# Using Computerized Lexical Analysis of Student Writing to Facilitate Just-in-Time Teaching in Large-Enrollment Biology Courses

Luanna Prevost, Kevin Haudek, Emily Norton Henry, Matthew Berry, Mark Urban-Lurain

Automated Analysis of Constructed Response (AACR)

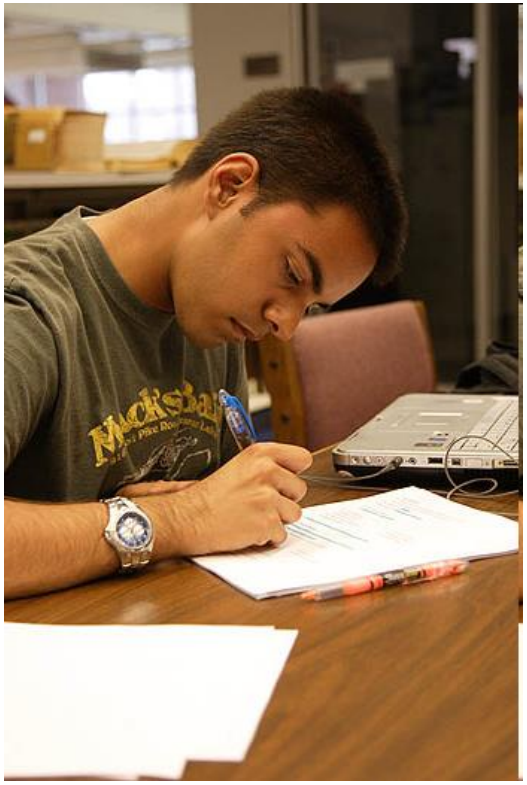
Research Group

www.msu.edu/~aacr

ceer Center for Engineering Education Research @ Michigan State University

MICHIGAN STATE UNIVERSITY

# Assessment to Reveal Student Thinking



- Large enrollment courses prohibit the use of constructed response assessments

# Constructed Response (CR) Assessments

- Allow students to represent their understanding in their own words (Keuchler and Simpkin, 2010)
- Give faculty greater insight into student thinking compared to multiple choice assessments (Birenbaum and Tatsuoka, 1987)
- Students treat CR and multiple- choice assessments as different cognitive tasks and prepare for them differently (Stanger-Hall, 2012)

Kuechler, W. L., & Simkin, M. G. (2010). Why is performance on multiple-choice tests and constructed-response tests not more closely related? Theory and an empirical test. *Decision Sciences Journal of Innovative Education, 8(1), 55-73.*

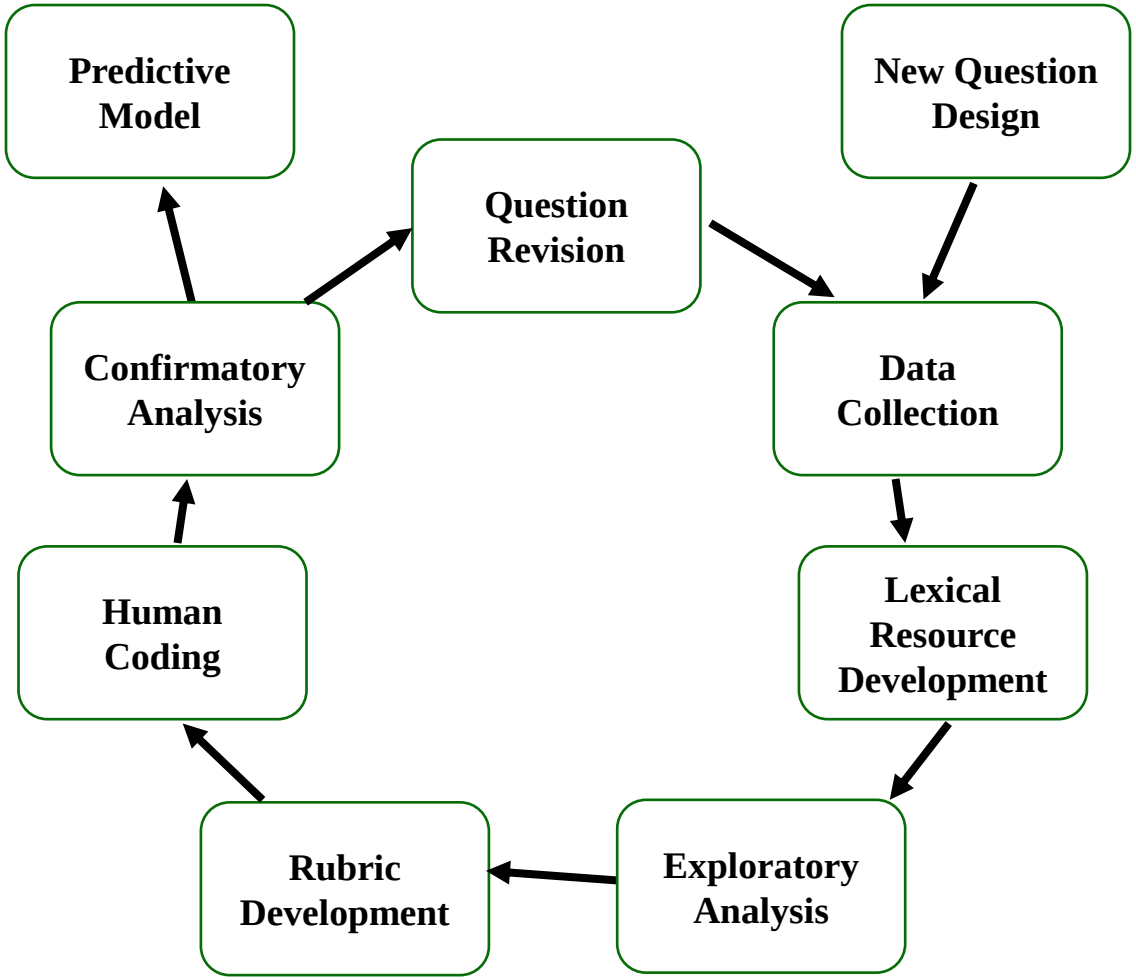
Birenbaum, M., & Tatsouka, K. K. (1987). Open-ended versus multiple-choice response formats - It does make a difference for diagnostic purposes. *Applied Psychological Measurement, 11, 329-341.*

Stanger-Hall, K. F. (2012). Multiple-choice exams: An obstacle for higher-level thinking in introductory science classes. *CBE-Life Sciences Education, 11(3), 294-306.*

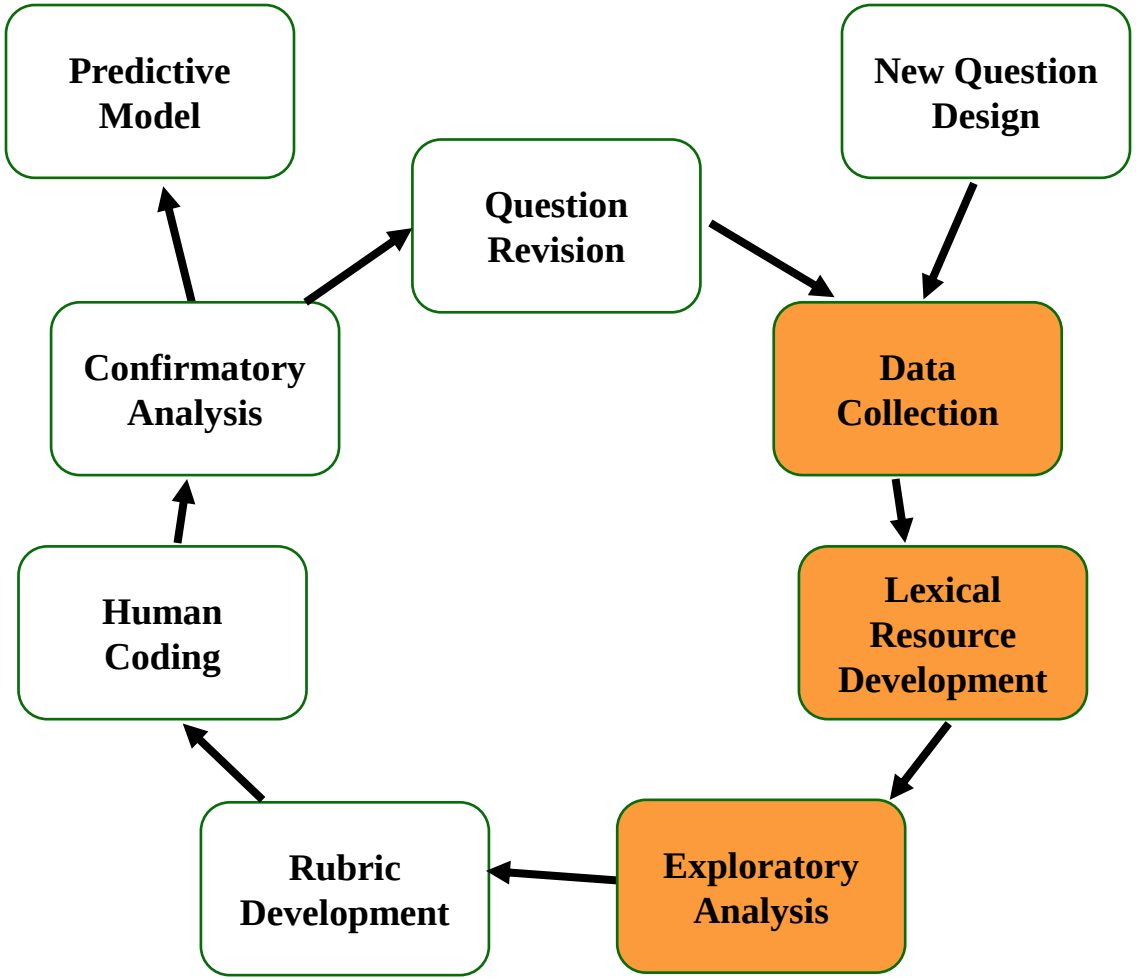
# AACR Objectives

- Evaluate students' understanding of scientific concepts
- Create models of student thinking
- Use linguistic and statistical analysis to analyze students' writing

# Question Development Cycle



# Question Development Cycle



# Data Collection: Study Population

- 3 sections of Introductory Biology Cell and Molecular Course for Majors
- 4 instructors

| | Section 1 | Section 2 | Section 3 |
|---|---|---|---|
| Enrollment | 309 | 466 | 302 |
| % Female | 46 | 58 | 49 |
| % First and second years | 69 | 69 | 67 |
| Cum GPA at start of term | 2.48 | 2.69 | 2.52 |

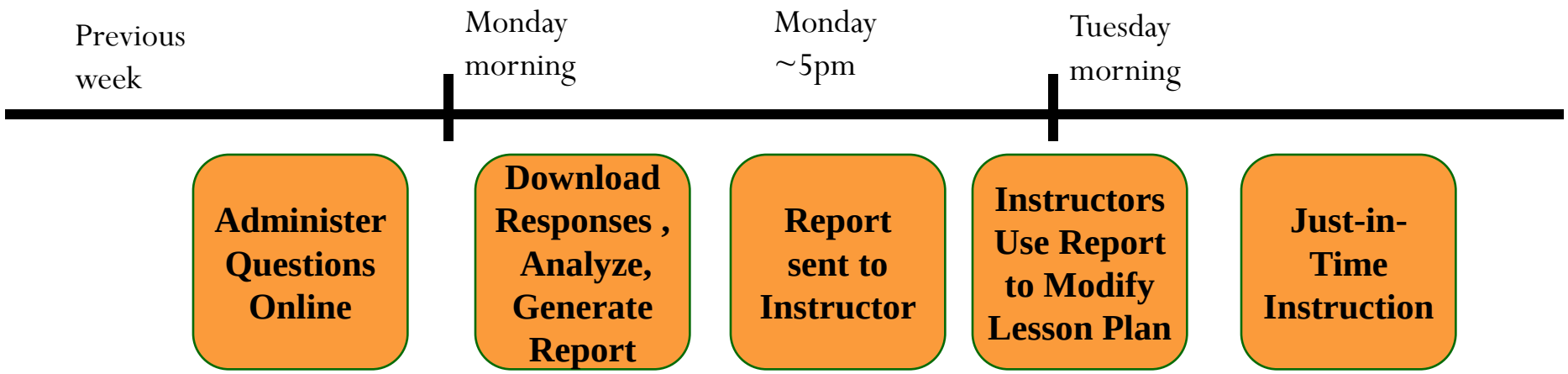
# Scope of Analysis

- 15 questions
  - Genetics , Thermodynamics, Acid-Base Chemistry, Metabolism

- Responses collected

| Pre | Post | Total |
|---|---|---|
| 8,290 | 4,387 | 12,677 |

# Timeline:
# Feedback Report and Just-in-Time Teaching

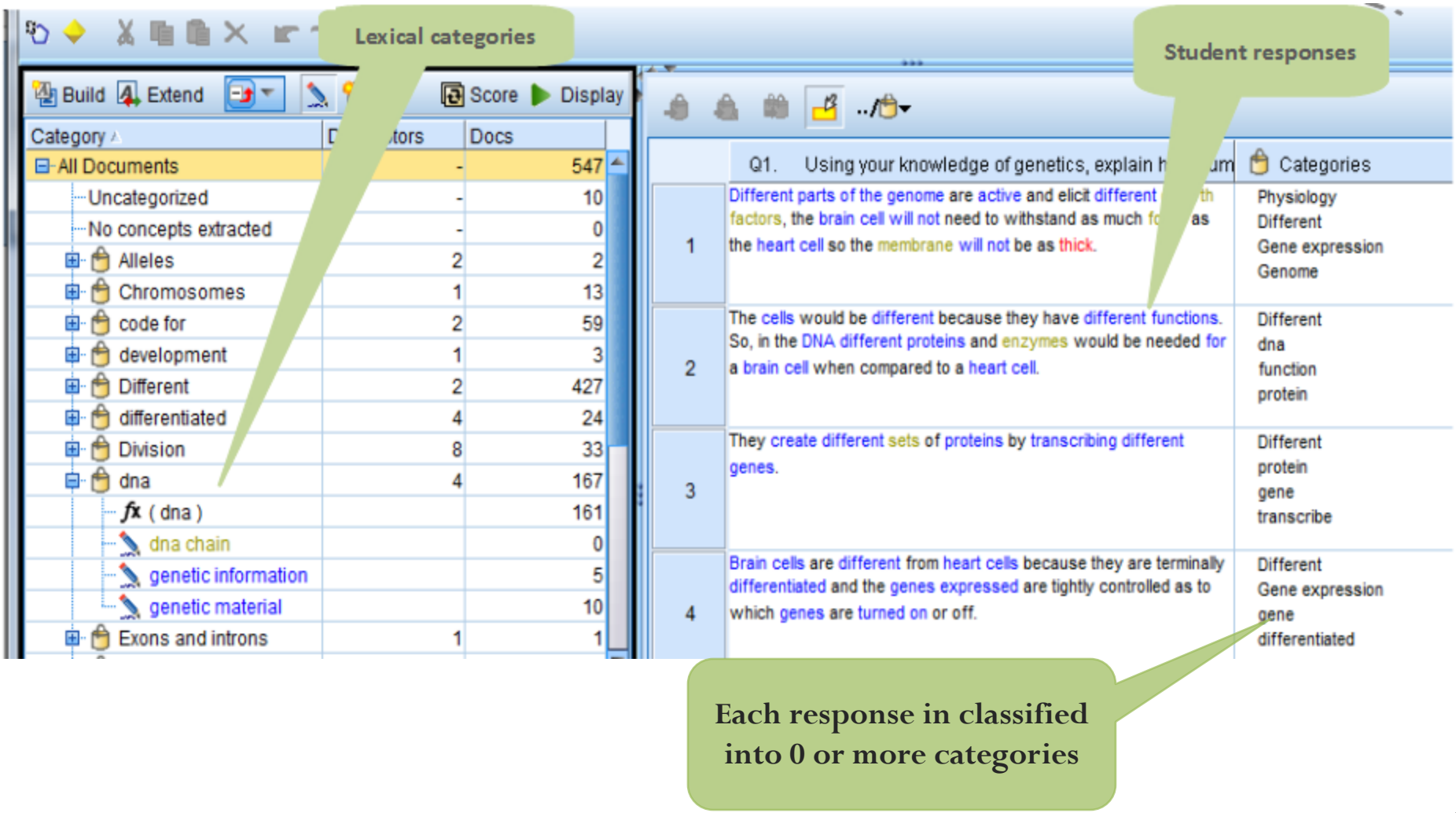


# Question

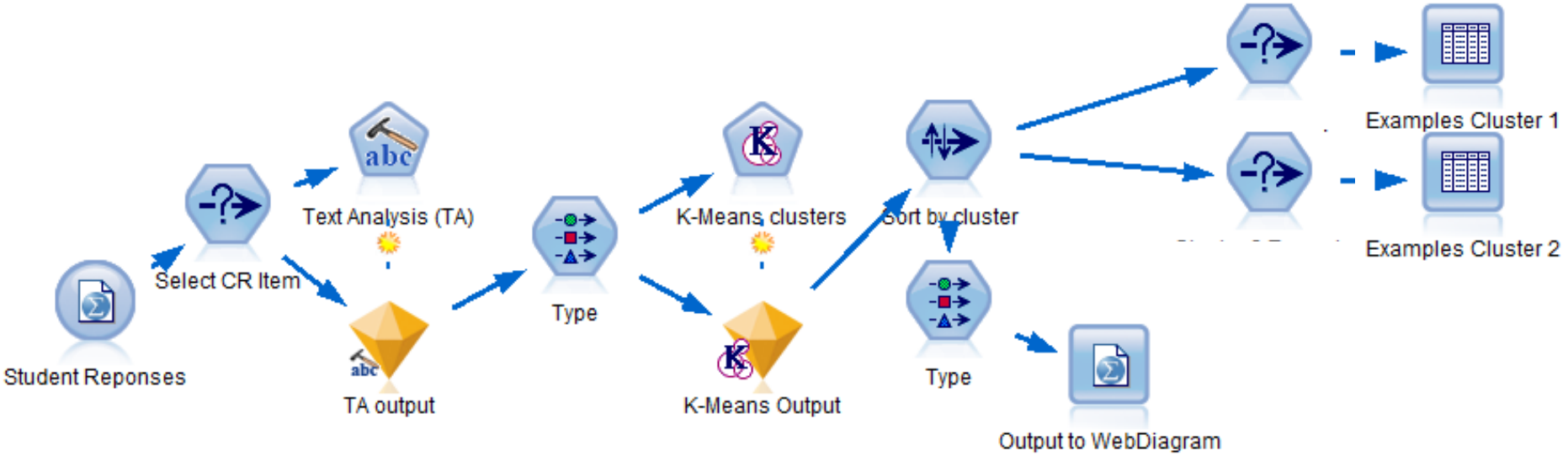
- Using your knowledge of genetics, explain how human brain cells and heart cells are different.

derived from Genetics Concept Assessment (Smith et al., 2008)

# Lexical Resource Development: IBM SPSS Text Analysis

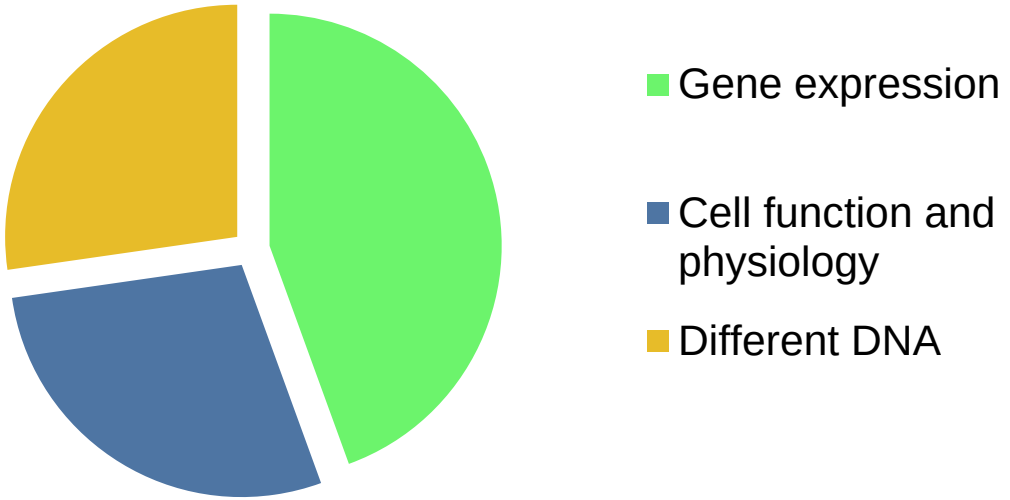


# Analysis Stream in IBM SPSS Modeler




- Connects text  and cluster analyses
- Generates output for feedback report
- Allows rapid analysis of new data sets

# Feedback Report



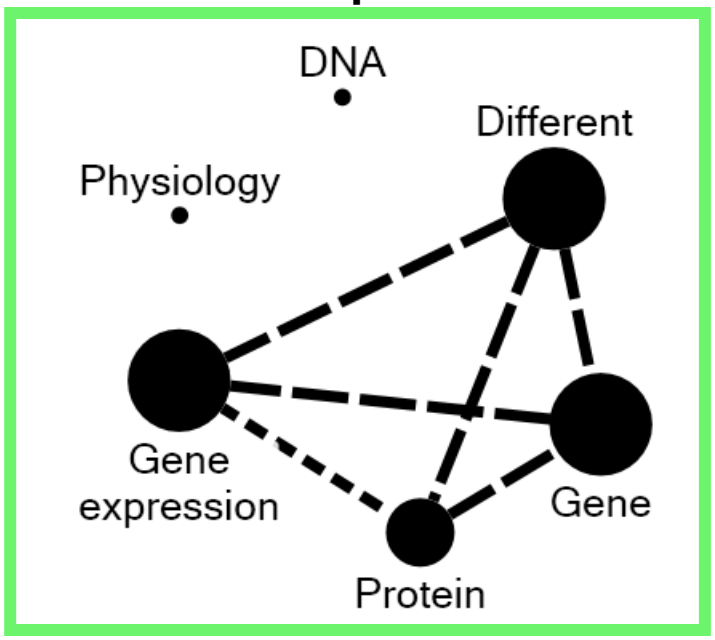

| | Cluster 1 44% | Cluster 2 28% | Cluster 3 27% |
|---|---|---|---|
| **Cluster description** | Gene expression | Cell function and physiology | Different DNA |
| | | | |
| **Sample Response** | Each cell has different genes turned on and off which expresses different proteins. | The function of the cells within the heart cells and eye cells is what makes them different. | Cells have different jobs Heart cells and eye cells are different because their DNA is different the DNA is coded into different RNA strands which code for proteins that are very different… |

# Distribution of Categories by Cluster

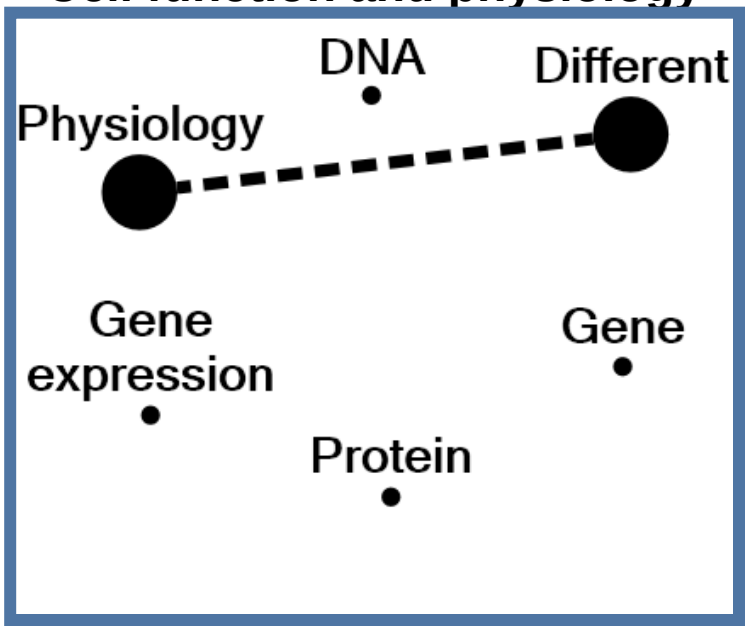
| Lexical category | Cluster 1<br>Gene expression | Cluster 2<br>Cell function and physiology | Cluster 3<br>Different DNA |
|---|---|---|---|
| Genes | 98% | 6% | 11% |
| Gene expression | 79% | 2% | 2% |
| DNA | 15% | 14% | 88% |
| Physiology | 11% | 66% | 17% |
| Protein | 60% | 10% | 46% |
| Different | 92% | 75% | 94% |

| >70% of responses were assigned to the category | 30-70% of responses were assigned to the category | <30% of responses were assigned to the category |
|---|---|---|

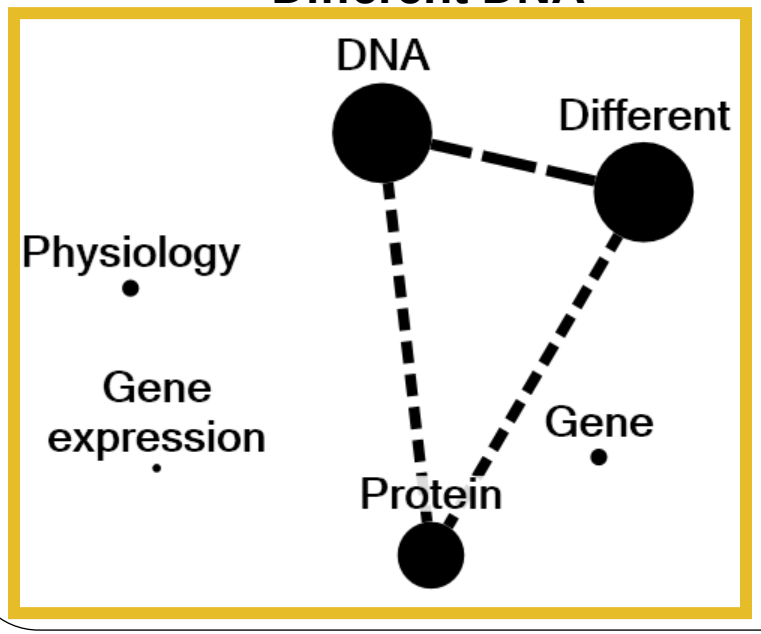
## Gene expression




## Cell function and physiology




## Different DNA




Node size: proportion of responses in category

Share 75 – 100 % of responses
Share 50 - 74% of responses
Share 25 – 49% of responses

# Comparison of Student Responses PRE/POST Instruction

| | | | Post-instruction | | |
|---|---|---|---|---|---|
| | Final distribution | | 44% | 28% | 27% |
| | Initial distribution | **Cluster** | Gene expression | Cell function and physiology | Different DNA |
| **Pre-instruction** | 35% | Gene expression | 70% | 13% | 17% |
| | 37% | Cell function and physiology | **23%** | 51% | 26% |
| | 28% | Different DNA | **41%** | 18% | 42% |

# Instructors response to CR questions and feedback reports

- Created clicker questions and led discussions based on results from feedback report
- Reported that written assessments were particularly important for gaining insight as to *why* students have struggled continuously with certain concepts
- Proposed future in-class activities to improve student writing skills

# Improving Automated Analysis for JiTT

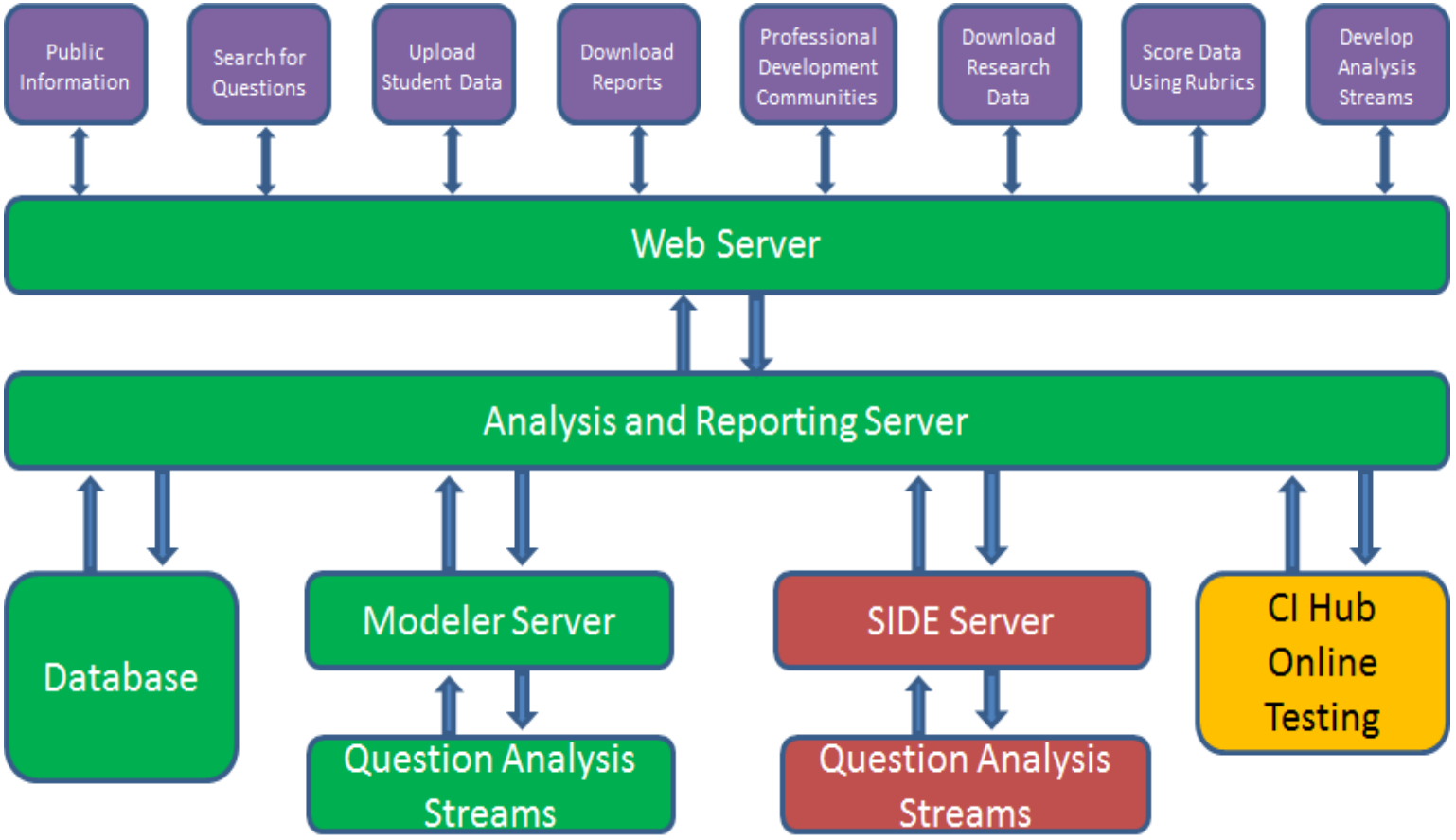
- Encourage student participation by giving credit for homework assignments
- Allow more time between each assignment and the next class for preparing instructional activities
- Professional development for faculty to help them address concepts that students find challenging

# Future Directions

- Faculty Learning Communities
  - Local: groups of faculty within a department or teaching the same course
  - Virtual: faculty across institutions
  - Use the same assessment & share instructional materials

# Future Directions

- Web Portal
  - support rapid assessment and feedback



# Acknowledgements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