Assessment for Data Geeks:
Business Intelligence, Relational Databases, and Dashboard Reporting Applied to Learning Outcomes Assessment

2021 IUPUI Assessment Institute
Agenda Outline

- Background
- Assessment of Learning Dashboard
- Key Concepts from Business Intelligence and Relational Databases
- Applications for Learning Outcomes Assessment
National Louis University

- Pathways program begins (2015-16)
- Undergraduate College begins (2018-2019)
- In AY 2021...
  - Over 3200 students served
  - 51% entered as first-time freshmen, 49% adult/transfer
  - 57% Hispanic or Latino, 20% Black or African American
  - 76% Pell eligible or undocumented
  - 73% first generation college students
## Undergraduate College Programs

| Business                          | BA: Business Administration  
|                                  | BA: Communications           
|                                  | BS: Computer Science & Information Systems |
| Education                        | BA: Early Childhood Education |
|                                  | BA: Elementary Education     |
|                                  | BA: Infant/Toddler Studies  |
| Social & Behavioral Sciences     | BA: Criminal Justice         |
|                                  | BA: Human Services           |
|                                  | BA: Psychology               |
My Role

- **Director of Undergraduate Analytics**
  - Organized under the Undergraduate College
  - Collaborate with IR, IT, provost’s office, other university departments

- **Representing Undergraduate College on University Assessment Council**
  - Monthly committee focused on assessment
  - Facilitated by provost’s office
  - Representation from Student Affairs & all colleges

- **Representing a college as an analytics administrator**
  - What you’re giving up
  - What you’re getting
Obligations to Stakeholders...

To our program chairs and faculty...
- Provide clear & bounded requirements for assessment planning
- Support & consultation during assessment planning
- Perform all data gathering, transformation, reporting
- Support & consultation for meaning-making of assessment data

To my dean and academic leadership...
- Standard metrics across programs
- Consistent of methodology (when possible)
- Consistent visualization/reporting across programs
- Create a longitudinal dataset for future strategic analysis

Design principles
Annual Program Review

Previous process...

- Assessment Cycle Review (University Assessment)
- Program Health (Institutional Research)
- Data Deep Dive (Undergrad College)

Calendar:
- October
- November
- December
- January
- December

Chart:
- September
- October
Annual Program Review

New process as of AY 2019…
Consolidates multiple review cycles into one
Encompasses multiple dimensions of program health:

- Enrollment & Revenue
- Student Outcomes
- Assessment of Learning
Dashboard Reporting

- Annual Program Review
- Focus on Assessment of Learning
Dashboard

- Program Review Dashboard
  - Enrollment & Revenue
  - Student Outcomes
  - Assessment of Learning
Assessment of Learning Dashboard

Features to view interact with assessment results...
... as a trend in Key Performance Indicators
... as annual summary by measure
... disaggregated by demographic
... by program learning outcome
... by University learning outcome
... deep dive into individual measures
Key Concepts from Business Intelligence and Relational Databases

- Identifiers and Keys
- Entity Relationship Diagrams / Star Schema
- Facts and Dimensions
Relational Databases

- If you have ever worked with an Excel spreadsheet, you have worked with a database.
- Storage and retrieval of information structured in rows and columns

Example: `SELECT * FROM t_bi_course`

![Query Result](image)
Relational Databases

- *Relational* refers to how data is split into different tables for more efficient storage
- Can be merged or joined together when needed
Identifiers and Keys

- Well-organized databases will have a key for each table (or most important tables)
- Keys have two purposes:
  - Define what a unique record is in the context of a table (primary key)
  - Join together data from two or more tables

<table>
<thead>
<tr>
<th>STUDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
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</tr>
<tr>
<td>N0123</td>
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<tr>
<td>N1234</td>
</tr>
<tr>
<td>N2345</td>
</tr>
<tr>
<td>N0123</td>
</tr>
</tbody>
</table>
Identifiers and Keys

- Well-organized databases will have a **key** for each table (or most tables)
- Keys have two purposes:
  - Define what a unique record is in the context of a table (primary key)
  - *Join together data from two or more tables*

<table>
<thead>
<tr>
<th>T_BI_COURSE</th>
<th>TERM_CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>crs_term_code</strong></td>
<td><strong>term_code</strong></td>
</tr>
<tr>
<td><strong>crn_crn</strong></td>
<td><strong>term_name</strong></td>
</tr>
<tr>
<td><strong>crs_start_date</strong></td>
<td><strong>term_start_date</strong></td>
</tr>
<tr>
<td>202190</td>
<td>202160</td>
</tr>
<tr>
<td>01234</td>
<td>Summer 2021</td>
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<tr>
<td>09/21/2021</td>
<td>07/10/2021</td>
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<tr>
<td>202190</td>
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<tr>
<td>12345</td>
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<td>202210</td>
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<td>23456</td>
<td>Winter 2022</td>
</tr>
<tr>
<td>09/21/2021</td>
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<tr>
<td>09/22/2021</td>
<td>04/21/2022</td>
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</table>
Entity Relationship Diagrams

• An ERD is a visual map that illustrates how different tables in the database are related.
• Tableau, Microsoft Power BI, and similar dashboard software have an interface where you define the ERD for your data. Modeling your data correctly is often very important to building legible charts and graphs!

```
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<td><code>term_name</code></td>
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<td>crs_catalog_number</td>
<td><code>term_start_date</code></td>
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<tr>
<td>crs_title</td>
<td><code>term_end_date</code></td>
</tr>
<tr>
<td>crs-campus</td>
<td></td>
</tr>
</tbody>
</table>
```

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An ERD Model

- Example from Microsoft Power BI
- Optimized for counting unique students served per AY (annualized enrollment)
- Small fraction of the tables in the University’s data lake
Facts and Dimensions

Dimensions

- Stable entities or “objects”
- Change more slowly (or not at all)
- The *nouns* in a data sentence

Facts

- Transactional / event data generated when two dimensions intersect
- Changes more quickly
- The *verbs* in a data sentence
### A Simple Higher Ed Example...

**Students (Dimension)**

<table>
<thead>
<tr>
<th>ID</th>
<th>First</th>
<th>Last</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>N012</td>
<td>Juan</td>
<td>Albion</td>
<td>M</td>
</tr>
<tr>
<td>N123</td>
<td>Jill</td>
<td>Bly</td>
<td>F</td>
</tr>
<tr>
<td>N234</td>
<td>Lucy</td>
<td>Cortes</td>
<td>F</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Courses (Dimension)**

<table>
<thead>
<tr>
<th>ID</th>
<th>Term</th>
<th>Code</th>
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<tbody>
<tr>
<td>1234X</td>
<td>FA21</td>
<td>MTH-101</td>
</tr>
<tr>
<td>2345Y</td>
<td>FA21</td>
<td>ADG-201</td>
</tr>
<tr>
<td>3456Z</td>
<td>SP22</td>
<td>MTH-101</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Registration (Fact)**

<table>
<thead>
<tr>
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<th>SDNT</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234X</td>
<td>N012</td>
<td>Actv</td>
</tr>
<tr>
<td>1234X</td>
<td>N234</td>
<td>Actv</td>
</tr>
<tr>
<td>2345Y</td>
<td>N012</td>
<td>Actv</td>
</tr>
<tr>
<td>2345Y</td>
<td>N123</td>
<td>Wthd</td>
</tr>
<tr>
<td>2345Y</td>
<td>N234</td>
<td>Actv</td>
</tr>
<tr>
<td>3456Z</td>
<td>N123</td>
<td>Actv</td>
</tr>
<tr>
<td>3456Z</td>
<td>N234</td>
<td>Actv</td>
</tr>
</tbody>
</table>
### Other Examples...

#### Customer (Dim)
- Customer ID
- Customer Name
- Address
- Phone

#### Product (Dim)
- Product ID
- Product Name
- Category

#### Gradebook
- Activity ID
- Activity Name
- Activity Category
- Points Possible
- Due Date

#### Sales (Fct)
- Invoice ID
- Customer ID
- Product ID
- Date
- Price

#### Grades (Fct)
- Student ID
- Activity ID
- Submitted Date
- Graded Date
- Points Earned

#### Roster
- Student ID
  ...

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“Star Schema”

An ERD with the Fact at the center and the Dimensions arrayed around it

Star schemas are optimized for describing the facts in terms of the dimensions
“Squid” Schema
WE DO NOT SOW
GREYJOY
Applications for Learning Outcomes Assessment

- “The” Logic Model for Learning Outcomes Assessment
- Assessment Planning with Measurement at the Center
- Getting Your Fact (table) Straight
- “The” Entity-Relationship Model for Outcomes Assessment
Propositions / Assumptions

- We have students in an academic program.
- The academic program has a corpus: knowledge we want students to hold, skilled behaviors we want them to perform, and disciplinary values or attitudes we want them to embody. The corpus can be expressed as a list of learning outcomes.
- We want students to demonstrate a certain level proficiency in each of these outcomes by the time they complete the program.
- A student’s performance on specific learning activities from the curriculum offers the evidence for their proficiency. Learning activities are measures.
- A measure can be relevant evidence for some learning outcomes, but not others. One learning outcomes can be evaluated distinctly from other learning outcomes.
- We can rely of the professional judgment of the program’s faculty to make appropriate connections between learning outcomes and learning activities.
Assumption / Propositions

Design Parameters

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- A measure can be relevant evidence for some learning outcomes, but not others. One learning outcomes can be evaluated distinctly from other learning outcomes.
- We can rely of the professional judgment of the program’s faculty to make appropriate connections between learning outcomes and learning activities.
Assessment Planning

Informed by the assumptions of our logic model, which are taken as design principles, the assessment planning process has three aims:

1) Define the list of program learning outcomes

2) Define the list of measures

3) Align / index the outcomes against the measures (i.e. specify which measures are relevant to which outcomes)
Assessment Planning

Align / index the outcomes against the measures

Creating a “user-friendly” worksheet:

Google Sheets example
Smartsheet example

Across all nine programs, there were…

179 measures in AY 18-19 (avg. of 20 measures per program)
165 measures in AY 19-20 (avg. 18 measures per program)
## Assessment Planning

Define the list of program learning outcomes

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLO_01</td>
<td>Summarize the historical development of human services.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_02</td>
<td>Explain the dynamics of interaction within and among human systems including individual, interpersonal, group, family, organizational, community, and societal.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_03</td>
<td>Identify and analyze the scope of conditions that promote or inhibit human functioning.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_04</td>
<td>Obtain, organize, evaluate, present, and utilize information while using appropriate technology.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_05</td>
<td>Systematically analyze service needs, plan appropriate intervention strategies, services, and implementation, and evaluate outcomes.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_06</td>
<td>Identify and apply appropriate practices for providing client services and intervening to clients and client groups.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_07</td>
<td>Effectively resolve conflict, establish rapport with colleagues and clients, and act in ways that reflect the values and ethics of the human services profession.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_08</td>
<td>Explain the functioning of the administrative aspects of the services delivery system.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_09</td>
<td>Apply and promote values and ethics intrinsic to the human services profession in practice, including self-determination, interdisciplinary team collaboration, and diversity.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_10</td>
<td>Develop awareness of their own values, personalities, reaction patterns, interpersonal styles, and limitations.</td>
<td>BA HMS</td>
</tr>
<tr>
<td>PLO_11</td>
<td>Apply human services, knowledge, theory, and skills in the professional environment.</td>
<td>BA HMS</td>
</tr>
</tbody>
</table>
Assessment Planning

Define the list of measures

Elements of the list are...

- Name of assessment
- Course
- Assessor
  - Faculty
  - student (self assessment)
  - cooperating teachers
  - test/exam score
- Beginning, middle, end of program
- Data system
- Success definition
Assessment Planning

Align / index the outcomes against the measures

Smartsheet Plan in Grid View

<table>
<thead>
<tr>
<th>Program</th>
<th>Measure ID</th>
<th>Course</th>
<th>PLO 01</th>
<th>PLO 02</th>
<th>PLO 03</th>
<th>PLO 04</th>
<th>PLO 05</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA CJ</td>
<td>M_01</td>
<td>CSJ-354</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>BA CJ</td>
<td>M_02</td>
<td>CSJ-354</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>BA CJ</td>
<td>M_03</td>
<td>CSJ-354</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>BA CJ</td>
<td>M_04</td>
<td>CSJ-354</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>BA CJ</td>
<td>M_05</td>
<td>CSJ-355</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLO 1</th>
<th>MSR 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLO 3</td>
<td>MSR 1</td>
</tr>
<tr>
<td>PLO 2</td>
<td>MSR 2</td>
</tr>
<tr>
<td>PLO 3</td>
<td>MSR 3</td>
</tr>
</tbody>
</table>
Assessment Planning

Align / index the outcomes against the measures

- Measure 1 offers evidence for PLOs 1 and 3
- Measure 2 offers evidence for PLO 2 only
- Measure 3 offers evidence for PLOs 2 and 3
Curriculum Map

- *Emergent* from measures-focused plan, not a separate step
- Simple guidance for scoping plan:
  - For each PLO, one beginning, one middle, and one end of program measure. [Smartsheet](#)
Getting Your Fact (table) Straight

Student Inf. System (University Data Lake)

Course Mgt. & Other Results Systems

Measures & Alignments
Getting your Fact (table) straight

The most important single table in “the” model is a novel data structure.

Table with… one row per completed course attempt by a student in the program per assessment measure in the course. “Expected assessments”

- Similar to registrations but with...
  - ...withdrawn students excluded
  - ...students from other programs excluded
  - ...only the most recent attempt by any single student
  - ...rows duplicated if multiple assessment measures in same course
Getting Your Fact (table) Straight

Join measures to class registrations where the course and program match

<table>
<thead>
<tr>
<th>prg</th>
<th>msr</th>
<th>sdnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>CJ</td>
<td>M_01</td>
<td>N012</td>
</tr>
<tr>
<td>CJ</td>
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</tr>
<tr>
<td>ELED</td>
<td>M_02</td>
<td></td>
</tr>
<tr>
<td>ELED</td>
<td>M_03</td>
<td></td>
</tr>
<tr>
<td>PSY</td>
<td>M_05</td>
<td></td>
</tr>
</tbody>
</table>

Student Inf. System (University Data Lake)

Query class registrations

<table>
<thead>
<tr>
<th>sdnt</th>
<th>crs</th>
<th>prg</th>
</tr>
</thead>
<tbody>
<tr>
<td>N012</td>
<td>CSJ-106</td>
<td>CJ</td>
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<td>CJ</td>
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<td>CSJ-106</td>
<td>CJ</td>
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<table>
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<tbody>
<tr>
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<td>M_01</td>
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<td>PSY</td>
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### Query class registrations

<table>
<thead>
<tr>
<th>sdnt</th>
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</thead>
<tbody>
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<td>N345</td>
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<tr>
<td>N789</td>
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<td>ECE</td>
</tr>
</tbody>
</table>
Getting Your Fact (table) Straight

Join measures to class registrations where the course and program match.

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<td>EDU-300</td>
</tr>
<tr>
<td>PSY</td>
<td>M_05</td>
<td>PSY-306</td>
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<td>ELED</td>
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<td>N456</td>
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<td>ELED</td>
</tr>
<tr>
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<td>ECE</td>
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</table>

Query class registrations

Student Inf. System (University Data Lake)
Getting Your Fact (table) Straight

Join measures to class registrations where the course and program match

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<td>WW</td>
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</tbody>
</table>
## Getting Your Fact (table) Straight

<table>
<thead>
<tr>
<th>Measures</th>
</tr>
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</tr>
</tbody>
</table>

~ 180 rows

<table>
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<tr>
<th>Assessments (Fact)</th>
</tr>
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<tbody>
<tr>
<td>Program (student &amp; measure)</td>
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~ 7000 rows (avg. ~40 students per assessment)
Getting Your Fact (table) Straight

~ 180 rows

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Assessment Measures (Fact)

| Program (student & measure) |
| Measure ID |
| Course |
| Term |
| Section CRN |
| Student ID |
| Completion? |
| Result? |
| Met Success Def.? |
## Getting Your Fact (table) Straight

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- **Course**
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- **Result?**
- **Met Success Def.?**
Granular Results

- Table with one row per expected assessment is linked to a table with more granular fact tables from the assessment system

Assessment Measure (Fact)

<table>
<thead>
<tr>
<th>prg</th>
<th>msr</th>
<th>stdnt</th>
<th>sys</th>
</tr>
</thead>
<tbody>
<tr>
<td>CJ</td>
<td>M_01</td>
<td>N0123</td>
<td>D2L Rubric</td>
</tr>
<tr>
<td>CJ</td>
<td>M_01</td>
<td>N0234</td>
<td>D2L Rubric</td>
</tr>
</tbody>
</table>

Rubric (Granular Fact)

<table>
<thead>
<tr>
<th>prg</th>
<th>msr</th>
<th>stdnt</th>
<th>criteria</th>
<th>score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CJ</td>
<td>M_01</td>
<td>N0123</td>
<td>Content</td>
<td>4</td>
</tr>
<tr>
<td>CJ</td>
<td>M_01</td>
<td>N0123</td>
<td>Creativity</td>
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</tr>
<tr>
<td>CJ</td>
<td>M_01</td>
<td>N0123</td>
<td>Writing Mechanics</td>
<td>3</td>
</tr>
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Getting Your Fact (table) Straight

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<th>Score</th>
<th>Possible Points</th>
<th>Date Assessed</th>
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</table>
“The” Model
Technology / Process Stack

Outcomes Assessment Cycle
- Planning
- Data Collection / Transformation
- Meaning-Making / Interpretation

Cloud Systems
- Smartsheet
- Alchemer
- Power BI

Local Systems
- R

Collaborators
- Chair / Faculty
- Analytics
- Chair / Faculty (implementation)
- Analytics (transformation)
- Dean / College Leaders
- Provost / University Leaders
- Chair / Faculty
Thank you!

Nate Flint
nflint1@nl.edu
Presentation Materials at: https://assessmentinstitute.iupui.edu/