# Accessible Data Dashboards & Visualizations as Pragmatic Planning Tools for Educators

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**Data and IT Security in the "New Now"**
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TECH TACTICS IN EDUCATION
THE JOURNAL CAMPUS TECHNOLOGY

# A little about me…

- David Amiel, Research Associate, Rutgers
- MS in Statistics (Data Science)
- BA in Biomathematics (CS, Econ)
- Research Interests
  - K12 Computer Science Education, Ed. Partnerships
- Academic Interests
  - Causal Inference, Natural Language Processing
- Personal Interests
  - Photography, Astronomy, Harry Potter *(go Ravenclaw!)*

# …and a little about you.

- In your neighborhood of tech tacticians:
  - Introduce Yourselves
    - Name, Location, Role
    - How your work intersects with educational data
  - Begin to Ponder
    - How do you define “data” in education? Elsewhere?
    - Is there a general enough definition or broad enough characteristics to capture any type of data inside a working conceptualization?

# Talking about data

Some theoretical underpinnings.

## Idea 1

# Data is packaged.

- Data is a source of truth – we'll consider it as a package of three components
  - Information
  - Level
  - Format

- Example: Test scores
  - information – Standardized test scores
  - level – Student
  - format - numeric results in a spreadsheet


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## Idea 2

# Data can be acted upon.

- With a “box” of data, an agent is empowered to act:
  - Contribute to data through additions/revisions
  - Interpret data to understand meaning
  - Analyze data for a deeper understanding
  - Repackage data for easier future use
  - Aggregate data to simplify and summarize
  - Redact data to protect student privacy
  - Act on data to initiate changes to practice
  - Synthesize data to support recommendations/actions

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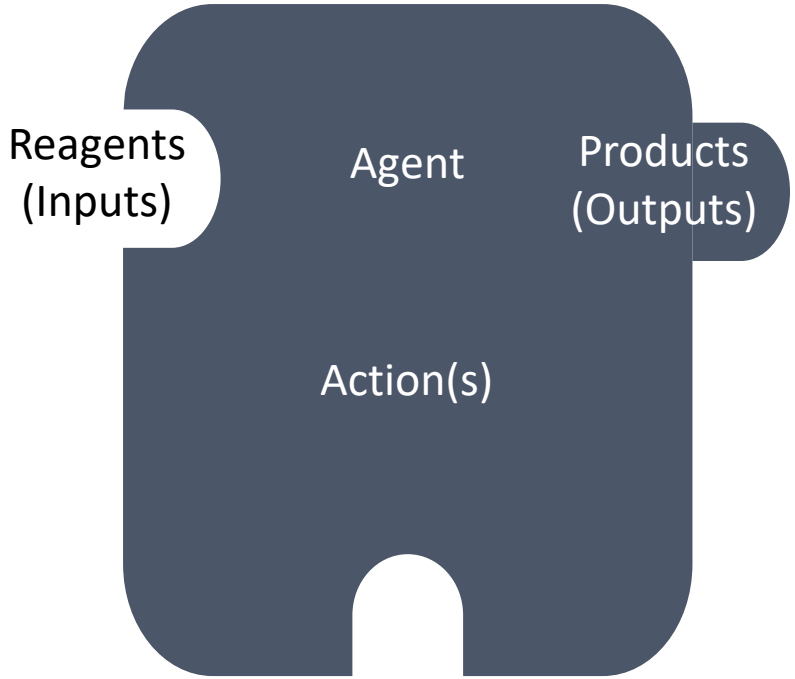

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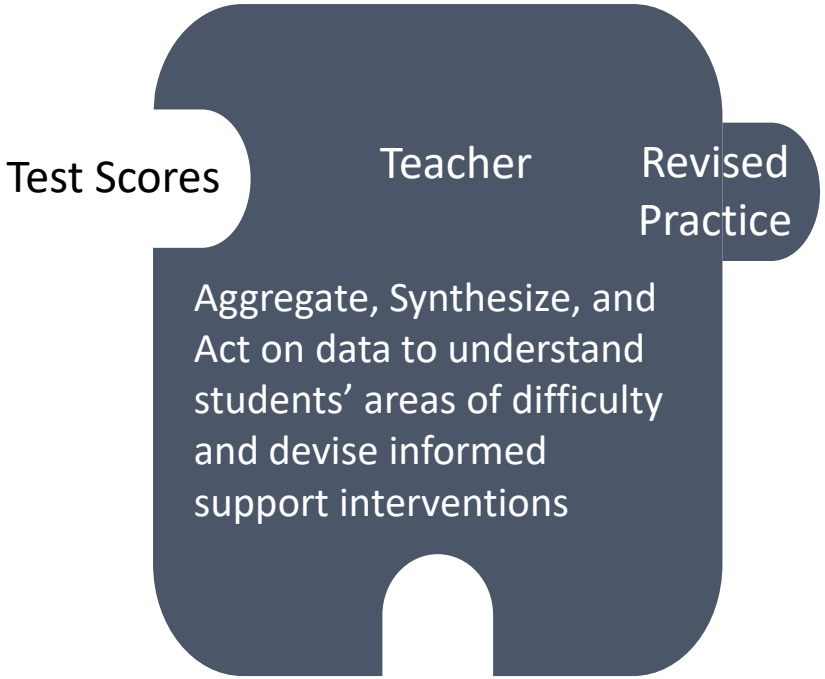

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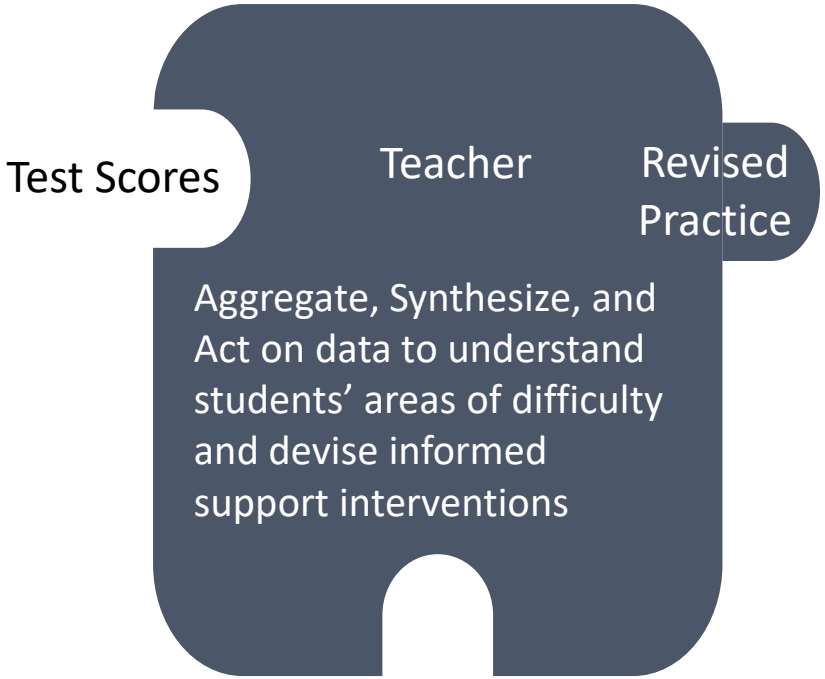
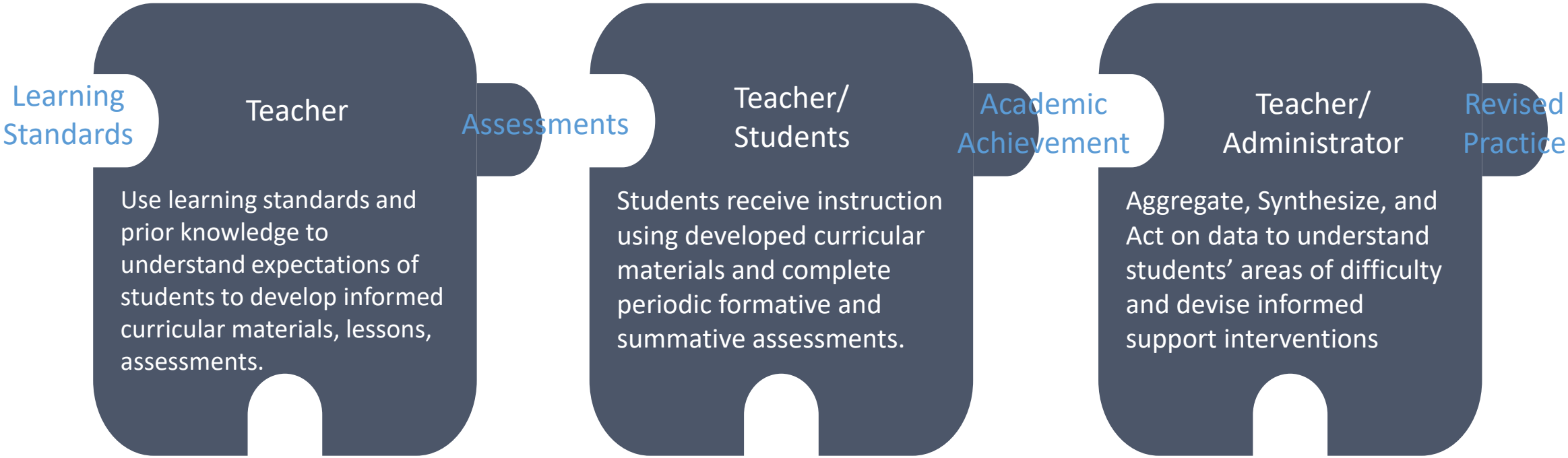
  - Synthesize data to support recommendations/actions
  - Send data to others for their own use



## Idea 3

# Actions can be strung together.



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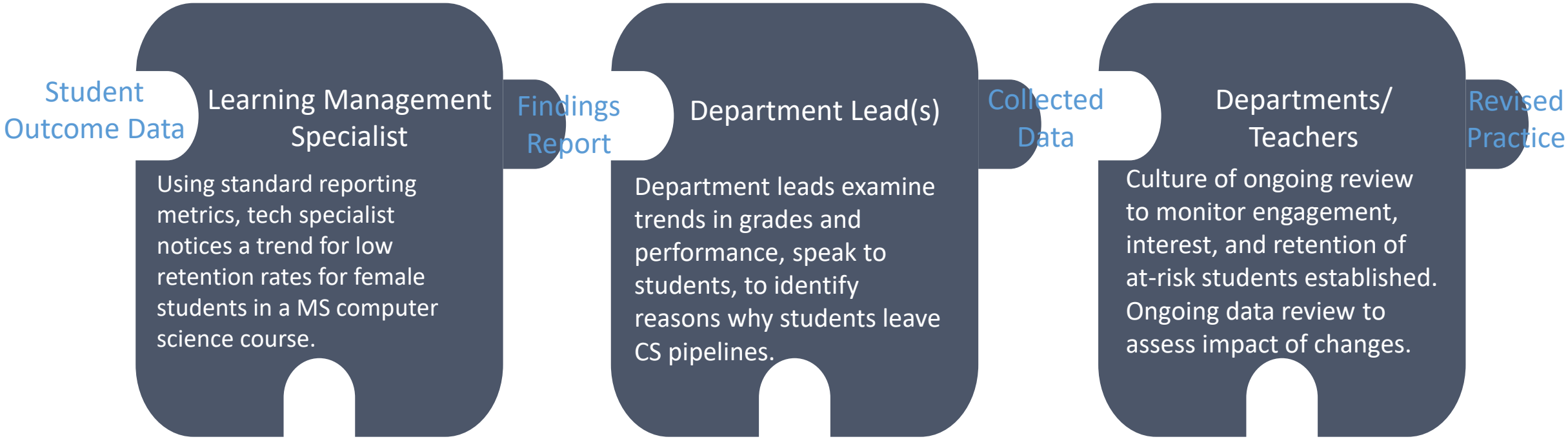
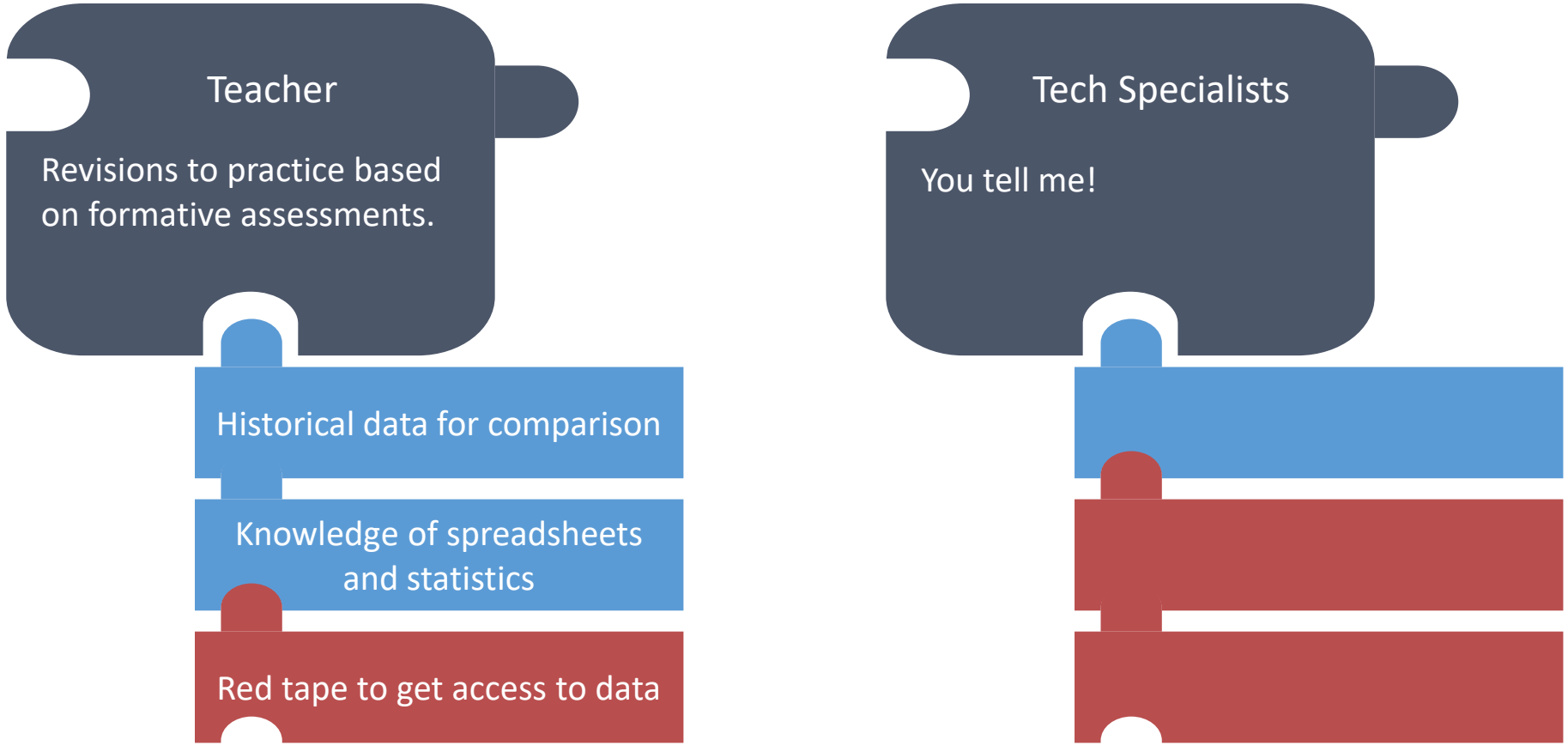


# Idea 4

# Action can be catalyzed and inhibited.



# Idea 5

# Mapped workflows give us planning power.

| Step | #1: Planning & Design | #2: Administering Assessments | #3: Analyzing Results | #4: Mobilizing Findings to Practice |
|---|---|---|---|---|
| Description | Development of thoughtful assessments | Students take assessments | Understanding student responses, performance | Putting revisions into practice |
| Agent | Teacher | Teacher, Students | Teacher, Administration | Teacher (& Administrator) |
| Reagents | Curriculum Goals, Standards | Developed assessments from Step #1 | Student response data from Step #2 | Curriculum and instructional revisions |
| Inhibitors & Catalysts | Data silos – inhibitor<br>Data management system to centralize standards – catalyst | Online LMS – catalyst<br>Connectivity | Data visualizations – catalyst<br>Complex datasets, inaccessibility – inhibitor | |
| Products | Data-informed assessment strategies | Student responses<br>Student grades | Findings from data analysis, plan to revise | Ongoing cycle of improvement |
| Action | Design | Generation | Aggregation & Analysis | Mobilization |

## Idea 5

# Mapping workflows give us planning power.

- Activity – take a few, map out a *problematic or interesting* data workflow you are directly or indirectly involved with.

| Step | #1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Data | | | | |
| Agent | | | | |
| Reagents | | | | |
| Inhibitors & Catalysts | | | | |
| Products | | | | |

# Data Dashboards & Visualizations

Thoughtful design, engineering, and implementation.

## Idea 6

# Dashboards and visualizations enhance work.

- They constitute the “format” piece of our data package
  - Leaves flexibility open in level and information
- Can be a reagent (input), product (output), catalyst, or *inhibitor* within workflows
  - Reflects how adaptive they can be, and the potential for over/misuse
- Several types (non-exhaustive): logistic, reporting, persistent

## Idea 7

# Dashboards must be thoughtful.

User needs and requirements

Ease of use and quality of life

Scalability and reliability

Integration with existing systems

Pilot testing, dissemination and training

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<u>Remember our theoretical discussion!</u>

Where in a data flow does it ***make sense*** to have a dashboard?

What ***data*** will it display, what ***purpose*** will it serve?

## Technical Considerations

# Statistical Caveats, Gains of Salt

Dashboards are not controlled experimental environments.

Dashboards can showcase trends (period).

| | | | |
|---|---|---|---|
| Control, Power, Causality | Generalizability | Repeated Experiments | Confidentiality & Privacy |

# A Simplified Example

The power of data-informed planning.

# Case Example Appleton Middle School

**Introductory CS Class Roster**

| ID | Race | Gender | Grade |
|---|---|---|---|
| **1** | **W** | **F** | **6** |
| 2 | W | F | 7 |
| **3** | **W** | **M** | **6** |
| **4** | **W** | **M** | **6** |
| **5** | **W** | **M** | **7** |
| 6 | W | M | 7 |
| 7 | W | M | 8 |
| 8 | H | F | 8 |
| **9** | **H** | **M** | **6** |
| **10** | **B** | **M** | **7** |
| 11 | B | F | 6 |
| **12** | **B** | **M** | **7** |

Bold = Continued to Next Course

**School Demographics**

| Female | White | Hispanic | Black |
|---|---|---|---|
| 51% | 40% | 18% | 42% |

**Intro Course Demographics**

| Female | White | Hispanic | Black |
|---|---|---|---|
| 33% | 58% | 17% | 25% |

**Advanced Course Demographics**

| Female | White | Hispanic | Black |
|---|---|---|---|
| 14% | 57% | 14% | 28% |

**Constraints**:

- No courses are required
- Intro must be taken before advanced
- Both courses can be taken at any grade level
- This is fake and very oversimplified

Based on available data, how would you advise this school team to proceed?

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**Females**:

- Underrepresented in introductory course
- Disproportionately dropping out of pipeline

**Recommendations**:

- Outreach to encourage girls to participate in CSE
- Introductory learning opportunities geared towards girls
- Examine relevance of introductory course material

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**Hispanic Students**:

- Well-represented in introductory course
- Disproportionately dropping out of pipeline

**Recommendations**:

- Examine relevance of introductory course material
- Explore possibility of language-related barriers to success

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**Black Students**:

- Underrepresented in introductory course
- Proportionately progressing through pipeline

**Recommendations**:

- Examine relevance of student recruiting/informational materials
- Examine relevance of introductory course material

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**Other questions we may have**:

- Are there skews in academic achievement? **No.**
  - Are they related to who progresses along the pipeline?
- What does representation look like at the high school level? **Similar.**
- What electives did the 30% of students to leave CS take? **Art & Forensics**
- What percentage of students are taking CS in general? **34%**

**Red = Fake Answers for Discussion Purposes**

# Case Example Appleton Middle School

Original Intervention Plan

- Outreach campaign to incoming 6th graders
- Family Code Night for middle school students
- HS presentation to advanced computer science course
- New tutoring program for introductory computer science

# Case Example Appleton Middle School

Data-Responsive Intervention Plan

- Outreach campaign to incoming 6th graders

*Focus heavily on marketing to girls (all but one of 6th graders are male)*

- Family Code Night for middle school students

*Heavily incorporate CRT and student choice (CS students likely to be the ones attending)*

- ~~HS presentation to advanced computer science course~~

*Likely not going to be impactful yet (HS participation mirrors MS)*

- New tutoring program for introductory computer science

*Great idea! Market well.*

- New: Revisit pedagogy and content material for introductory CS

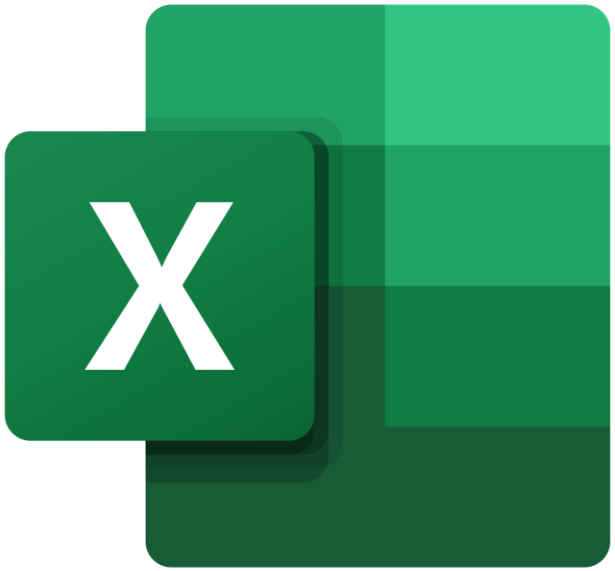
# Technique Demonstration

# PivotTables

Case Study #1: University Chemistry Department

# PivotTables: Excel's Dashboard Feature

- What's a PivotTable?
  - Excel feature for data summarization
  - Reorganizes and extracts meaningful insights
  - Ideal for quick analysis without altering data
- PivotTable Strengths
  - Interactive data exploration
  - Flexible views with simple adjustments
  - Efficient data summarization



# Case Study (& Demos!)
# University Chemistry Department

**Scenario**: The Chemistry Department at our university is facing a challenging issue regarding academic performance across its various courses. While some classes consistently produce high average grades, others show a fluctuating pattern of student achievement. This fluctuation is particularly noticeable in the Chemistry Lab courses, where academic performance seems to vary significantly from semester to semester.

**Available Data**: To address this issue, we have collected comprehensive educational data spanning multiple semesters from Spring 2020 to Spring 2023. The data includes various attributes like semester, class name, teacher ID, day of the week, class size, and average grade for each class.

**Objective**: We're seeking to identify any hidden trends or patterns that could explain this variability in academic performance. Specifically, we want to explore whether class size has an impact on average grades, especially for Chemistry Lab courses. The ultimate goal is to use these insights to make data-driven decisions for optimizing class sizes and improving student achievement.

# PivotTable Demonstration

# Technique Demonstration

# R & Shiny

Case Study #2: Freshman Biology Gradebook

# What is R?

R is an open-source programming language and environment, widely used for statistical computing and graphics.

- Comprehensive statistical analysis toolset
- Extensive library of packages for specialized analyses
- Graphical capabilities for high-quality plotting

# What is Shiny?

Shiny is an R package that enables the creation of interactive web applications directly from R.

- Interactive User Interface: Users can interact with your data analysis in real-time
- No Web Development Required: Write in R, deploy as a web app

Transform static data reports into interactive web applications.

# Execute youR Code

*datalore.jetbrains.com*

Sign in with Google, email, etc.

New Notebook –> Select R Kernel

Use the folder on the left to upload files

Note – this is NOT a plug! I would recommend downloading Rstudio if you wish to continue with R.


Datalore

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Use the folder on the left to upload files

Note – this is NOT a plug! I would recommend downloading Rstudio if you wish to continue with R.

*go.rutgers.edu/amiel2023tt*

```r
### Install Necessary Packages
# install.packages("tidyverse")
# install.packages("ggplot2")
# install.packages("dplyr")

### Load Packages We'll Need
library("tidyverse")
library("ggplot2")
library("dplyr")


### Open our CSV File
data <- read.csv("biologygradebook.csv") %>% tibble()

### View our data
head(data, 5)
```

Table | Raw | Visualize | Statistics

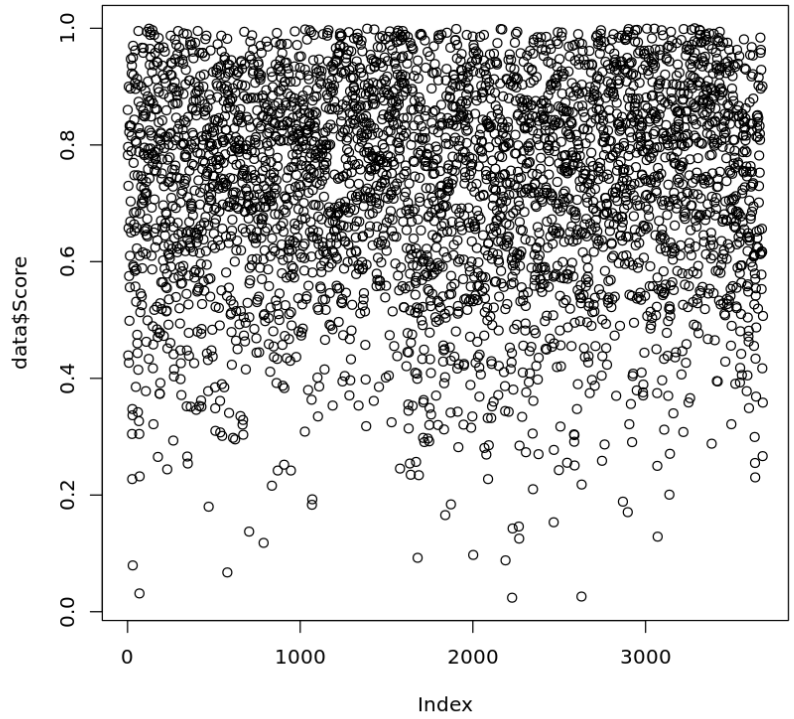
| | Student | Assignment | Type | MaxPts | EarnedPts | Unit |
|---|---|---|---|---|---|---|
| 1 | Student 1 | Classwork U1A1 | Classwork | 15 | 12.9 | 1 |
| 2 | Student 2 | Classwork U1A1 | Classwork | 15 | 11.74 | 1 |
| 3 | Student 3 | Classwork U1A1 | Classwork | 15 | 11.95 | 1 |
| 4 | Student 4 | Classwork U1A1 | Classwork | 15 | 6.59 | 1 |
| 5 | Student 5 | Classwork U1A1 | Classwork | 15 | 10.95 | 1 |

5 rows x 7 columns  Jump to top  Jump to bottom

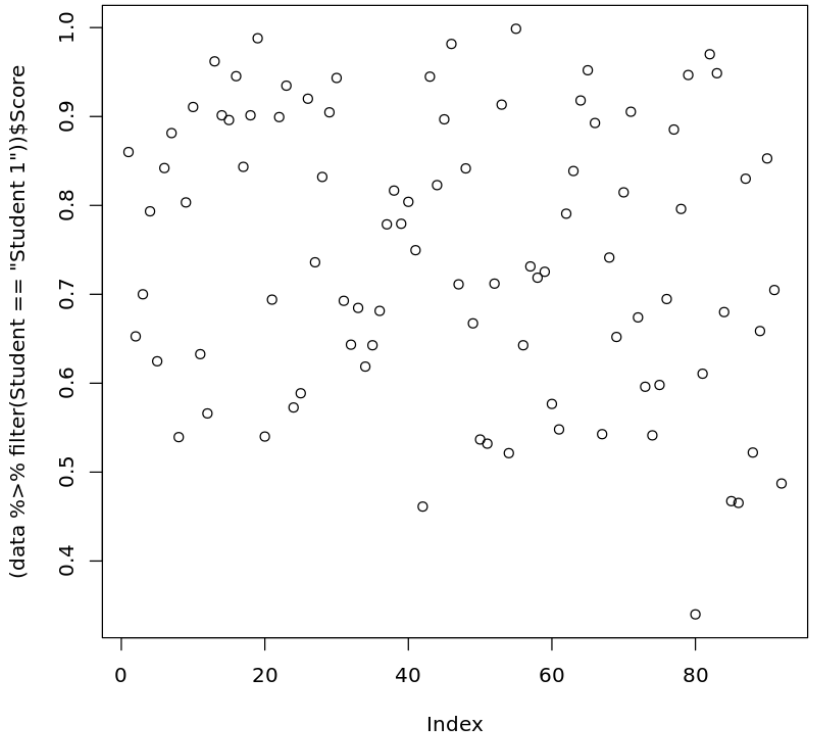
```
0.0s

### Subset our data by column
data.subset1 <- data$Assignment

### ...by row
data.subset2 <- data[1:2]

### ...using a filter
data.subset3 <- filter(data, Student == "Student 1")
```

```
### The pipe operator
data <- data %>% mutate(Score = EarnedPts/MaxPts)
```

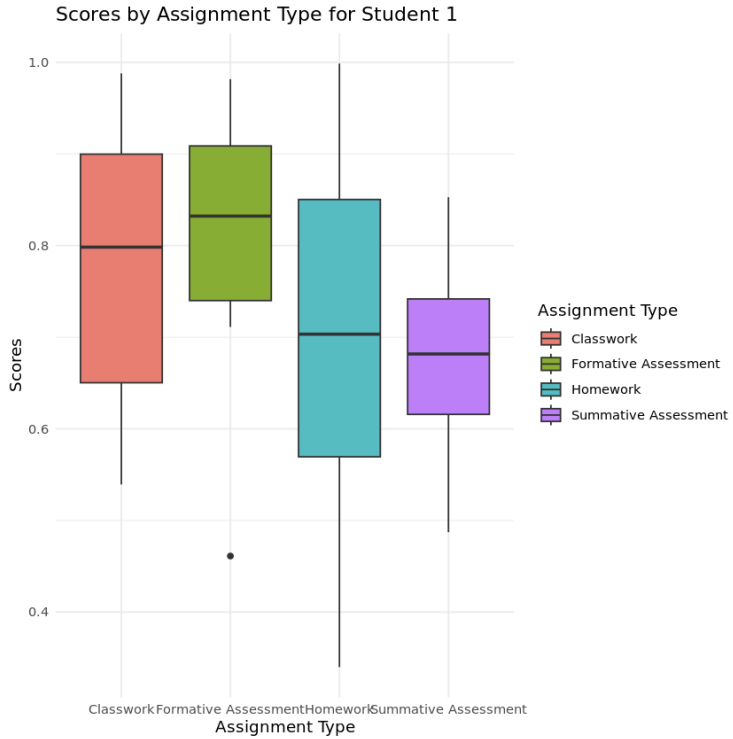
```
plot(data$Score)
```



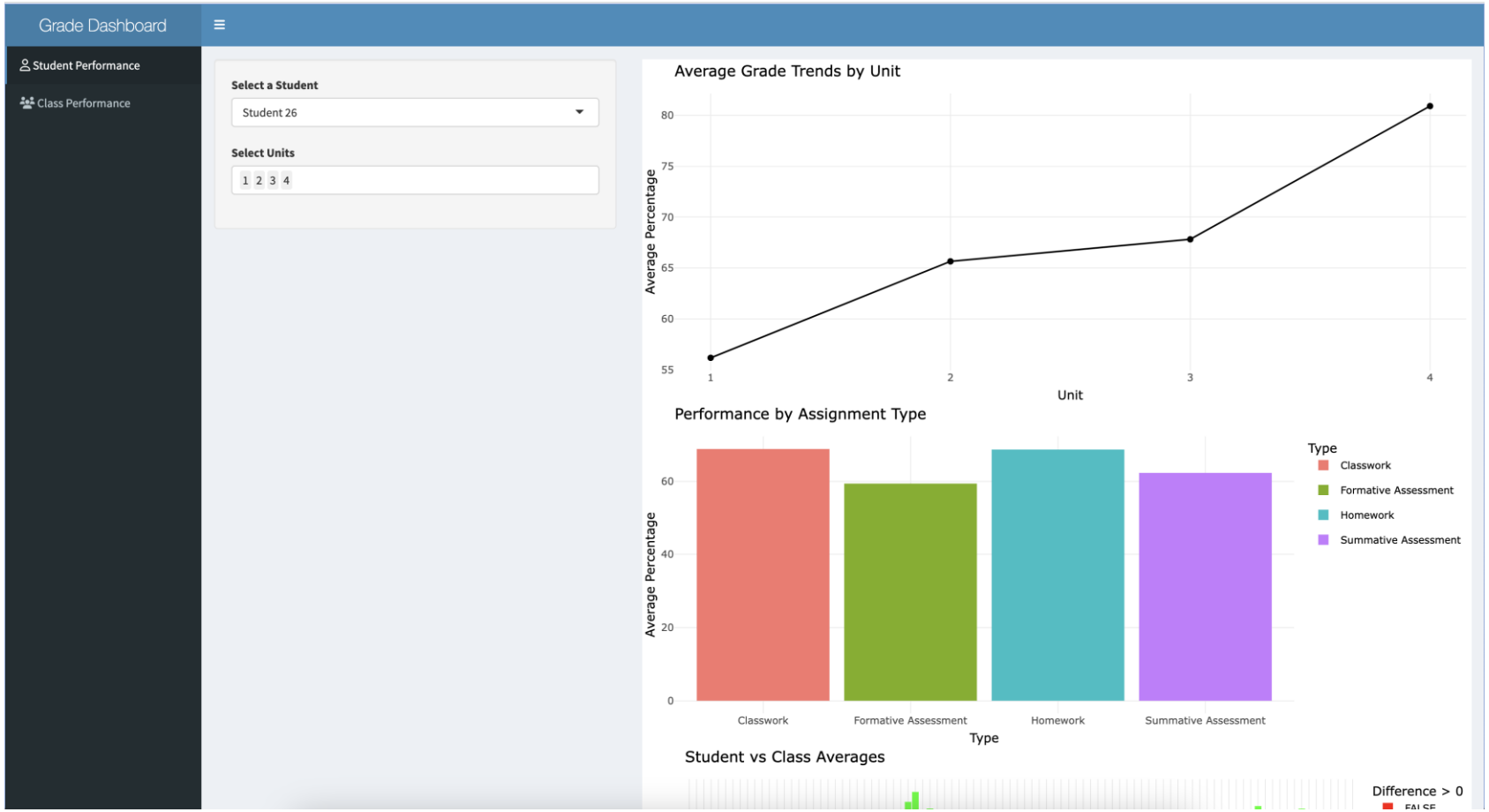
```
plot((data %>% filter(Student == "Student 1"))$Score)
```



```r
Student1Data <- data %>% filter(Student == "Student 1")

ggplot(Student1Data, aes(x = Type, y = Score, fill = Type)) +
  geom_boxplot() +
  theme_minimal() +
  labs(title = "Scores by Assignment Type for Student 1",
       x = "Assignment Type",
       y = "Scores",
       fill = "Assignment Type")
```



# Dashboards are not far off!




Two-Page Dashboard
~100 Lines of Code

# Wrapping Up

Bringing it all back together.

# Visualization & Dashboard Techniques

## Manual Techniques

- PivotTable, Excel
- Python
- R
- External Resources (Fiverr, Upwork, etc.)

Please reach out!
david.amiel@rutgers.edu

## AI-Based Techniques

- I'd like to create a visualization in Python that shows the relationship between class size and average student performance. My data is saved in a file named "data.csv" and contains the following fields:
  - *Class_ID* a unique identifier for the class
  - *Class_Name* the name of the course
  - *Teacher_ID* an identifier for the course teacher
  - *Class_Size* the number of students in the class
  - *Average_Grade* students' average grade in the course
  - *Semester* the semester the course was offered, written as "Fall 2021" as an example

# Our Big Ideas

1. Data is packaged.
2. Data can be acted upon.
3. Actions can be strung together.
4. Action can be catalyzed and inhibited.
5. Mapped workflows give us planning power.
6. Dashboards and visualizations (can) enhance work.
7. Dashboards must be thoughtful.
8. Research and technical considerations.

*pollev.com/davidamiel965*

# Thank You for Attending!

Your feedback is important to us. Please take a moment to complete the session evaluation via the QR code. Thank you!