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An Interactive Data Tool to Explore State and County Model-based Estimates of Adult Literacy and Numeracy Skills

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Federal Committee on Statistical Methodology Conference

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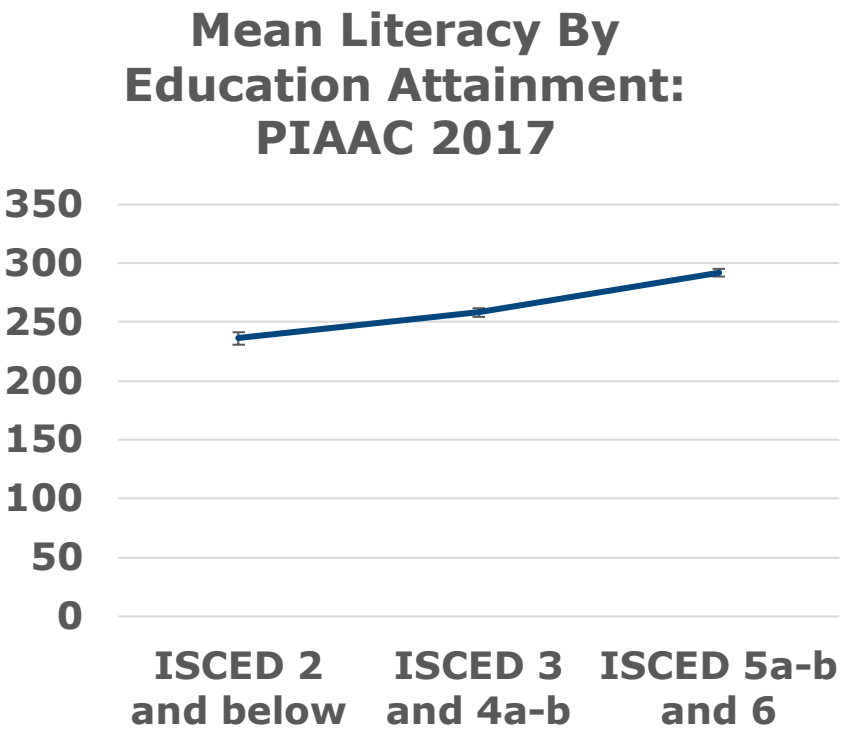
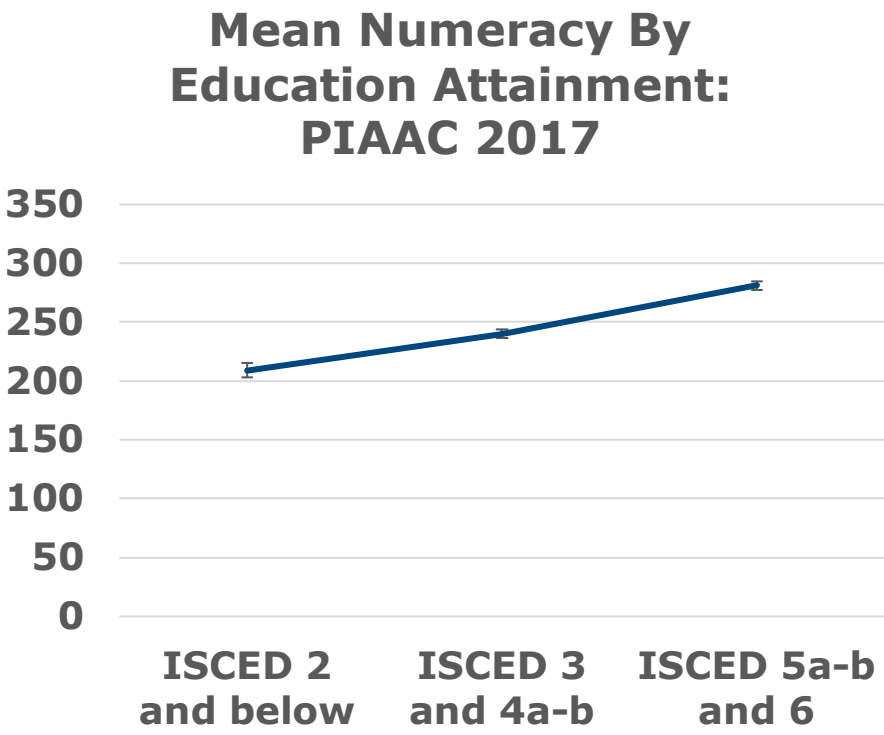
PIAAC International Survey of Adult Skills

- Program for the International Assessment of Adult Competencies (PIAAC)
- Over 35 countries in Cycle 1 (2012 to 2017)
- PIAAC in the U.S. (sponsored by the National Center for Education Statistics)
  - Surveyed 12,330 U.S. adults ages 16 to 74 living in households over three data collections (2012, 2014, 2017) that were combined together
  - Included a Background Questionnaire and assessment of literacy and numeracy skills (in English)
  - Involved a complex sample design for each data collection
  - Designed to produce national estimates

National Statistics on Adult Literacy and Numeracy Skills by Education Attainment Group





ISCED: International Standard Classification of Education

Source: U.S. Department of Education, National Center for Education Statistics, U.S. Program for the International Assessment of Adult Competencies (PIAAC), 2017.

PIAAC Small Area Estimation

- Small area estimation (SAE) includes a variety of statistical techniques to predict survey outcomes for smaller areas
- U.S. PIAAC in Cycle 1 had sample in most states, but only 185 counties
- Methodology was built upon previous work relating to a previous national assessment with one outcome – Mohadjer, et al (2009)
- Eight outcomes were estimated
  - 2 components: Literacy/numeracy
  - 4 types: average scores, percentage at or below Level 1 (low proficiency), at Level 2 (medium proficiency), at or above Level 3 (high proficiency)
- Three sets of model-based estimates were developed
  - Set 1. State and county (released in 2020)
  - Set 2. State by group (new) – age and education attainment groups
  - Set 3. County by group (new) – age and education attainment groups

Set 1: PIAAC SAE Models for States and Counties

- Models used the PIAAC survey results in conjunction with data from the 2013-2017 Census Bureau's American Community Survey (ACS)
- Included the following covariates: education attainment, poverty, race/ethnicity, health insurance, and service occupations
- Model structures
  - Proportions -- Area-level *bivariate* Hierarchical Bayes linear three-fold models
  - Averages – Area-level *univariate* Hierarchical Bayes linear three-fold models
- Models were fit at the county level, and predictions aggregated to state level
- Models were subjected to rigorous diagnostic checks
- 4,500 posterior samples were generated
- Credible intervals are provided to indicate how confident the user can be in the estimates

Set 2: PIAAC SAE Model for States and Groups

- 10 Groups were created
  - 6 age groups:16-24, 25-34, 35-44, 45-54, 55-64, and 65-74
  - 4 education groups: less than high school, high school diploma or GED, some college (no degree or attained associate's degree), and bachelor's degree or higher
- Models, like Set 1, used the PIAAC survey results in conjunction with ACS data
- Included a subset of the following covariates: education attainment, poverty, race/ethnicity, health insurance, and service occupations
- Model structure for proportions and averages involved an area-level univariate Hierarchical Bayes linear models
- Models were fit at the state level
- Predictions were benchmarked to state-level model-based estimates
- Evaluated the model predictions

Set 3: PIAAC SAE Model for Counties and Groups

- An allocation deterministic model approach used the following:

  Set 3 County group pseudo posterior sample

  = Set 2 state group posterior sample * Set 1 county posterior sample / Set 1 state posterior sample

- Computation assumes ratios of county-to-state model-based posterior samples are constant across groups
- Aggregations of county by age/education group estimates agree closely, but not exactly, to the state by age/education group model-based estimates
- Credible intervals are provided to assess the precision of estimates (as in Sets 1 and 2)

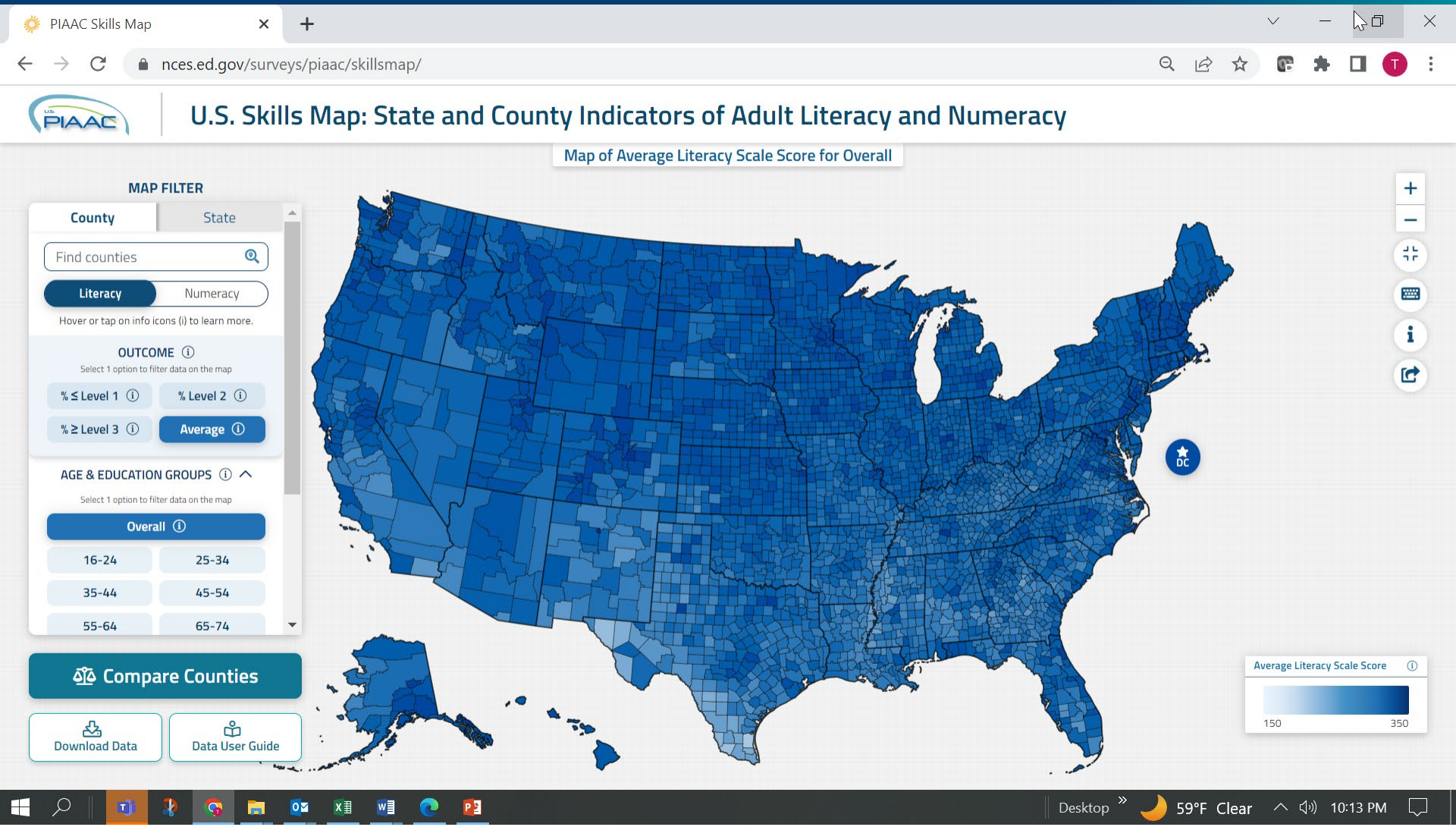
Demonstration

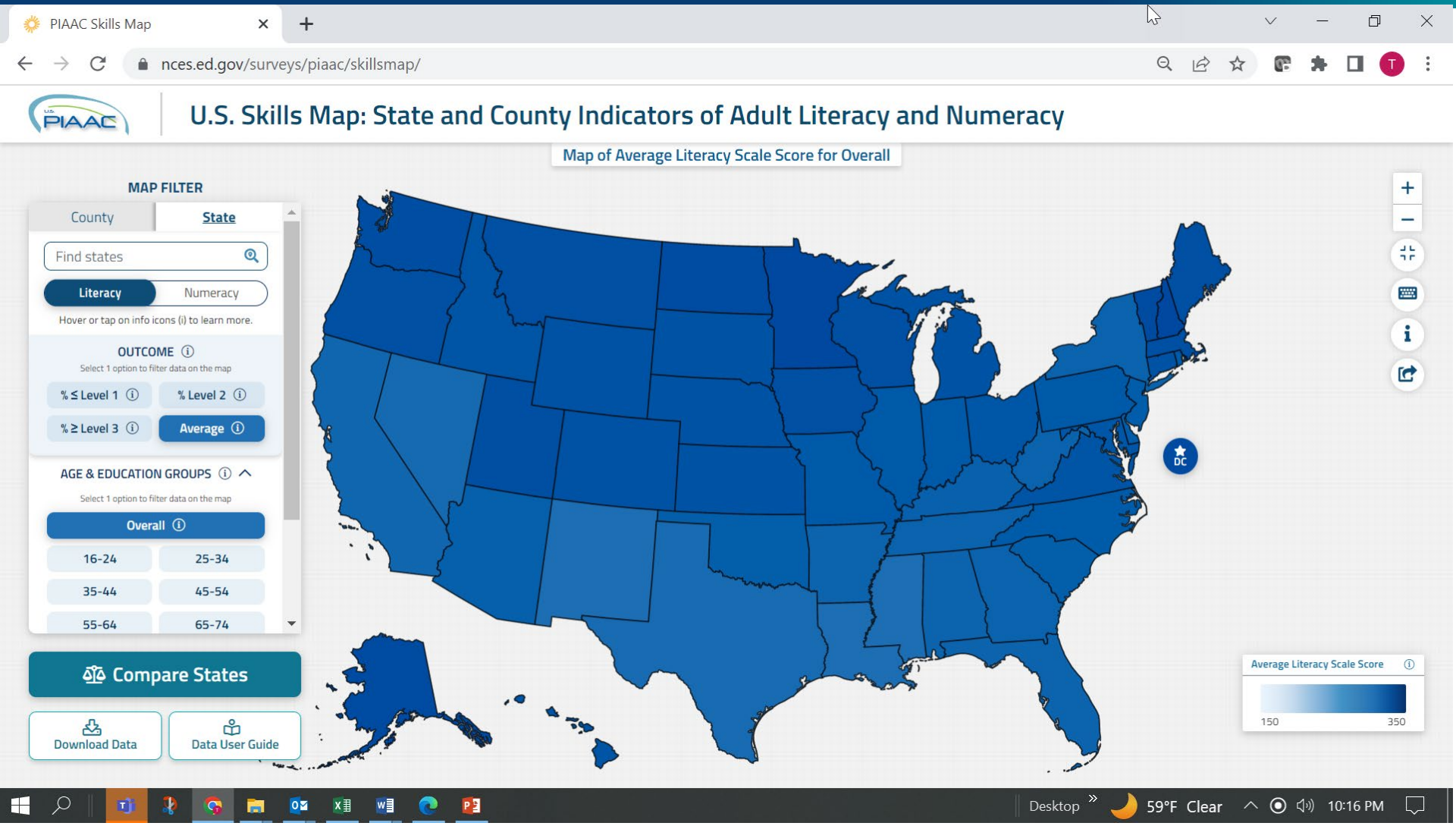
Skills Map: nces.ed.gov/surveys/piaac/skillsmap

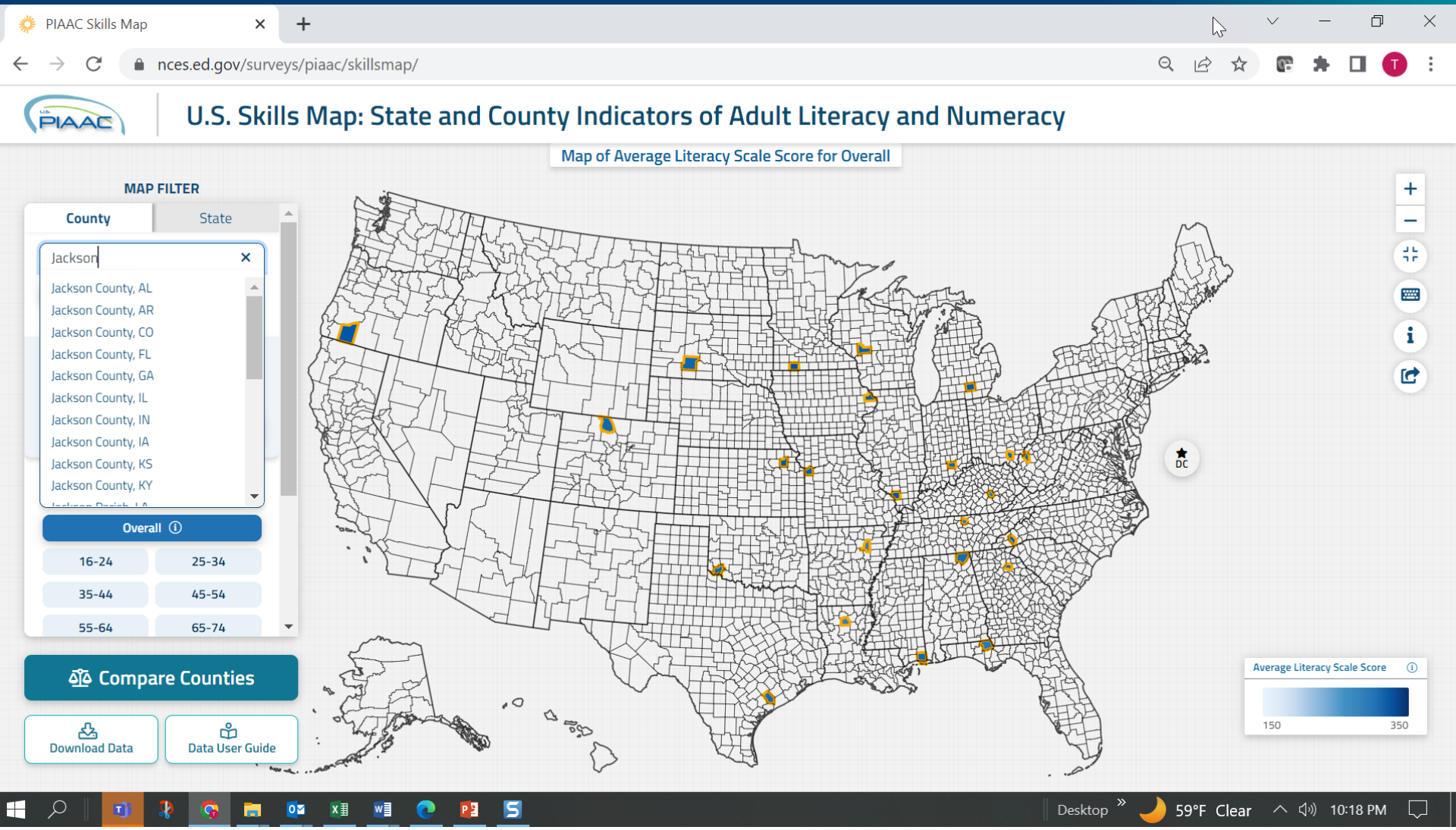
U.S. State and County Estimates:
nces.ed.gov/surveys/piaac/state-county-estimates.asp

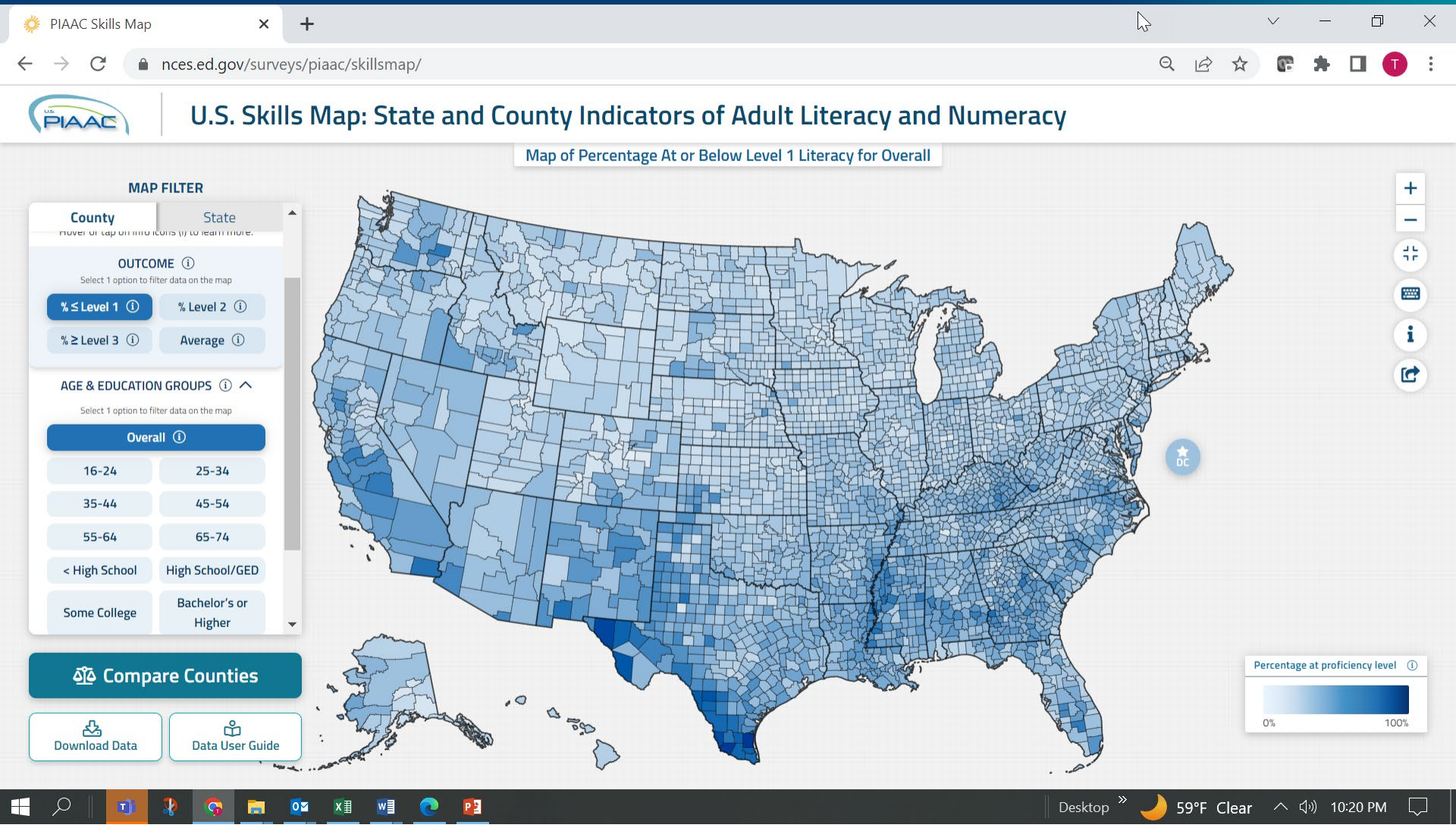
PIAAC Website: nces.ed.gov/surveys/piaac/

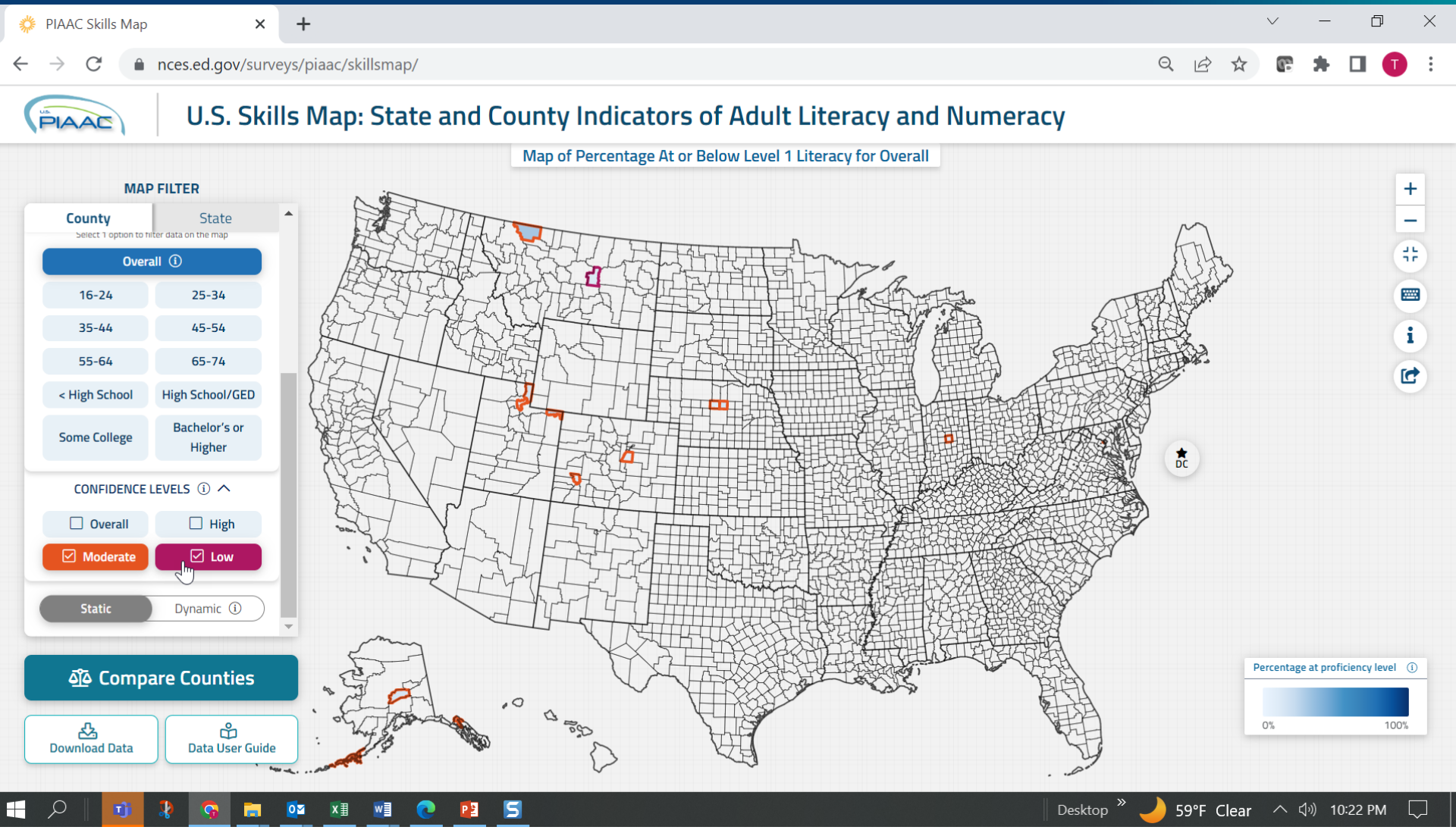
Skills Map Landing Page




PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy
Map of Average Literacy Scale Score for Overall
MAP FILTER
County
State
Find states
Literacy
Numeracy
Hover or tap on info icons (i) to learn more.
OUTCOME
Select 1 option to filter data on the map
% ≤ Level 1
% Level 2
% ≥ Level 3
Average
AGE & EDUCATION GROUPS
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
Compare States
Download Data
Data User Guide
DC
Average Literacy Scale Score
150
350
Desktop
59°F Clear
10:16 PM


PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy
Map of Average Literacy Scale Score for Overall
MAP FILTER
County
State
Jackson
Jackson County, AL
Jackson County, AR
Jackson County, CO
Jackson County, FL
Jackson County, GA
Jackson County, IL
Jackson County, IN
Jackson County, IA
Jackson County, KS
Jackson County, KY
Overall
16-24
25-34
35-44
45-54
55-64
65-74
Compare Counties
Download Data
Data User Guide
DC
Average Literacy Scale Score
150
350
Desktop
59°F Clear
10:18 PM


PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy
Map of Percentage At or Below Level 1 Literacy for Overall
MAP FILTER
County
State
OUTCOME
Select 1 option to filter data on the map
% ≤ Level 1
% Level 2
% ≥ Level 3
Average
AGE & EDUCATION GROUPS
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
< High School
High School/GED
Some College
Bachelor's or Higher
Compare Counties
Download Data
Data User Guide
DC
Percentage at proficiency level
0%
100%
Desktop
59°F Clear
10:20 PM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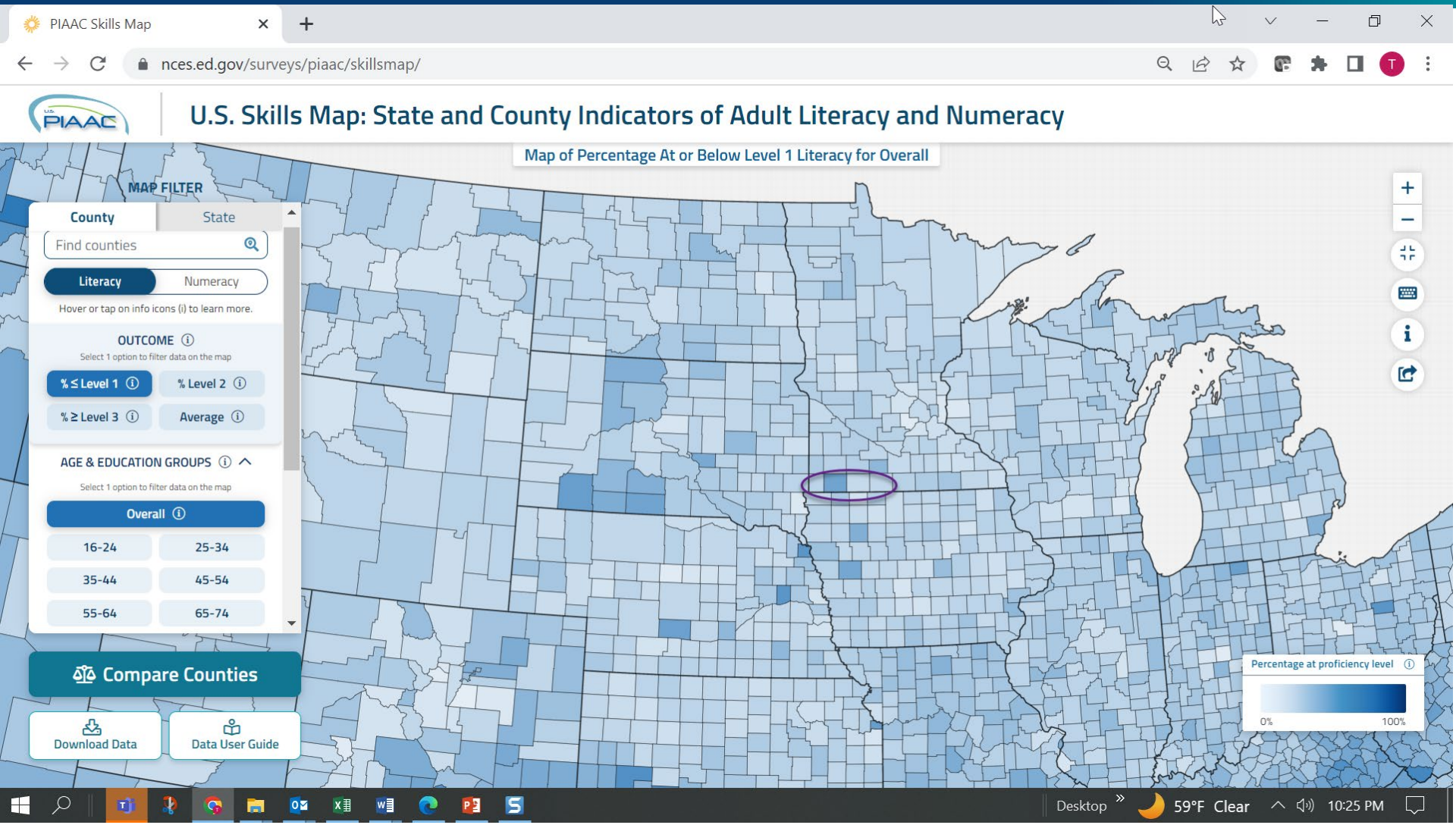
MAP FILTER
County
State
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
< High School
High School/GED
Some College
Bachelor's or Higher
CONFIDENCE LEVELS
Overall
High
Moderate
Low
Static
Dynamic
Compare Counties
Download Data
Data User Guide
DC
Percentage at proficiency level
0%
100%
Desktop
59°F Clear
10:22 PM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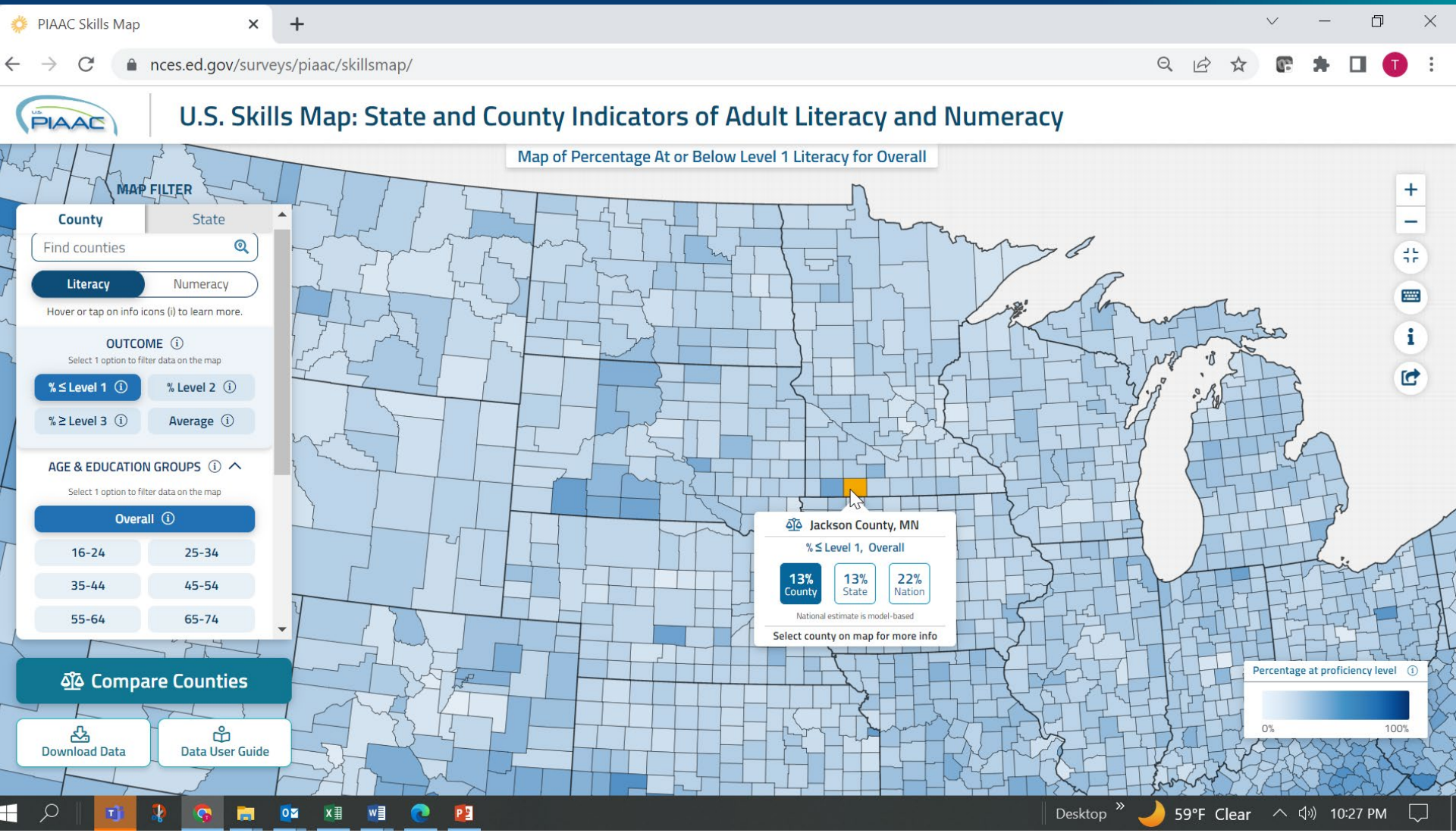
MAP FILTER
County
State
Find counties
Literacy
Numeracy
Hover or tap on info icons (i) to learn more.
OUTCOME
Select 1 option to filter data on the map
% ≤ Level 1
% Level 2
% ≥ Level 3
Average
AGE & EDUCATION GROUPS
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
Compare Counties
Download Data
Data User Guide
Percentage at proficiency level
0%
100%
Desktop
59°F Clear
10:25 PM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State
Find counties
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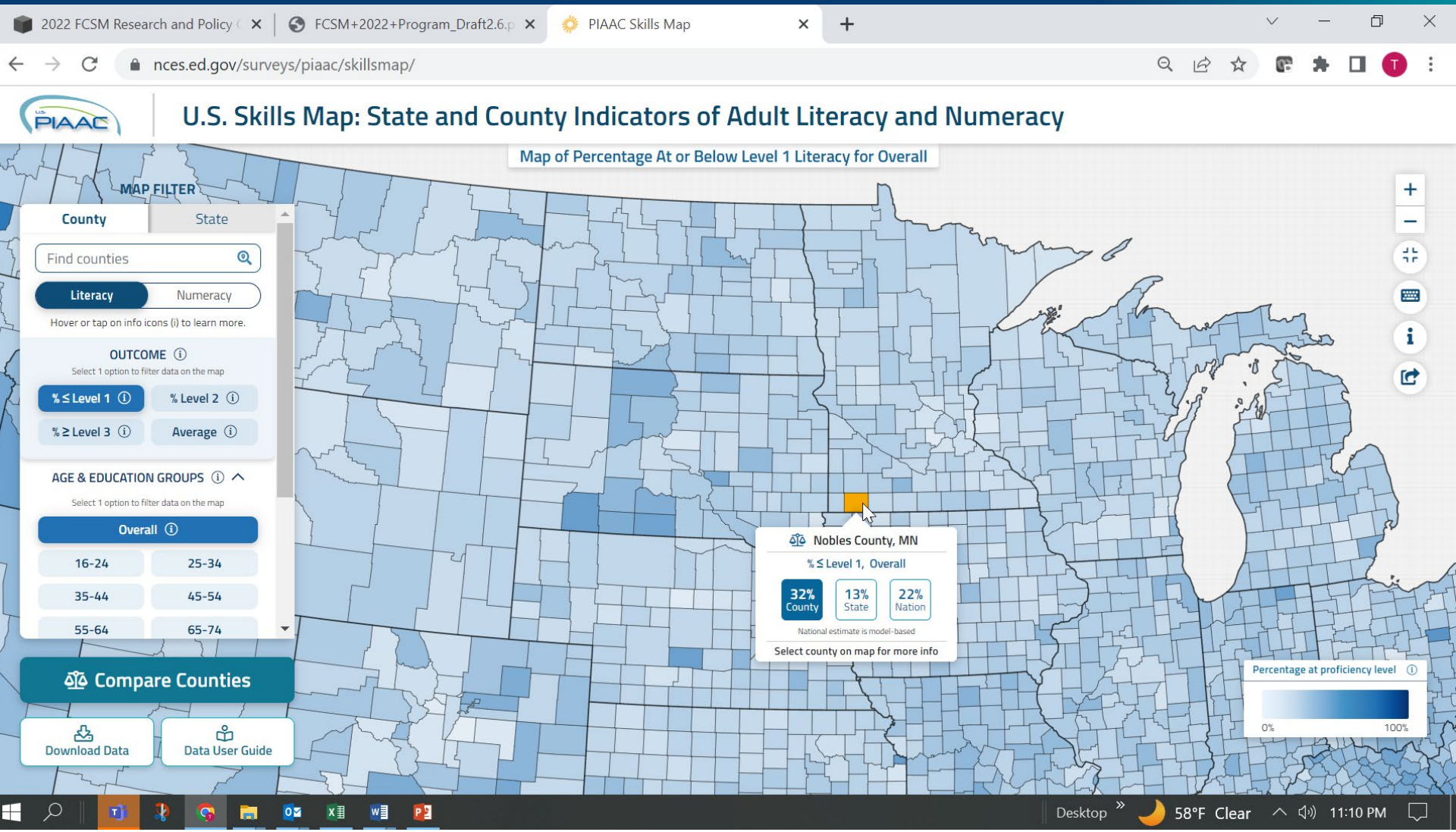
% ≤ Level 1
% Level 2
% ≥ Level 3
Average
AGE & EDUCATION GROUPS
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
Compare Counties
Download Data
Data User Guide
Jackson County, MN
% ≤ Level 1, Overall
13% County
13% State
22% Nation
National estimate is model-based
Select county on map for more info
Percentage at proficiency level
0%
100%
Desktop
59°F Clear
10:27 PM


2022 FCSM Research and Policy
FCSM+2022+Program_Draft2.6.p
PIAAC Skills Map
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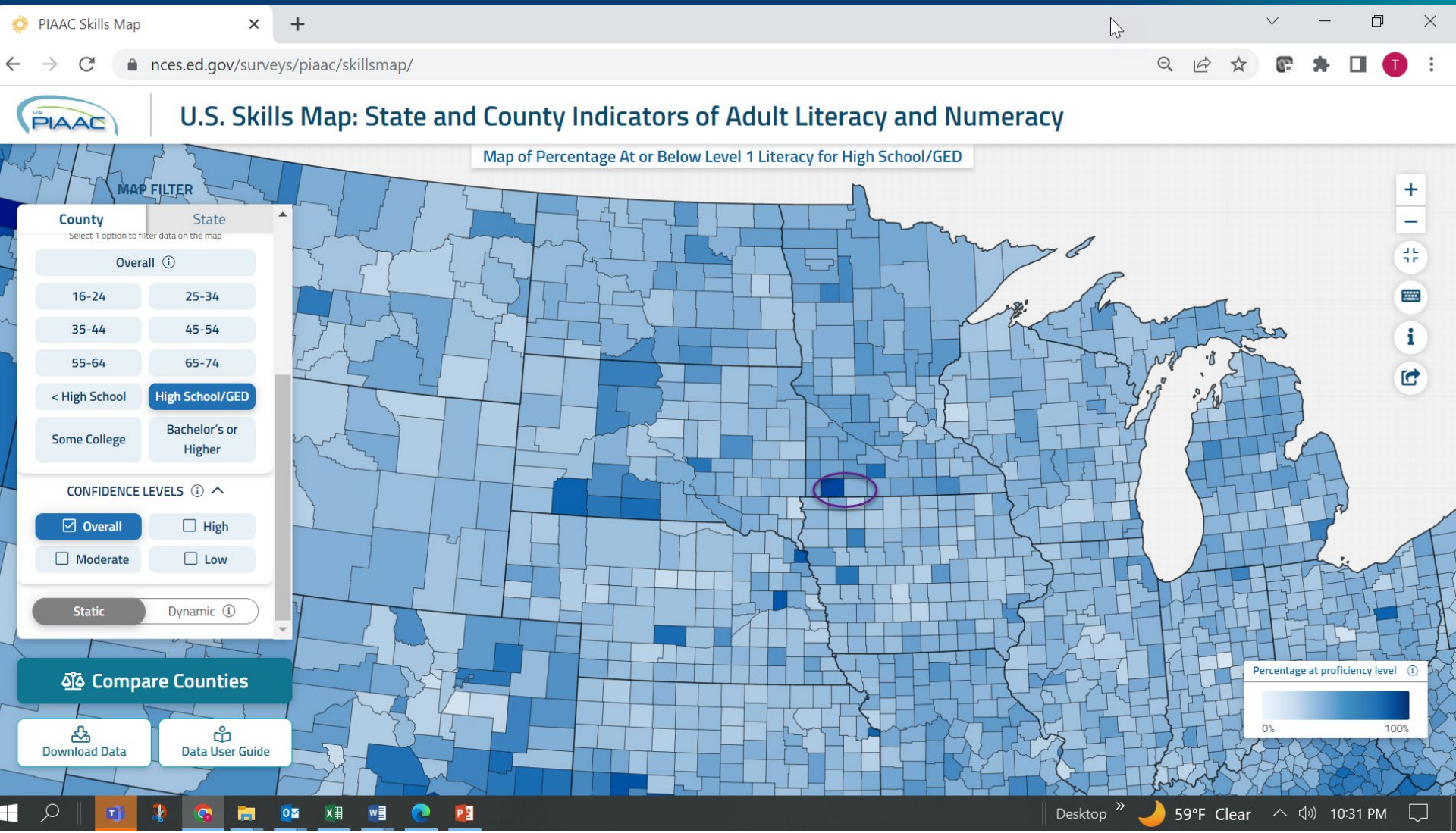
U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy
Map of Percentage At or Below Level 1 Literacy for Overall
MAP FILTER
County
State
Find counties
Literacy
Numeracy
Hover or tap on info icons (i) to learn more.
OUTCOME
Select 1 option to filter data on the map
% ≤ Level 1
% Level 2
% ≥ Level 3
Average
AGE & EDUCATION GROUPS
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
Compare Counties
Download Data
Data User Guide
Nobles County, MN
% ≤ Level 1, Overall
32% County
13% State
22% Nation
National estimate is model-based
Select county on map for more info
Percentage at proficiency level
0%
100%
Desktop
58°F Clear
11:10 PM


PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy
Map of Percentage At or Below Level 1 Literacy for High School/GED
MAP FILTER
County
State
Overall
16-24
25-34
35-44
45-54
55-64
65-74
< High School
High School/GED
Some College
Bachelor's or Higher
CONFIDENCE LEVELS
Overall
High
Moderate
Low
Static
Dynamic
Compare Counties
Download Data
Data User Guide
Percentage at proficiency level
0%
100%
Desktop
59°F Clear
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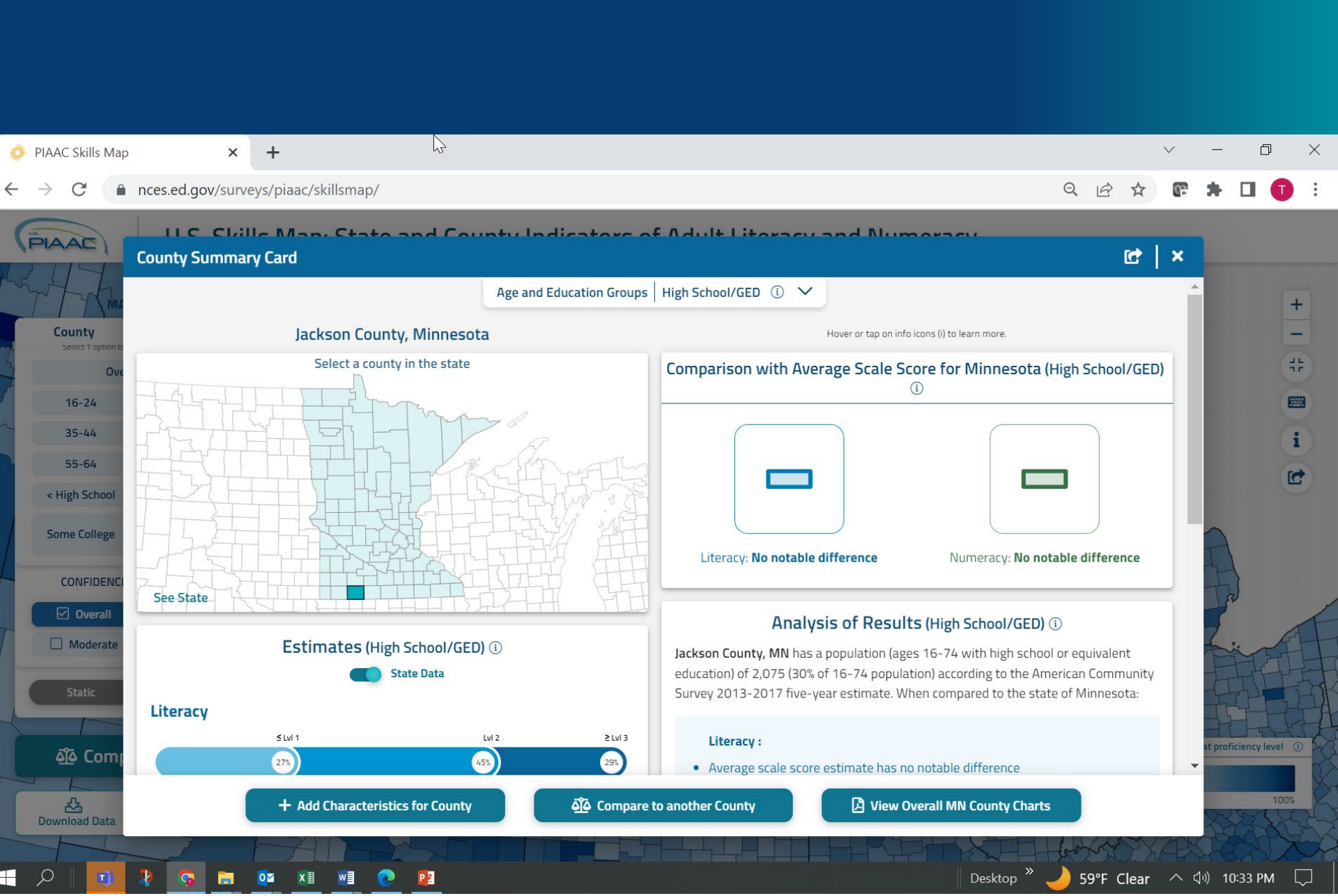
PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
County Summary Card
Age and Education Groups | High School/GED
Jackson County, Minnesota
Hover or tap on info icons (i) to learn more.
Select a county in the state
See State
Comparison with Average Scale Score for Minnesota (High School/GED)
Literacy: No notable difference
Numeracy: No notable difference
Analysis of Results (High School/GED)
Jackson County, MN has a population (ages 16-74 with high school or equivalent education) of 2,075 (30% of 16-74 population) according to the American Community Survey 2013-2017 five-year estimate. When compared to the state of Minnesota:
Literacy :
Average scale score estimate has no notable difference
Estimates (High School/GED)
State Data
Literacy
≤ Lvl 1
Lvl 2
≥ Lvl 3
27%
45%
29%
+ Add Characteristics for County
Compare to another County
View Overall MN County Charts
County
16-24
35-44
55-64
< High School
Some College
CONFIDENCE
Overall
Moderate
Static
Download Data
Desktop
59°F Clear
10:33 PM

PIAAC Skills Map

nces.ed.gov/surveys/piaac/skillsmap/

County Summary Card

See State

Age and Education Groups | High School/GED

Estimates (High School/GED)

State Data

Literacy

Numeracy

Analysis of Results (High School/GED)

Jackson County, MN has a population (ages 16-74 with high school or equivalent education) of 2,075 (30% of 16-74 population) according to the American Community Survey 2013-2017 five-year estimate. When compared to the state of Minnesota:

Literacy :

- Average scale score estimate has no notable difference
- Percentage at or below Level 1 has no notable difference
- Percentage at Level 2 has no notable difference
- Percentage at or above Level 3 is notably lower

Numeracy :

- Average scale score estimate has no notable difference
- Percentage at or below Level 1 has no notable difference
- Percentage at Level 2 has no notable difference
- Percentage at or above Level 3 is notably lower

+ Add Characteristics for County | Compare to another County | View Overall MN County Charts

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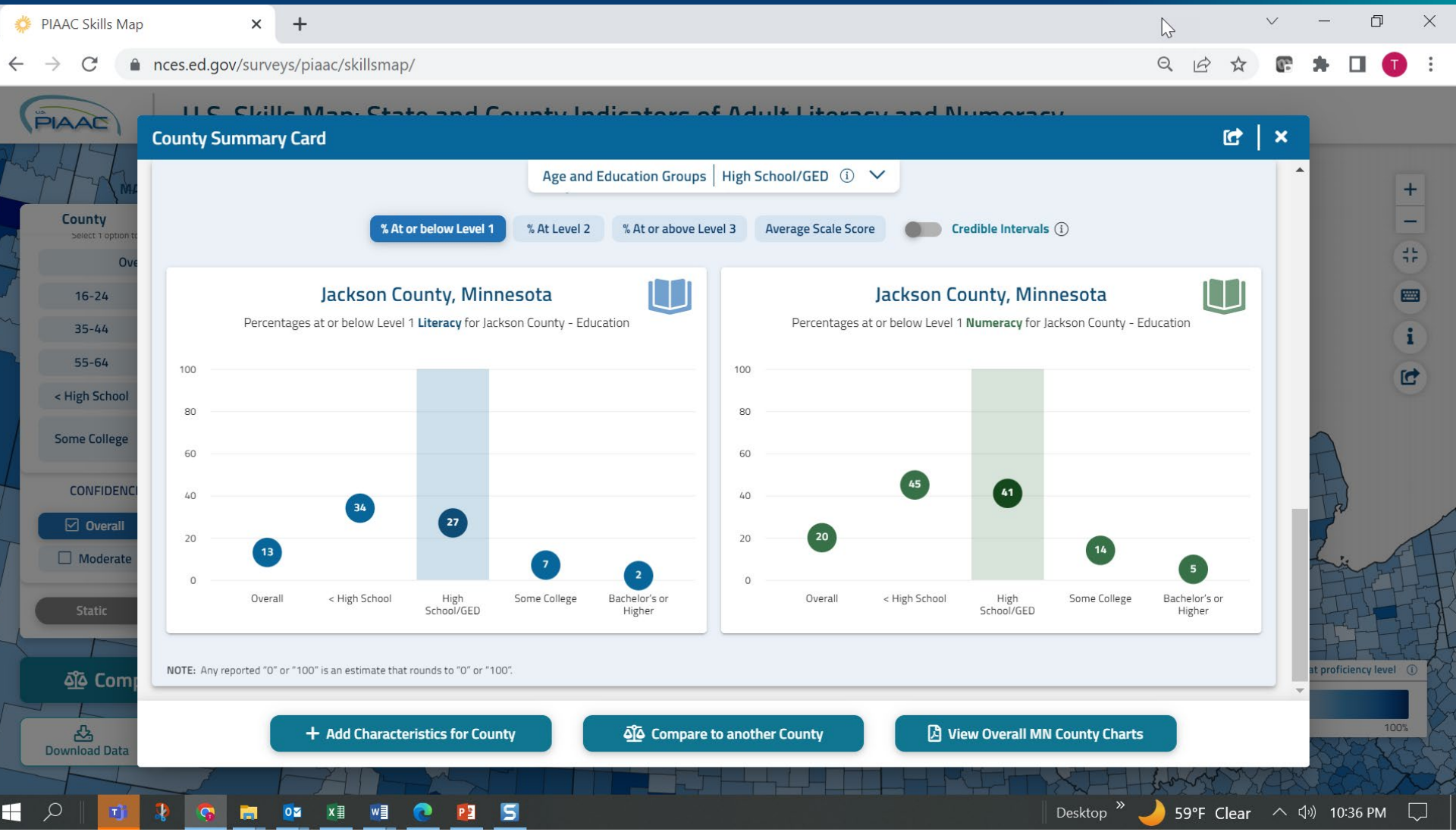

PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
County Summary Card
Age and Education Groups | High School/GED
% At or below Level 1
% At Level 2
% At or above Level 3
Average Scale Score
Credible Intervals
Jackson County, Minnesota
Percentages at or below Level 1 Literacy for Jackson County - Education
100
80
60
40
20
0
13
34
27
7
2
Overall
< High School
High School/GED
Some College
Bachelor's or Higher
Jackson County, Minnesota
Percentages at or below Level 1 Numeracy for Jackson County - Education
20
45
41
14
5
NOTE: Any reported "0" or "100" is an estimate that rounds to "0" or "100".
+ Add Characteristics for County
Compare to another County
View Overall MN County Charts
County
16-24
35-44
55-64
< High School
Some College
CONFIDENCE
Overall
Moderate
Static
Download Data
Desktop
59°F Clear
10:36 PM

PIAAC Skills Map | Comparison Charts of State and

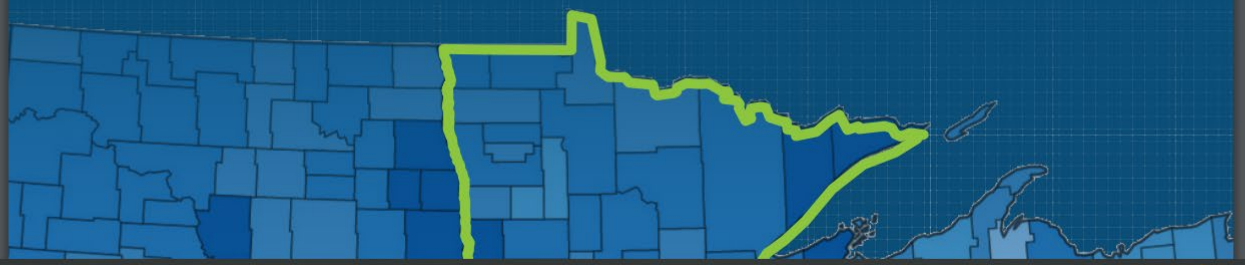
nces.ed.gov/surveys/piaac/skillsmap/src/PDF/Minnesota.pdf

Comparison Charts of State and County Estimates – Minnesota 1 / 34 100%

Comparison Charts of State and County Estimates

Program for the International Assessment of Adult Competencies (PIAAC)

Minnesota



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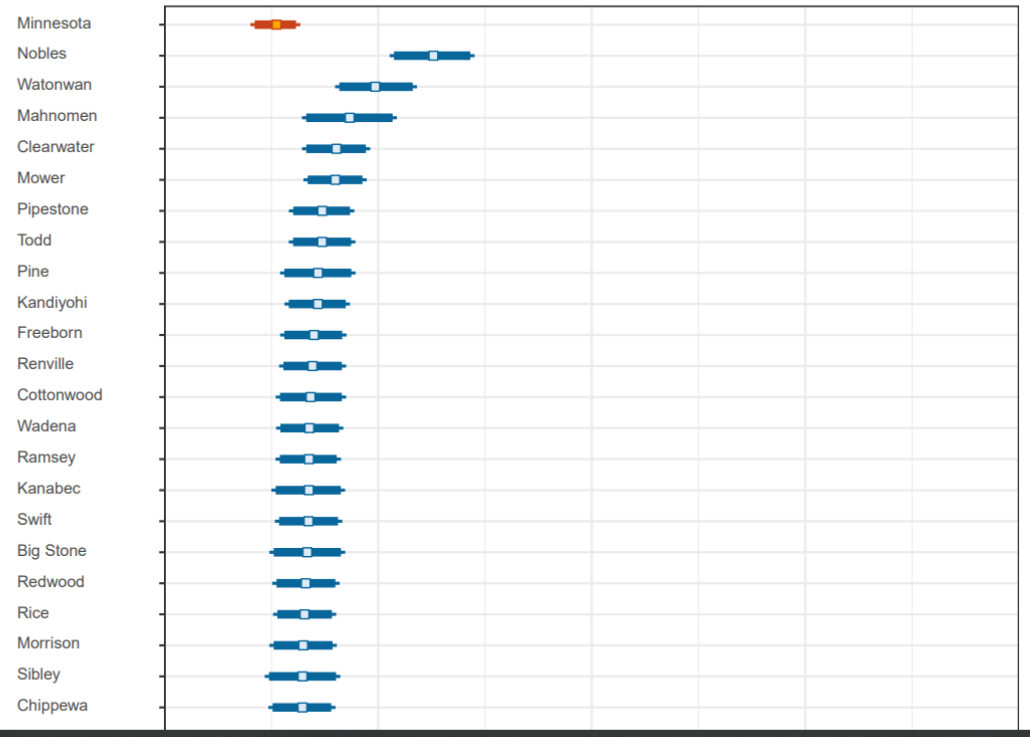
PIAAC Skills Map

Comparison Charts of State and

nces.ed.gov/surveys/piaac/skillsmap/src/PDF/Minnesota.pdf

Comparison Charts of State and County Estimates – Minnesota 7 / 34 100%

Percentage with Literacy Skills At or Below Level 1 in Counties in Minnesota: 2012/2014/2017



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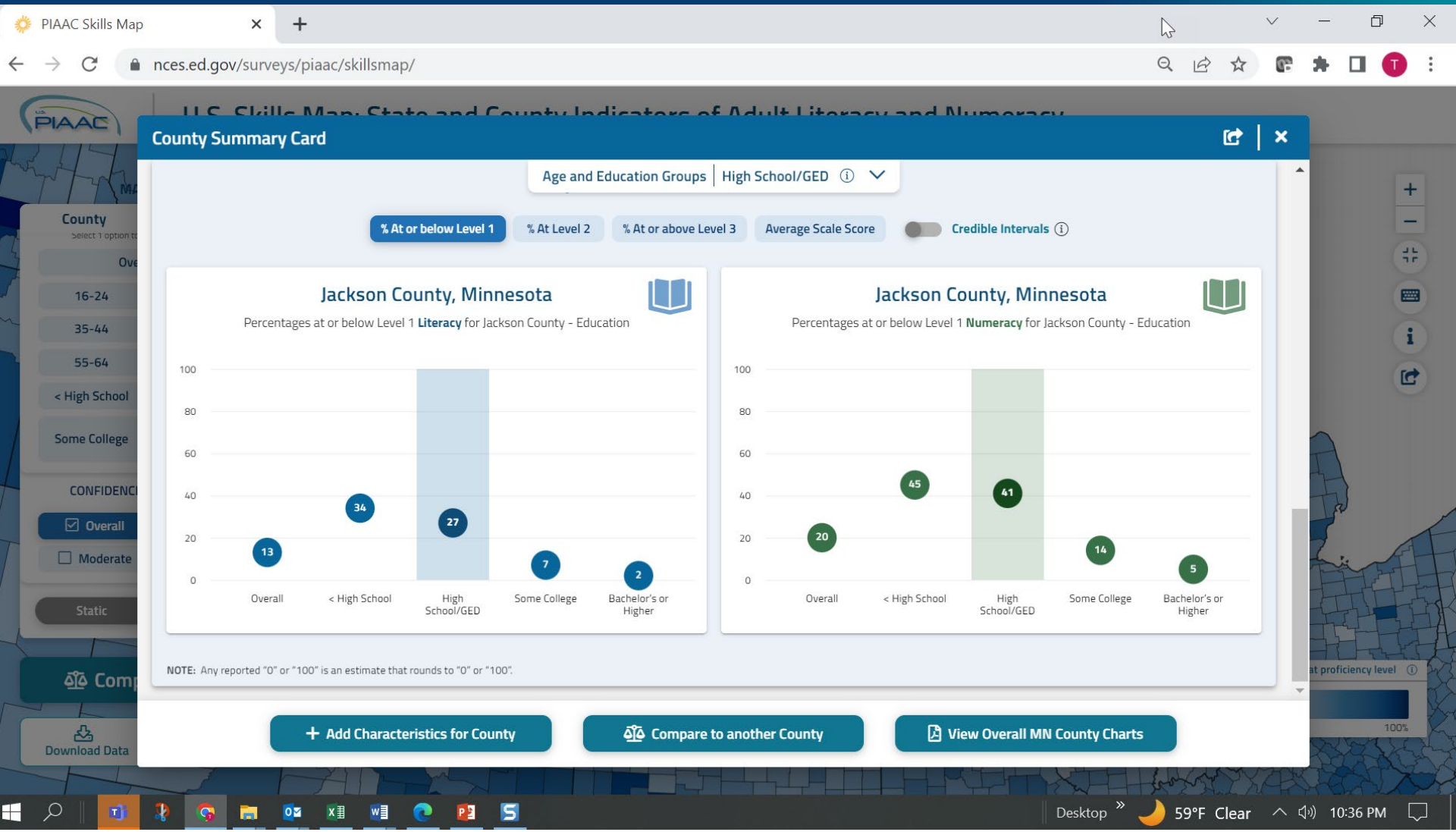
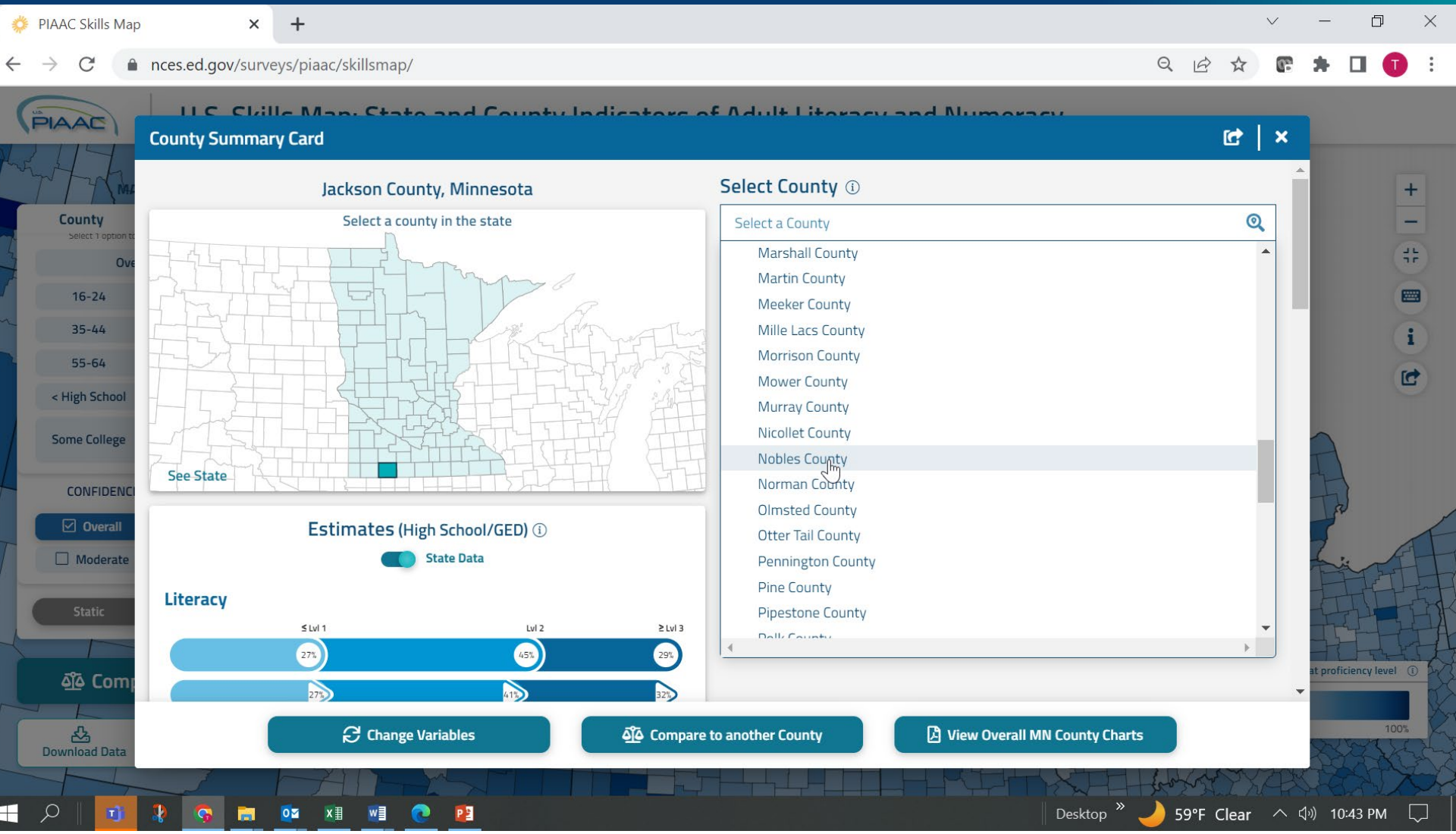

PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
County Summary Card
Age and Education Groups | High School/GED
% At or below Level 1
% At Level 2
% At or above Level 3
Average Scale Score
Credible Intervals
Jackson County, Minnesota
Percentages at or below Level 1 Literacy for Jackson County - Education
100
80
60
40
20
0
13
34
27
7
2
Overall
< High School
High School/GED
Some College
Bachelor's or Higher
Jackson County, Minnesota
Percentages at or below Level 1 Numeracy for Jackson County - Education
20
45
41
14
5
NOTE: Any reported "0" or "100" is an estimate that rounds to "0" or "100".
+ Add Characteristics for County
Compare to another County
View Overall MN County Charts
County
16-24
35-44
55-64
< High School
Some College
CONFIDENCE
Overall
Moderate
Static
Download Data
Desktop
59°F Clear
10:36 PM


PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
County Summary Card
Jackson County, Minnesota
Select a county in the state
See State
Estimates (High School/GED)
State Data
Literacy
≤ Lvl 1
Lvl 2
≥ Lvl 3
27%
45%
29%
27%
41%
32%
Select County
Select a County
Marshall County
Martin County
Meeker County
Mille Lacs County
Morrison County
Mower County
Murray County
Nicollet County
Nobles County
Norman County
Olmsted County
Otter Tail County
Pennington County
Pine County
Pipestone County
Change Variables
Compare to another County
View Overall MN County Charts
Download Data
Desktop
59°F Clear
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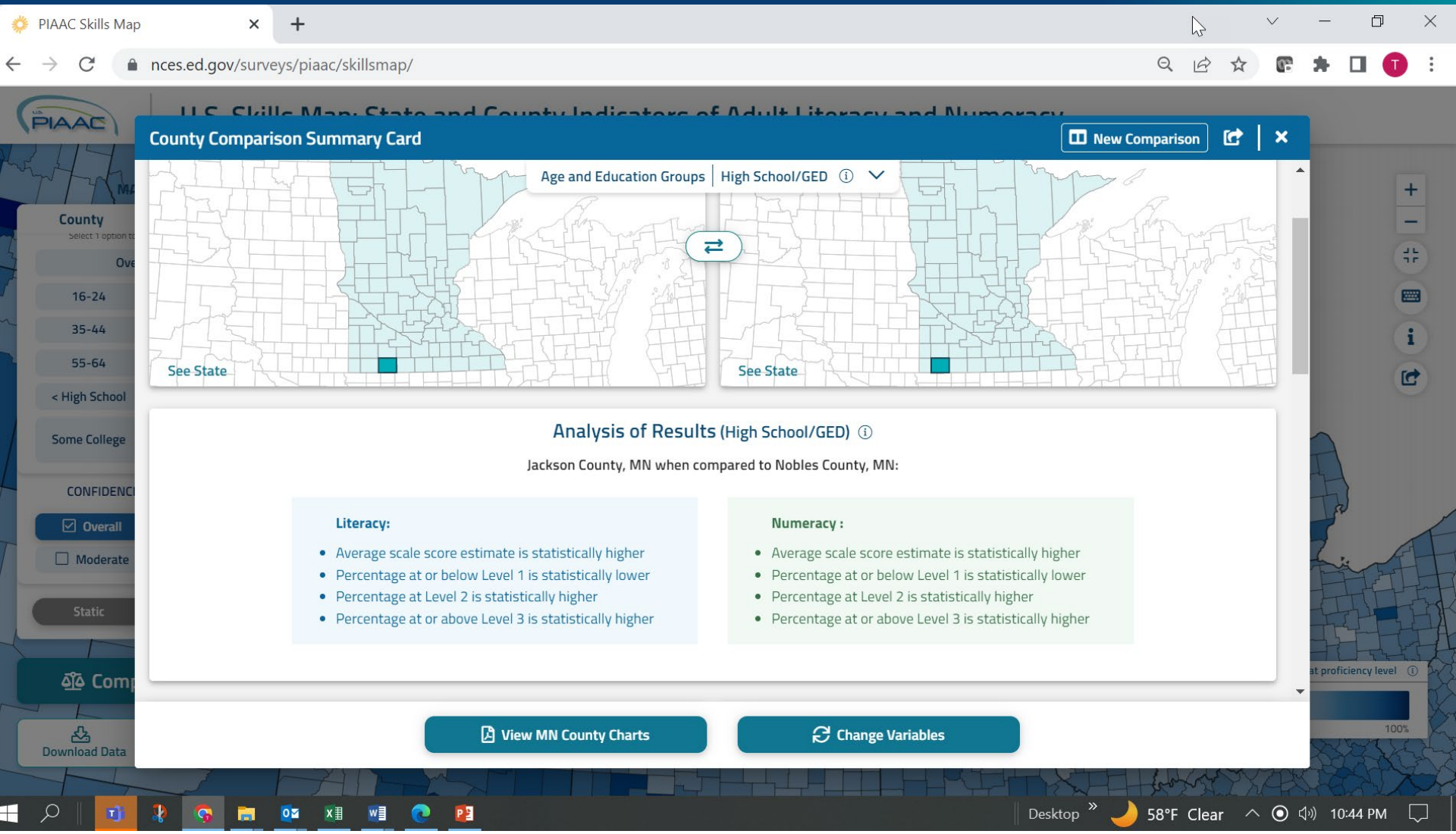
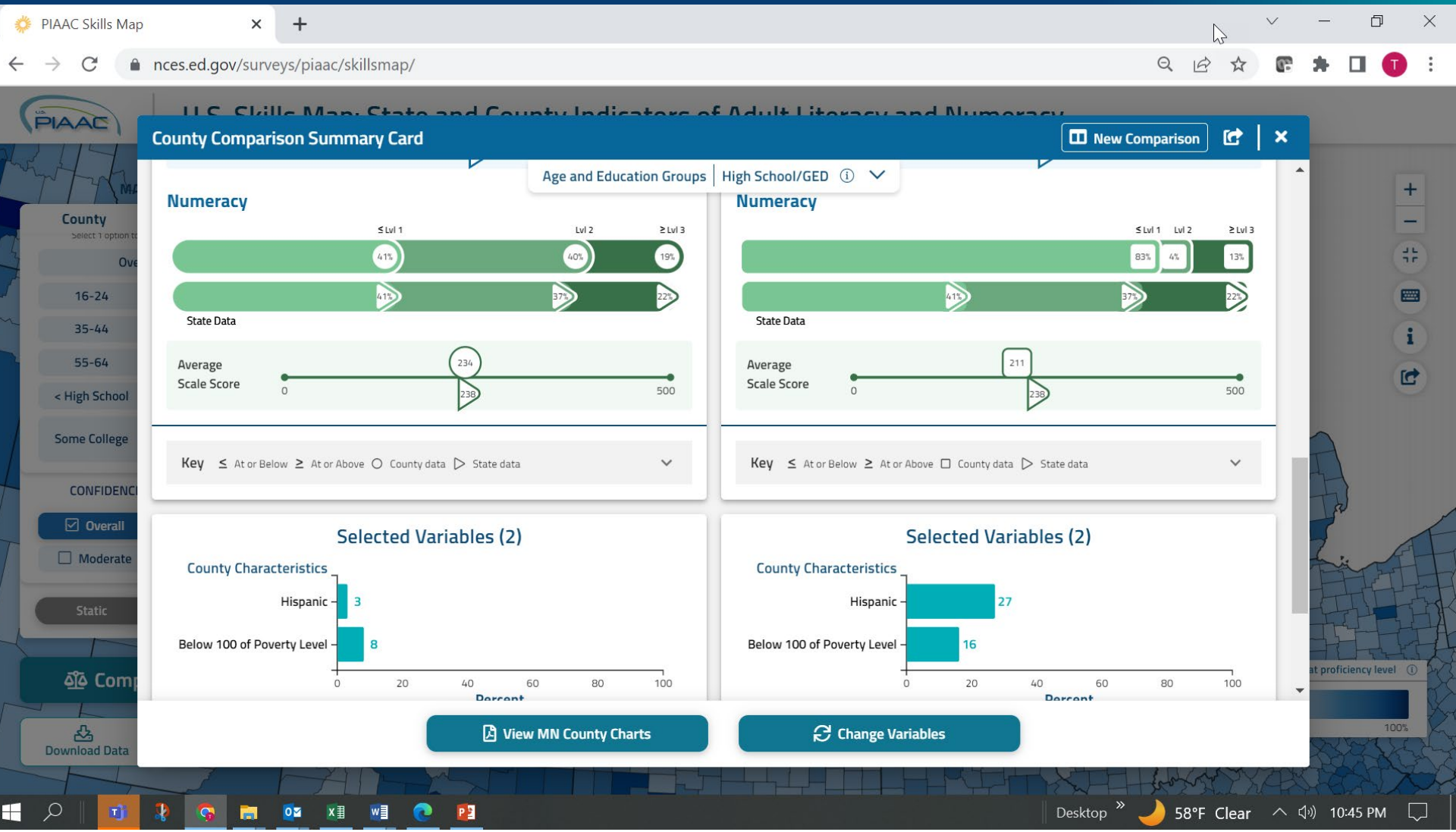
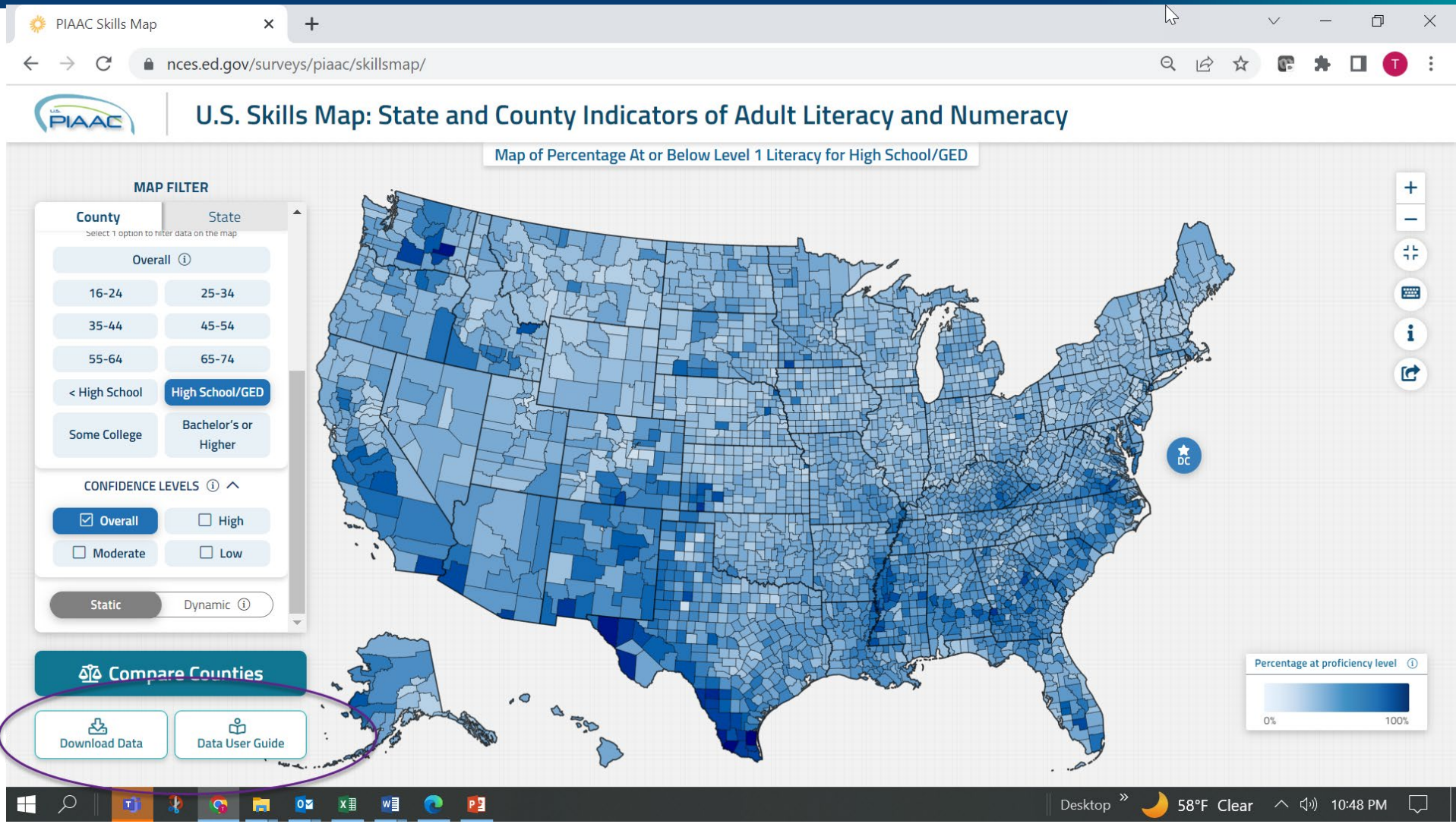

PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
County Comparison Summary Card
New Comparison
Age and Education Groups
High School/GED
See State
See State
Analysis of Results (High School/GED)
Jackson County, MN when compared to Nobles County, MN:
Literacy:
Average scale score estimate is statistically higher
Percentage at or below Level 1 is statistically lower
Percentage at Level 2 is statistically higher
Percentage at or above Level 3 is statistically higher
Numeracy :
Average scale score estimate is statistically higher
Percentage at or below Level 1 is statistically lower
Percentage at Level 2 is statistically higher
Percentage at or above Level 3 is statistically higher
View MN County Charts
Change Variables
Download Data
58°F Clear
10:44 PM


PIAAC Skills Map
nces.ed.gov/surveys/piaac/skillsmap/
County Comparison Summary Card
New Comparison
Age and Education Groups
High School/GED
Numeracy
≤ Lvl 1
Lvl 2
≥ Lvl 3
41%
40%
19%
41%
37%
22%
State Data
Average Scale Score
234
238
0
500
Key
≤ At or Below
≥ At or Above
County data
State data
Numeracy
≤ Lvl 1
Lvl 2
≥ Lvl 3
83%
4%
13%
41%
37%
22%
State Data
Average Scale Score
211
238
0
500
Key
≤ At or Below
≥ At or Above
County data
State data
Selected Variables (2)
County Characteristics
Hispanic
3
Below 100 of Poverty Level
8
0
20
40
60
80
100
Percent
Selected Variables (2)
County Characteristics
Hispanic
27
Below 100 of Poverty Level
16
0
20
40
60
80
100
Percent
View MN County Charts
Change Variables
County
16-24
35-44
55-64
< High School
Some College
CONFIDENCE
Overall
Moderate
Static
Download Data
Desktop
58°F Clear
10:45 PM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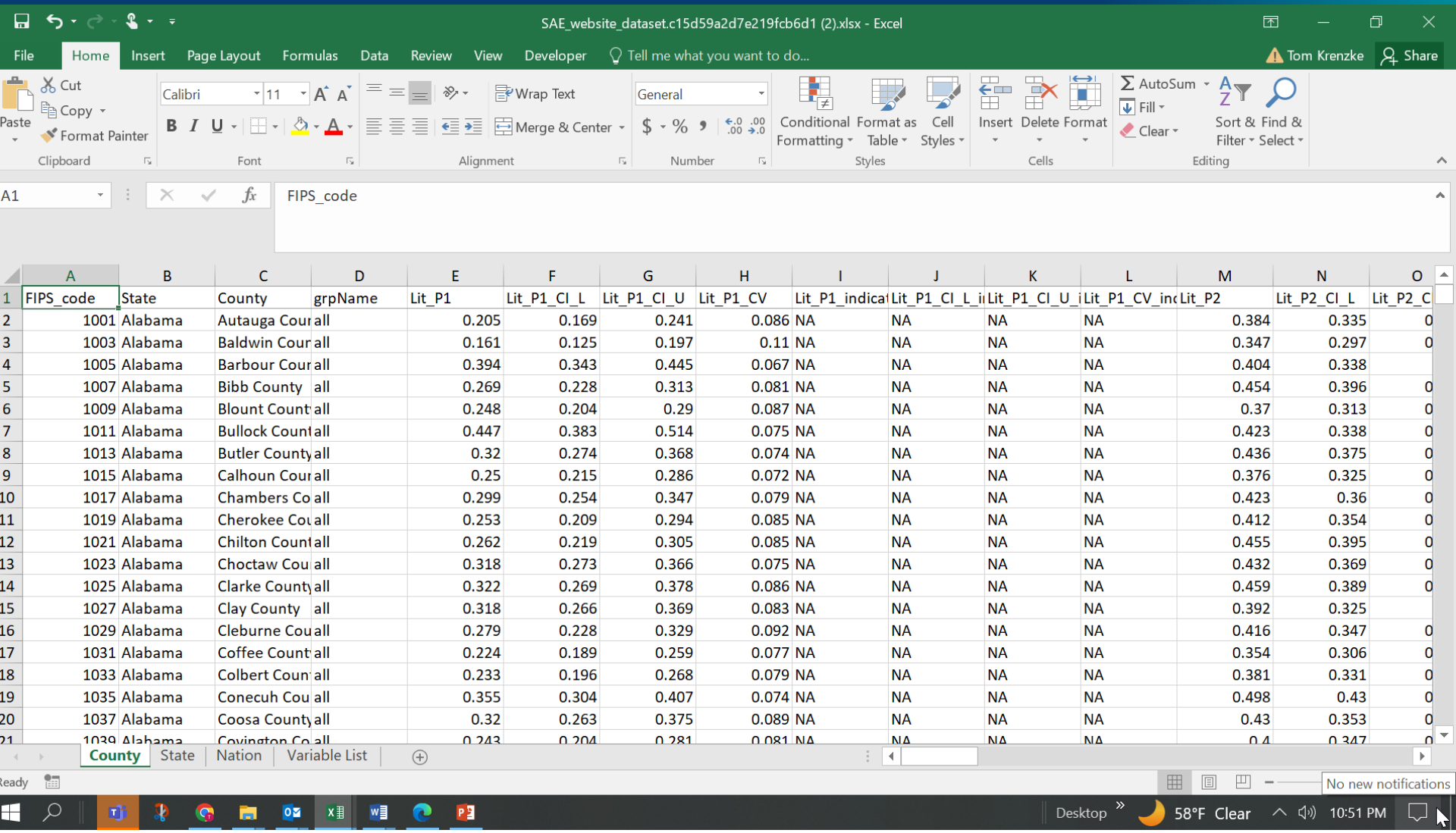
Map of Percentage At or Below Level 1 Literacy for High School/GED
MAP FILTER
County
State
Select 1 option to filter data on the map
Overall
16-24
25-34
35-44
45-54
55-64
65-74
< High School
High School/GED
Some College
Bachelor's or Higher
CONFIDENCE LEVELS
Overall
High
Moderate
Low
Static
Dynamic
Compare Counties
Download Data
Data User Guide
DC
Percentage at proficiency level
0%
100%
Desktop
58°F Clear
10:48 PM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File Home Insert Page Layout Formulas Data Review View Developer Tell me what you want to do...
Tom Krenzke Share
Cut Copy Format Painter Paste
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A1
FIPS_code
A B C D E F G H I J K L M N O
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1001 Alabama Autauga Cour all 0.205 0.169 0.241 0.086 NA NA NA NA 0.384 0.335 0
1003 Alabama Baldwin Cour all 0.161 0.125 0.197 0.11 NA NA NA NA 0.347 0.297 0
1005 Alabama Barbour Cour all 0.394 0.343 0.445 0.067 NA NA NA NA 0.404 0.338
1007 Alabama Bibb County all 0.269 0.228 0.313 0.081 NA NA NA NA 0.454 0.396 0
1009 Alabama Blount Count all 0.248 0.204 0.29 0.087 NA NA NA NA 0.37 0.313 0
1011 Alabama Bullock Count all 0.447 0.383 0.514 0.075 NA NA NA NA 0.423 0.338 0
1013 Alabama Butler County all 0.32 0.274 0.368 0.074 NA NA NA NA 0.436 0.375 0
1015 Alabama Calhoun Cour all 0.25 0.215 0.286 0.072 NA NA NA NA 0.376 0.325 0
1017 Alabama Chambers Co all 0.299 0.254 0.347 0.079 NA NA NA NA 0.423 0.36 0
1019 Alabama Cherokee Cou all 0.253 0.209 0.294 0.085 NA NA NA NA 0.412 0.354 0
1021 Alabama Chilton Count all 0.262 0.219 0.305 0.085 NA NA NA NA 0.455 0.395 0
1023 Alabama Choctaw Cou all 0.318 0.273 0.366 0.075 NA NA NA NA 0.432 0.369 0
1025 Alabama Clarke County all 0.322 0.269 0.378 0.086 NA NA NA NA 0.459 0.389 0
1027 Alabama Clay County all 0.318 0.266 0.369 0.083 NA NA NA NA 0.392 0.325
1029 Alabama Cleburne Cou all 0.279 0.228 0.329 0.092 NA NA NA NA 0.416 0.347 0
1031 Alabama Coffee Count all 0.224 0.189 0.259 0.077 NA NA NA NA 0.354 0.306 0
1033 Alabama Colbert Coun all 0.233 0.196 0.268 0.079 NA NA NA NA 0.381 0.331 0
1035 Alabama Conecuh Cou all 0.355 0.304 0.407 0.074 NA NA NA NA 0.498 0.43 0
1037 Alabama Coosa County all 0.32 0.263 0.375 0.089 NA NA NA NA 0.43 0.353 0
County State Nation Variable List
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PIAAC Skills Map

nces.ed.gov/surveys/piaac/skillsmap/

U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy

Data User's Guide

Northwest states is between 254.4 (=261.0-6.6) and 267.8 (=261.0+6.6).

Example 2: Average literacy score for 25 to 54 years old in California. The PIAAC SAE data for California provide information for individuals 25 to 34 years old, 35 to 44 years old, and 45 to 54 years old in California:

a. The ACS 2013-2017 population totals (POP_DOMAIN),

b. The estimated average literacy scores (LIT_A), and

c. The posterior variances of the average literacy score, which are derived as the squares of the products between the skills point estimates (LIT_A) and their associated CVs (LIT_A_CV).

To compute the estimated average literacy score for these three age groups combined within California (CA), take the weighted average of the three state by age group-level estimated average literacy scores in (b), using the corresponding ACS population totals in (a) as aggregation weights. That is, sum the product of the ACS population totals and the average literacy scores, and then divide by the sum of the ACS population totals:

$$\frac{[(5{,}822{,}870 \times 273.2) + (5{,}180{,}070 \times 252.1) + (5{,}202{,}335 \times 250.5)]}{5{,}822{,}870 + 5{,}180{,}070 + 5{,}202{,}335} = 259.2$$

(CA 25 to 34 years old) (CA 35 to 44 years old) (CA 45 to 54 years old)

To compute the estimated variance of the group skills estimate, sum the product of the ACS population totals and the skills estimated variances[12] for the areas in the group, and then divide by the sum of the ACS population totals for the areas in the group. Continuing with the example, the estimated variance of the group estimated average literacy score is computed as:

$$\frac{[(5{,}822{,}870 \times 26.9) + (5{,}180{,}070 \times 36.6) + (5{,}202{,}335 \times 36.1)]}{5{,}822{,}870 + 5{,}180{,}070 + 5{,}202{,}335} = 33$$

(CA 25 to 34 years old) (CA 35 to 44 years old) (CA 45 to 54 years old)

As noted before, the skills estimated variances are not directly available from the PIAAC SAE data. However, also as mentioned above, they can be derived as the squares of the products between the skills point estimates and their associated CVs. For example, for California 25 to 34 years old, the skills estimated variance of the estimated average literacy score is equal to $(273.2 \times 0.019)^2 = 26.9$.

As shown above, the estimated variance of the estimated average literacy score for the group of individuals 25 to 54 years old (25 to

PIAAC SAE Products

- **Skills Map** -- https://nces.ed.gov/surveys/piaac/skillsmap/
  - **User guide** – accessed via button in Skills Map
- Other state and county materials -- https://nces.ed.gov/surveys/piaac/skillsmap/
  - **FAQs**
  - **Brochure**
  - **Methodology** reports – one for each of the three sets of estimates
    - Set 1 estimates – Krenzke, et al (2020)
    - Set 2 estimates – Li, et al (2022)
    - Set 3 estimates – Erciulescu, et al (2022)

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