

Are Your Students “Getting It”?

Just look at their mental model - insert brain probe, or use the card sort technique (latter preferred).

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What are they learning?

- Probably not what you think...
- Individuals process information and experiences in unique ways based on prior knowledge, experiences, cognitive abilities, etc.
- Twenty students will leave your class with twenty variations of what you covered.
- Issue: memorization vs higher-level organization of content required for advanced performance, problem-solving, and transfer.

Traditional assessment

- Traditional methods such as exams don't often get at these higher level skills and understandings.
- Exams too often:
 - prompt responses based on instructor's organization/presentation of material.
 - are affected by environment of fear/tension due to grades.
 - lead toward strategic memorization, not deep thinking and learning.
 - fool us into believing they are all learning the same stuff.

“Many examinations may capture the students' ability to take certain kinds of tests, but reflect little about the way students think.” Ken Bain

Alternative assessment

- Need to find out *from the individual* how they perceive that subject and what they can do with it - much richer.
- So, the trick is to peer into their brain to “see” how they've structured the content.

Mental models

- The way an individual organizes information and concepts about a subject is called a *mental model*.
- Each individual's model of a subject will vary to some degree.
- These models change over time through experiences, failure, success, etc.

Examples

- Operating a car
- Thermostat
- Restaurants
- Music history
- Physical therapy
- Include your own discipline or context here

Application to education

- In education, we want to ensure students are “getting it” in our classes.
- Just because they score a 98 doesn’t mean they really understand it.
- Mental model analysis can reveal how they perceive the material, thereby informing instructional design of the course.

Levels of knowledge in a mental model

- Content (declarative - knowing stuff)
- Structural (relational - connecting stuff)
- Procedural (applying to actual work)
 - *Structural Knowledge: Techniques for representing, conveying, and acquiring knowledge.* Jonassen, Beissner, Yacci.

Instructional goals

- We want students to think similar to an expert in the field.
 - Accurate information
 - Organized in a meaningful way
 - Able to apply knowledge in performance
 - Can transfer knowledge to new situations

Expert vs novice

- Compare mental models of experts in the field to student models.
- Expert can be the instructor, practicing professionals, etc.
- Presumably the expert model is the goal for instruction, so examining student models reveals issues that can inform course instructional design.

Methods for eliciting mental models

- Various methods have been utilized in many fields.
 - Concept mapping
 - Procedural analysis (think-aloud)
 - Card sort
 - others...

Card sorts

- This method involves participants sorting terms into piles that seem to go together.
- Designed to capture how an individual organizes concepts about a particular subject.
- Sorts reveal areas of deficiency and inaccuracy (missing information, wrong connections between concepts).
- Can also reveal level of understanding.

Sort procedure

- Investigator develops a list of terms/concepts significant to a particular subject.
- Participants sort these terms by placing them into piles of relevance.
- Terms that seem most similar go into a pile.
- Piles are determined, and labeled, by the participant based on whatever criteria they want to use.
- Can use note cards or software.

You try

Chevrolet	Honda
Ford	Volvo
Volkswagon	Toyota
Mazda	Chrysler
Saturn	

Now try this

Chevrolet	Honda
Lexus	Volvo
Volkswagon	Toyota
BMW	Chrysler
Jaguar	

Or this

plastic	fried	round tables
candle	silk	noisy
Muzak	coke	dessert
wine	medium-rare	teenager
romance	Mozart	carpet

Analysis

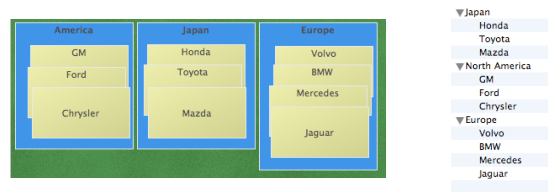
So now what do you do?

- Look for patterns - correct, incorrect, categories you never thought of, etc.
- Trends show you how a majority of students see your content.
- Keep an open mind - other people see things differently than you.
- Remember - this is not a grading exercise!

Analysis methods

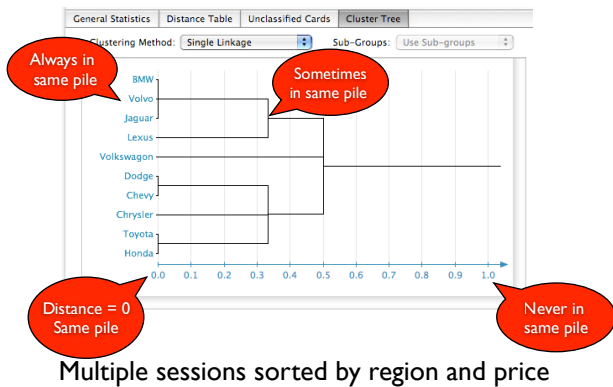
- Manually look at the piles and categories.
- Process with software:
 - Cluster analysis
 - Multidimensional scaling cognitive maps
 - Excel spreadsheets

Manually reviewing piles

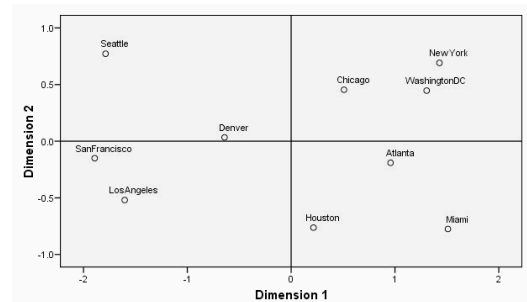


This sort organizes the auto makers by country/region of origin.

Cluster analysis

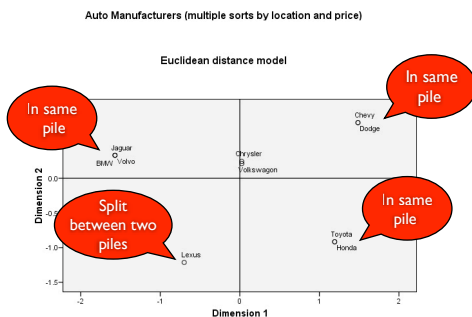


Multidimensional Scaling



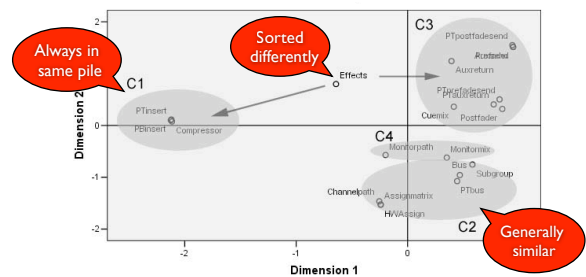
MDS plots items that are related (in same piles) closer than items perceived to be unrelated (distant). Can you find a pattern in this map?

MDS map showing which cards were grouped together in piles



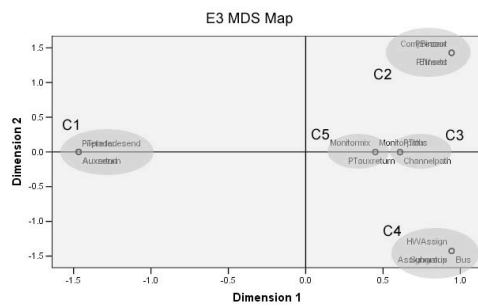
Lexus was placed by some in the BMW/Jag pile, but in the Toyota/Honda pile by others.

Complex MDS example



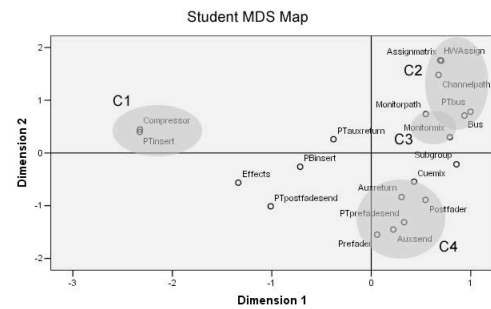
Analysis markings show clusters of terms that resulted from multiple sorts - less clearly defined due to people sorting differently.

Expert sort



Analysis markings show distinct clusters of terms that resulted from this single expert sort.

Student sort



This composite student sort is messier and ill-defined compared to the expert sort.

Faculty projects

- Music history
- Physical therapy
- Audio recording engineering

Music history

- First semester music history class
- Typical chronological sequence, content-based
- Fairly basic level of organization - in this case sorting terms by time periods.
- Could be expanded for higher-level conceptual relationships.

Music history results

- 50% of the students sorted similar to the expert sort completed by the instructor.
- In this case, by time periods, which demonstrated broad connections in the material.
- Several sorted by a lower-level conceptual organization.
- Definitions-based organization. Showed lack of ability to make broader, more meaningful connections.

“Correct” sort



Lower-level organization (definitions-based)

Intervals & Key	Style of Singing	Form & Style of Music	Time Periods	Composers	Instruments
modal	a cappella	polyphony	Medieval	Bach	sackbut
triads	opera	monophony	Renaissance	Machaut	harpischorid
perfect intervals		homophony	Baroque	Monteverdi	
		ornamentation		Josquin	

History results cont.

- The most common “mistake” was placing composers in the wrong time period.
- Students were generally able, however, to place other relevant terms into correct time periods.
- Instructor now realizes that although students seemed to grasp the literature, more emphasis must be placed on composers.
- She was surprised a bit by the results--would not have known these issues existed.

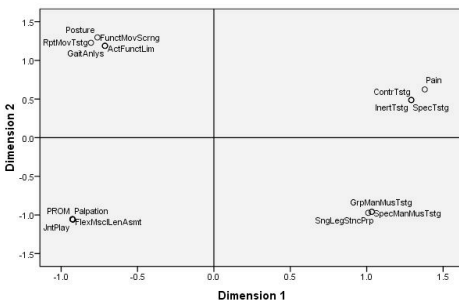
Physical therapy

- Faculty member wanted to see how students were approaching clinical decision making.
- Experts apply pattern recognition when matching presenting symptoms with possible solutions.
- Students tend to adopt hypothesis testing.
- Need to get students thinking more like the professionals to produce more efficient, effective patient care.

Physical therapy

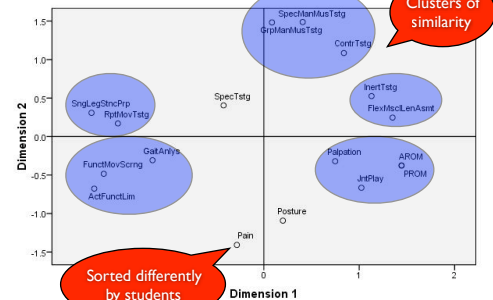
- The patterns that experts utilize are the higher level relationships among content - a very high functioning mental model.
- Need to bridge this gap to help students develop similar models.
- The card sort presented a list of terms related to clinical exam situations.
- The objective was to see how students organized these items.

Lehr Expert Sort 1
Derived Stimulus Configuration
Euclidean distance model

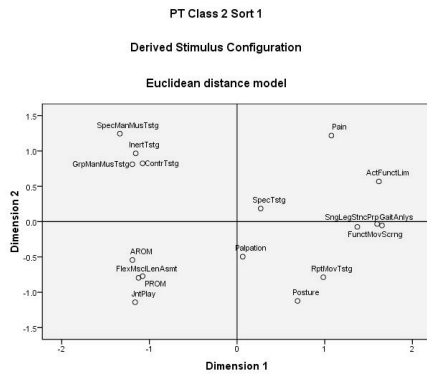


The instructor's sort results.

PT Class 1 Sort 1
Derived Stimulus Configuration
Euclidean distance model



Group I student sort results.



Group 2 student sort results - very similar to Group 1.
The specific quadrant is insignificant - can rotate the map. Main issue is distance and similarity between items on the map.

Physical therapy

- Benefits for the faculty member?
- “Sometimes you don’t know what you don’t know.” Have to find out *from the students*.
- Don’t assume anything - the exercise provided feedback that helped guide further instruction.
- He actually used the sort results in labs to discuss with students. Very effective.

Questions?

- Feel free to contact me:

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