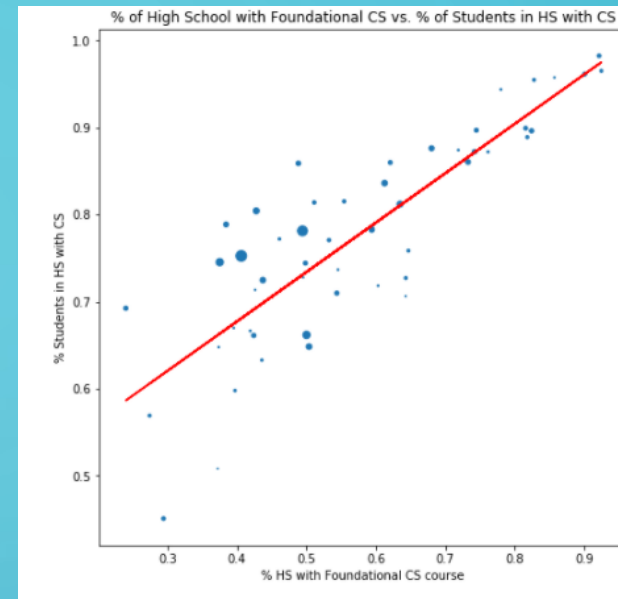
R2 = .716

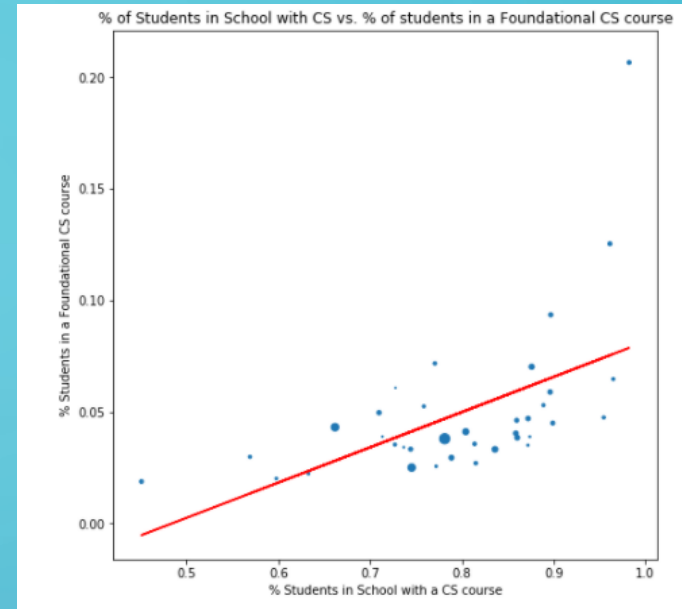% HS with Foundational CS
Vs
% Students in HS with CS
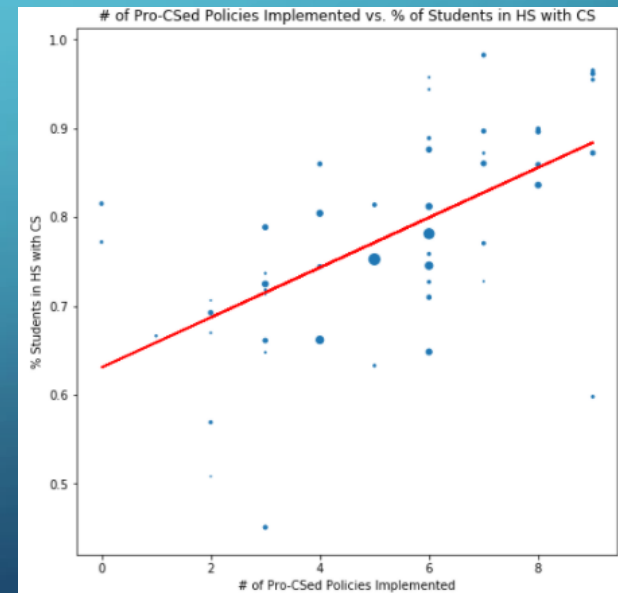
R2 = .328

# of Policies
Vs
% Students in HS with CS

# of Policies
vs.
% of Students in
Foundational CS

# of Pro-CS Policies vs. % of students in a Foundational CS course

R2 = .127

Size of dots reflect # HS, # Students;
not reflected in regression

% of Students in School with CS vs. % of students in a Foundational CS course

R2 = .295

% Students in HS
with CS
Vs.
% of Students in
Foundational CS

% of High School with Foundational CS vs. % of students in a Foundational CS course
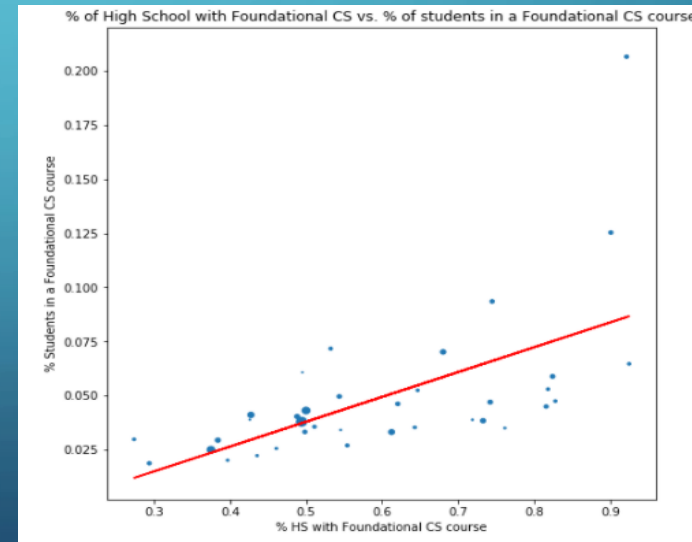
% HS with
Foundational CS
Vs
% of Students in
Foundational CS

R2 = .363

OBSERVATIONS

- Relative R-squared values used to understand how success metrics correlate to each other

- CsEd report indicates R-squared of appx 0.42 for line of regression between # of policies and % of HS with foundational CS; The R-squared shows here indicates .404.   Difference likely due to how policies considered implemented

- Strongest relationship between % of HS with foundational CS and % of students in HS with CS (.716).   If all schools were same size and all CS were FCS, R-squared would be 1.0.

- Predictive power of # of policies decreases as go up the CAPE pyramid (.408 -> .328 -> .127)

- Despite lower position in CAPE pyramid, % of HS with foundational CS (.363) is a better predictor than % of students in HS with CS (.295) of % in Students in foundational CS

EFFECT OF INDIVIDUAL POLICIES

Correlation matrix between individual policies, number of policies implemented, and % of HS with Foundational CS
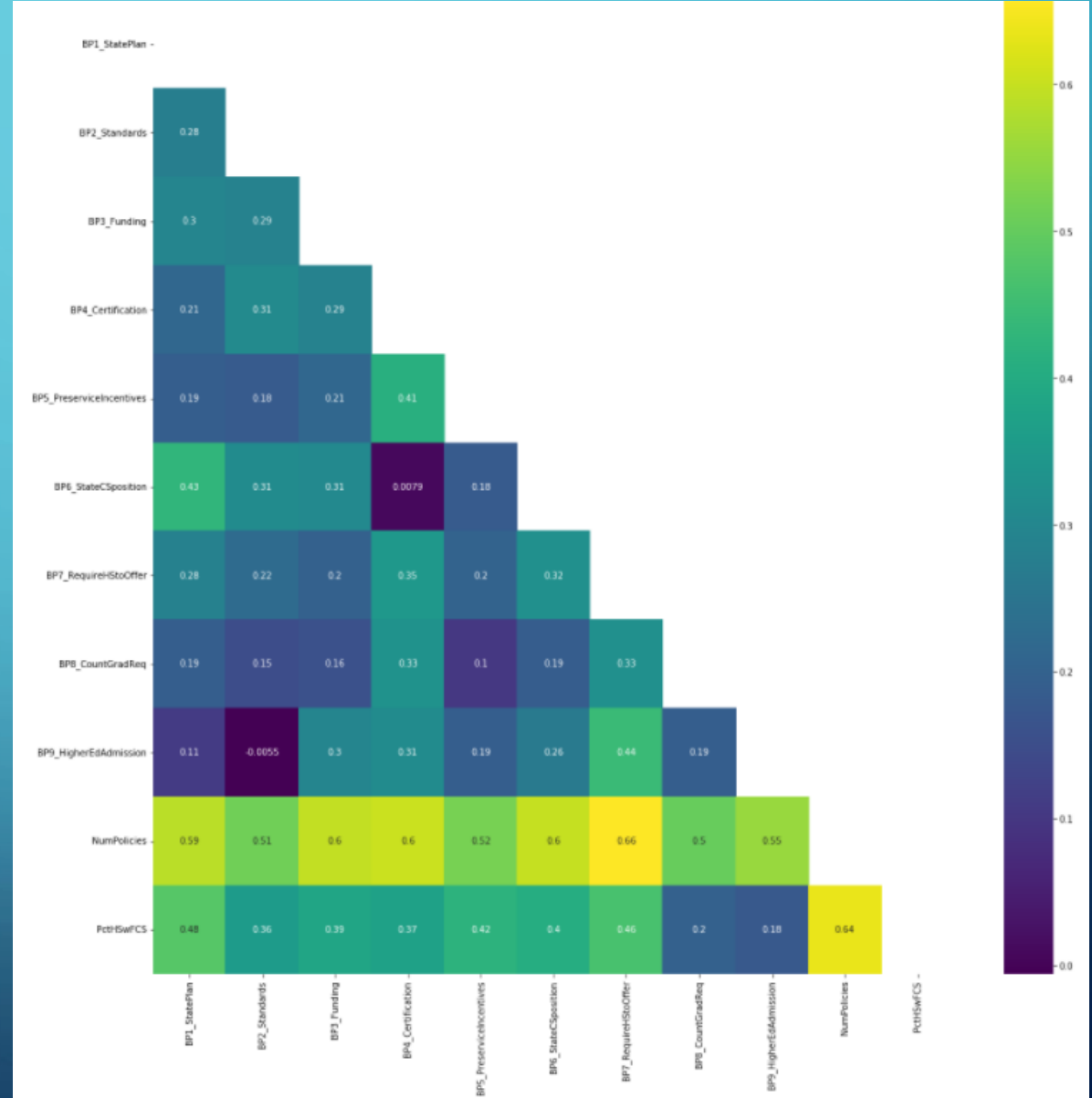
Correlation of Individual Policies vs. Success Metrics

	PctHSwFCS	PctStudentsHSwCS	PctInFCS
BP1_StatePlan	0.48	0.40	0.17
BP2_Standards	0.36	0.35	0.25
BP3_Funding	0.39	0.37	0.19
BP4_Certification	0.37	0.32	0.26
BP5_PreserviceIncentives	0.42	0.32	0.09
BP6_StateCSposition	0.40	0.37	0.24
BP7_RequireHStoOffer	0.46	0.48	0.23
BP8_CountGradReq	0.20	0.18	0.23
BP9_HigherEdAdmission	0.18	0.14	0.25
NumPolicies	0.64	0.57	0.36

	PctHSwFCS	PctStudentsHSwCS	PctInFCS
BP1_StatePlan	0.76	0.70	0.48
BP2_Standards	0.56	0.61	0.70
BP3_Funding	0.61	0.64	0.52
BP4_Certification	0.59	0.56	0.72
BP5_PreserviceIncentives	0.66	0.57	0.25
BP6_StateCSposition	0.64	0.64	0.68
BP7_RequireHStoOffer	0.73	0.84	0.66
BP8_CountGradReq	0.31	0.32	0.64
BP9_HigherEdAdmission	0.28	0.25	0.72
NumPolicies	1.00	1.00	1.00

Absolute Correlation Value

Correlation Value Relative to
# of Policies Correlation
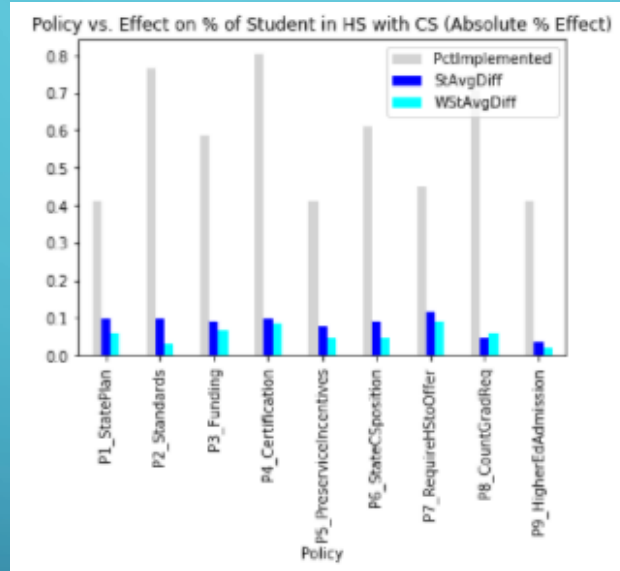
Tables Created By Copying Data from Various Jupyter
Notebooks and further processing/formatting in Excel
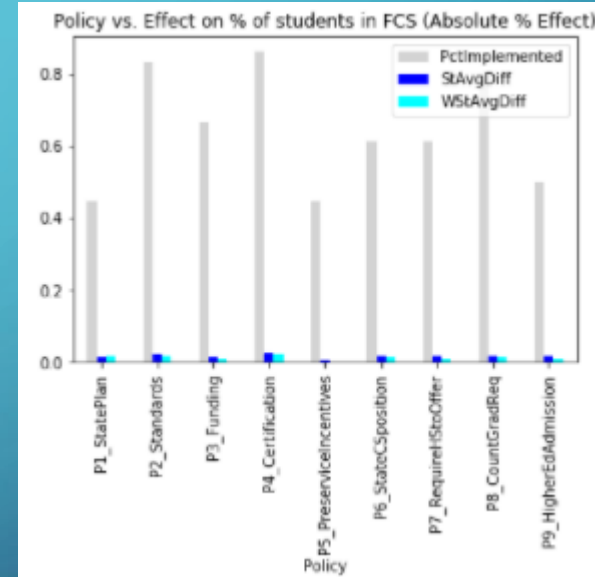
POLICY VS % CHANGE (ABSOLUTE)
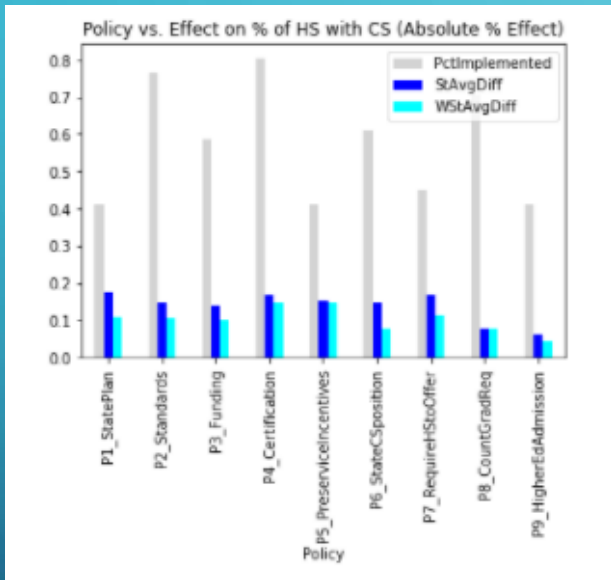
% HS with Foundational CS

% Students in HS w/ CS

% Students in Foundational CS

POLICY VS. % CHANGE (RELATIVE)
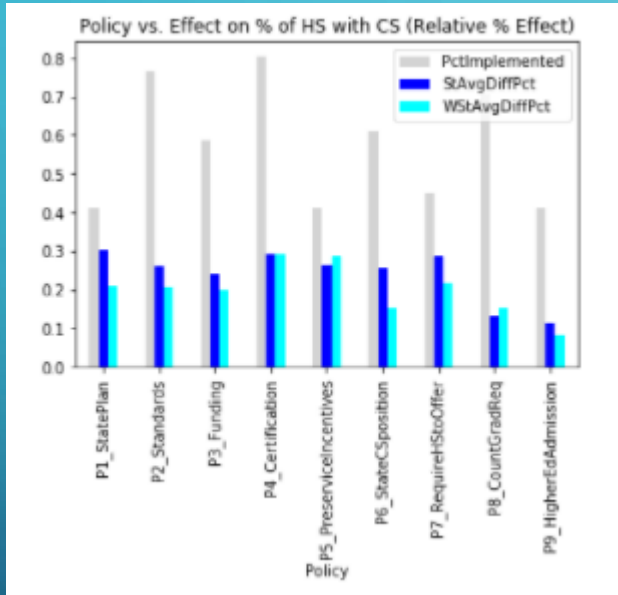
% HS with Foundational CS
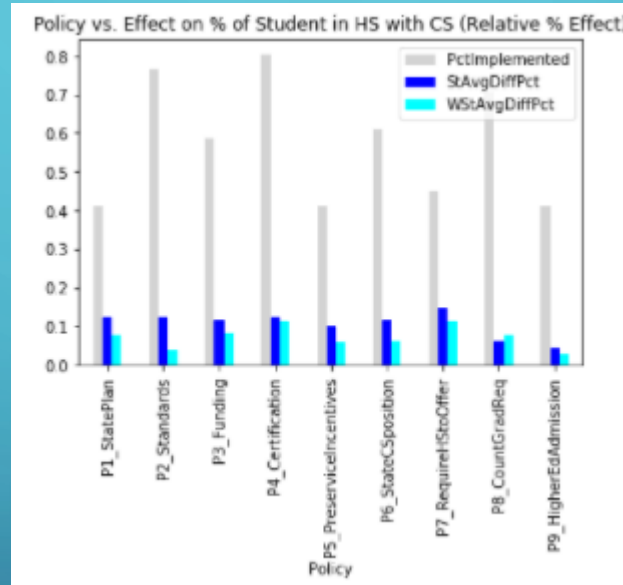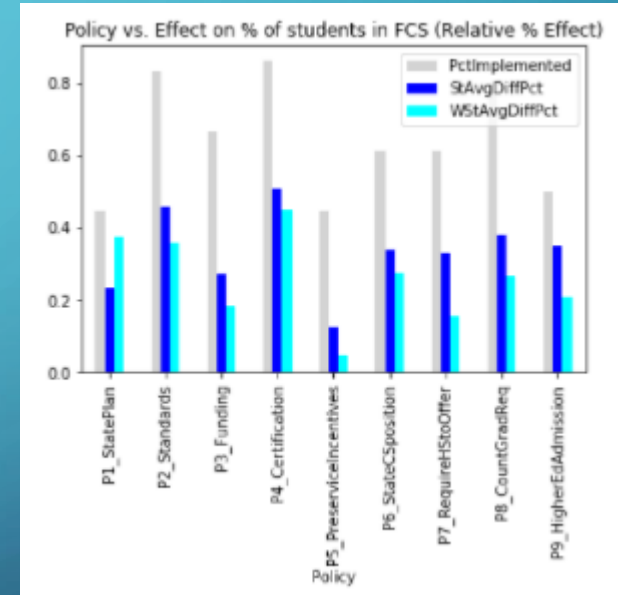
% Students in HS w/ CS

% Students in Foundational CS

OBSERVATIONS

- Correlation between number of policies and other success metrics provides a baseline to understand the relative strength of each policy.

- Number of policies is more strongly correlated to all success metrics than any one policy

- Low positive correlation between individual policies seems to be a good sign

- P7 Requiring all schools to offer CS has strong correlation across all success metrics

- P6 CS Supervisor provides moderate correlation across all success metrics

MORE OBSERVATIONS

- P1 State Plan has strong correlation at Capacity/Access layer, but weak correlation at Participation layer

- P2 Standards, P4 Certification, P9 Higher Ed Admission have weak correlation at Capacity/Access layer, but stronger correlation at Participation layer. However, Participation layer only shows weak correlation to current tracked policies

- P3 Funding, P5 Preservice Programs, P8 Count Grad Requirements have weak correlation at two of layers and only moderate correlation at one layer

OVERALL CONCLUSIONS AND RECOMMENDATIONS

- TBD/For Discussion

LINKS

- Google Colab Notebooks
  - https://colab.research.google.com/drive/1AM9XiDWffbZK6fpejKGW4VNHQjML3p5L?usp=sharing
  - https://colab.research.google.com/drive/1px_IbXFVVElbGNbCBs_AbUEefjK1pv57?usp=sharing
  - https://colab.research.google.com/drive/1XTa2745XZNSxDYkrQNwDq_5xQB-wtYJC?usp=sharing

- Data Files
  - https://drive.google.com/file/d/1jCUBaWoe52GdzIwLaM7TcZ_SQII9Jglv/view?usp=sharing (CSV)
  - https://docs.google.com/spreadsheets/d/1MZpi5Nid-BfpQ833Uy9rYgrvD8H3Yads/edit?usp=sharing&ouid=112866292549895118363&rtpof=true&sd=true (XLSX used to create CSV)

- Original Data Sources
  - https://advocacy.code.org/2021_State_of_CS_data.xlsx (Numeric Data)
  - http://bit.ly/9policies (Policy data)

PLANNED NEXT STEPS

- Further Jupyter file cleanup and documentation

- Public Github Checkin.   Kaggle?

- Gender/Ethnicity Data Study

- Location/FRL Data Study?

- Analysis with other state population/education data?