Integrating Writing into a Cell Biology Laboratory Class

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Department of Biology

- > 1000 undergraduate biology majors
- 70% cell and molecular/physiology
- Laboratory classes are technique-oriented

Biol 402: Cell Biology Lab

Objective

Design an inquiry-based cell biology laboratory class with an integral writing component that teaches students about the scientific process

Mechanics

Teach the same class three consecutive quarters with different senior biology majors each quarter. Students participate in an on-going research project culminating in submission of a written research proposal

Biol 402 Advanced Cell Biology Lab Research Focus

Question: How do plants respond rapidly to environmental challenges at the level of gene regulation?

Model system: *Arabidopsis*

Approach: Assess role of chromatin regulatory factors in regulating stress-induced gene expression

Tool: *Arabidopsis* knock-out mutants

Why an Inquiry-Based Course?

- Provide students with real research experience
- Increase students' understanding of scientific process
- Help students realize how little is known
- Help students recognize role reading and writing play in scientific research
- Encourage students to be creative

Why a Writing-Based Course?

- Scientists write
- Writing = Learning
- Opportunity to practice discipline-specific writing skills
- Written record
  - Continuity of ideas
  - Potential to publish findings

4 x 4 Writing Initiative

- UW College of Arts & Sciences faculty development program
  - Goal: improve student writing across the college
- 4 faculty from 4 different departments
- Year-long project to re-design or design a new course with writing-integrated instruction

Writing-integrated Course Design

- Create writing assignments that are directly associated with the goals of the course
- Avoid traditional “term paper” assignment
- Give students “low-stakes” opportunities to practice writing skills
- Share grading criteria and models of good papers
- Broaden the audience/importance of the writing assignments

FALL

Develop hypotheses
Develop Biological Tools
Assess Biological Tools
Design Experiments
Write Research Proposal

WINTER

Review Research Proposals
Develop Hypotheses
Refine Biological Tools
Assess Biological Tools
Design Experiments
Write Research Proposal
Review Panel
Criteria Rubric

SPRING

Review Research Proposals
Refine Hypotheses
Assess Biological Tools
Design Experiments
Perform Experiments
Write Research Proposal
Review Panel
Criteria Rubric

Biol 402
Fall Quarter Activities

1. Read and present assigned article to class (gene-specific groups)
   - Research a topic
   - Critically evaluate existing data
2. Develop hypotheses
   - Identify unanswered questions
3. Develop and assess biological tools
   - Gain hands-on practice designing & performing experiments
   - Gain technical skills
   - Understand how scientific data is generated
4. Write a NIH-style research proposal
   - Understand the scientific research process

Biol 402-Fall Quarter
Writing-integrated Course Design

- Assignments associated with course goals
  - Course goal: learn how to develop a hypothesis
  - Assignment: review literature and write “Background & Significance” that identifies unanswered questions in the field
- “Low-stakes” opportunities to practice writing skills
  - Students receive written feedback on ungraded drafts of each section of research proposal
- Broaden audience
  - Students have vested interest in writing strong proposals so their proposals are “funded” the next quarter

Scaffolding Research Proposal Writing Process for Fall Quarter

- Introduce research topic
- Introduce experimental methods
- Assign and discuss individual sections of new research proposal (draft of one section due each week)
- Provide written feedback on each draft (minimal marking)
- Grade final research proposals using specific rating criteria

Research Proposal Evaluation Criteria

1. Context/Interest
   - Hypothesis & Specific Aims
     - Context
     - Hypothesis
     - Specific Aims
   - Background & Significance
     - Introduce relevant topics
     - Literature review
     - Broader significance
2. Data Presentation/Argument
   - Preliminary data results
   - Interpretation/relevance
   - Experimental methods
3. Research Design
   - Overall design/expected outcomes
   - Alternate outcomes
   - Limitations of research design
4. Overall Presentation
   - Informative figures, spelling etc.

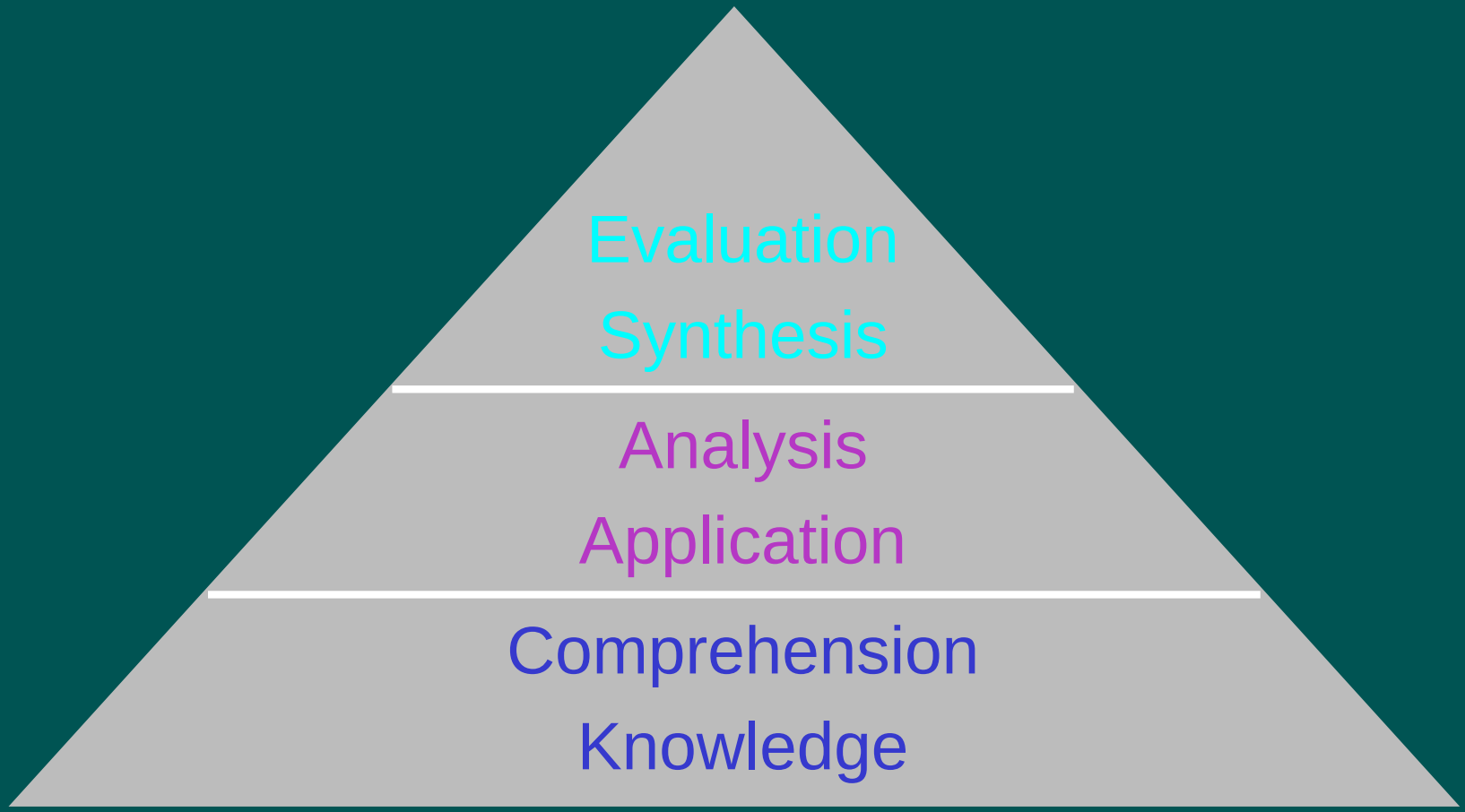
Research Proposal Grading Rubric: Hypothesis

Criteria

1. Context/interest
   - Hypothesis & Aims
     - Context
     - Hypothesis
       - 1 = prediction not a hypothesis
       - 2 = untestable and/or trivial hypothesis
       - 3 = testable hypothesis, but lacking specificity or creativity
       - 4 = creative/novel testable hypothesis
     - Specific Aims

Criteria	% students who lost points
1. Context	
Hypothesis & Aims	
Context	50 ☺
Hypothesis	77 ←
Specific Aims	91 ←
Background & Significance	
Introduce topics	50 ☺
Literature review	73
Broader significance	59 ☺
2. Data Presentation/Argument	
Preliminary data results	73
Interpretation/relevance	73
Experimental methods	68
3. Research Design	
Overall design	68
Alternate outcomes	77 ←
Limitations	91 ←

Bloom's Taxonomy



Bloom, B.S., 1956

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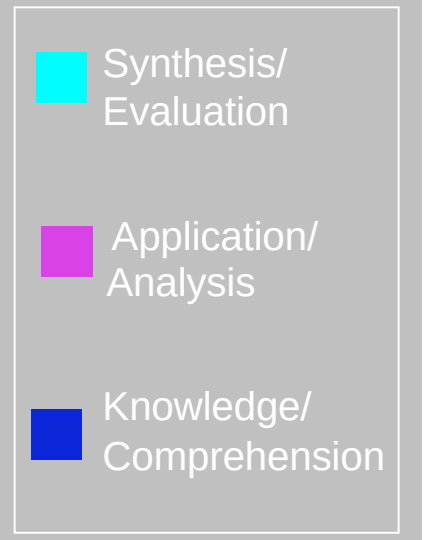
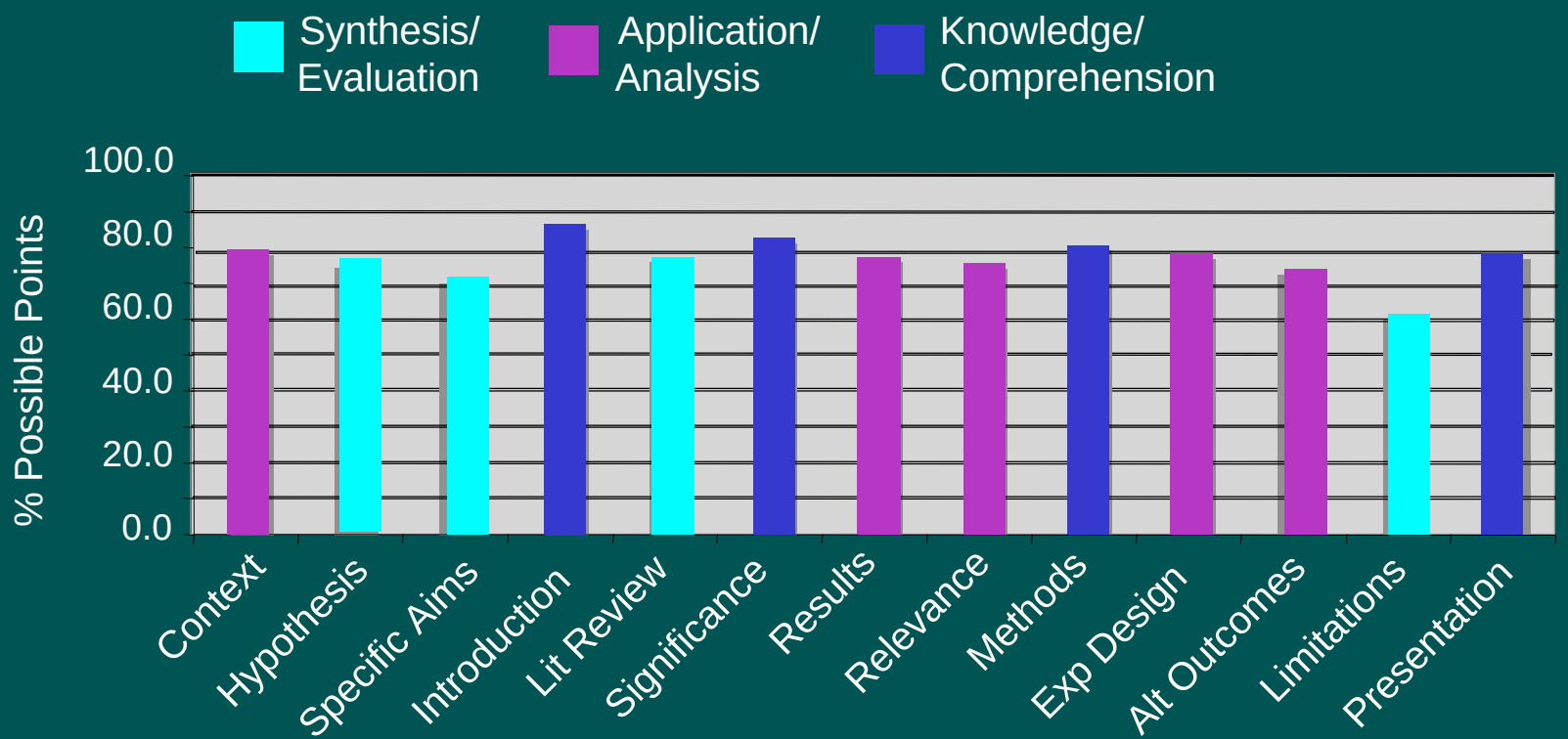


Identification of Weaknesses in Students' Scientific Writing



Winter Quarter Activities

1. Read and present assigned article to class
2. Peer review previous quarters' research proposals
   - Learn components of research proposal
   - Use guidelines to evaluate proposal
   - Perform role of expert
3. Refine and assess biological tools
4. Write a NIH-style research proposal

Scaffolding of Research Proposal Writing Process for Winter Quarter

- Introduce research topic
- Introduce experimental methods
- Introduce evaluation criteria
- Assign research proposals to review
- Hold scientific review panel
  - Each team selects one proposal to “fund”
- Assign and discuss individual sections of new research proposal
- Provide students with detailed rating criteria
- Provide written feedback and rating criteria feedback on each draft
- Grade final research proposals with rating criteria

Research Proposal Grading Rubric: Hypothesis

Criteria

1. Context/interest
   - Hypothesis & Aims
     - Context
     - Hypothesis
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     - Specific Aims

Norming Session

- Hypothesis #1:

1 We hypothesize that knocking out the function of the histone acetyl transferase HAC1 will cause downregulation of heat-shock response genes

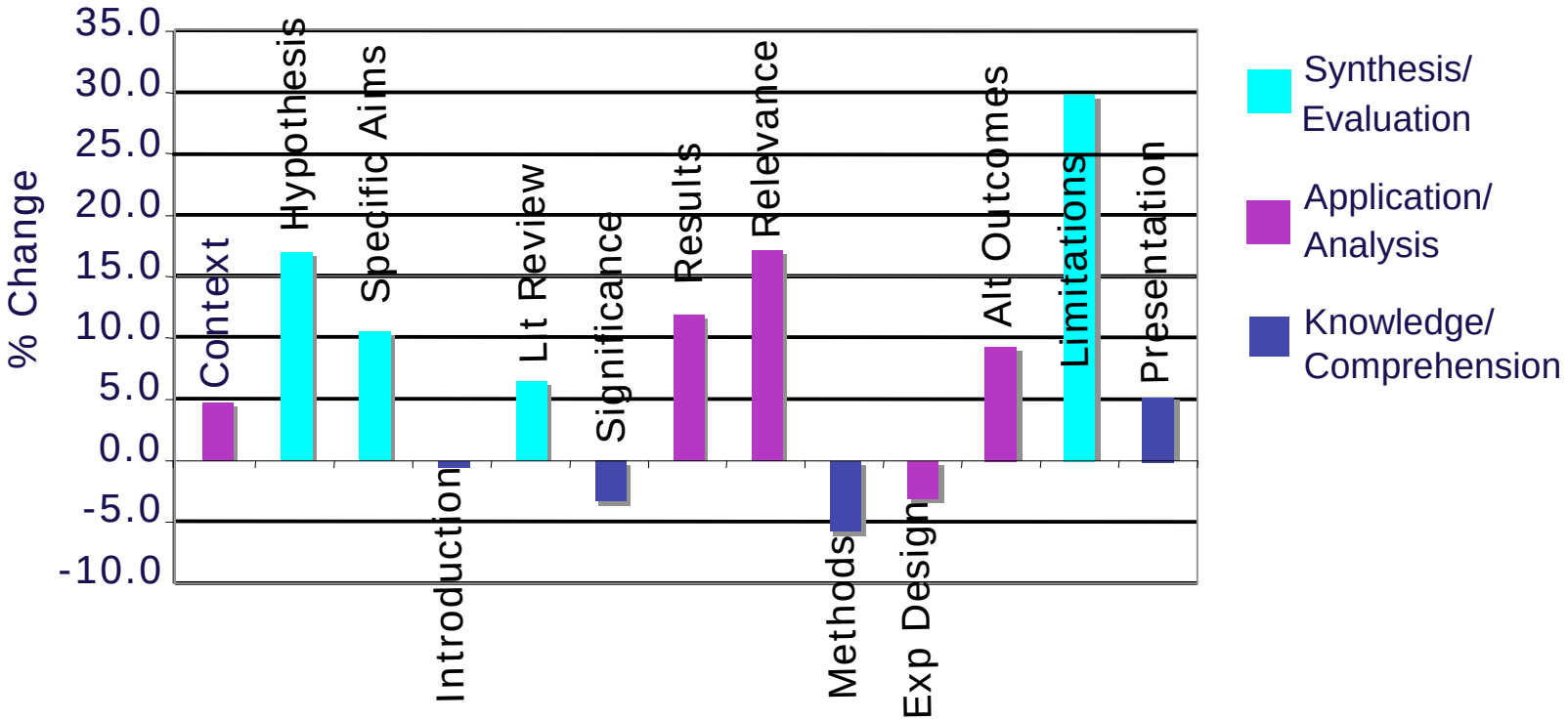
- Hypothesis #2:

4 We hypothesize that the histone deacetylase HD2C mediates the upregulation of cold responsive genes during cold acclimation in *Arabidopsis* by binding to COR gene promoters

- Hypothesis #3:

3 We hypothesize that the INO80 homolog CHR21 is necessary for the heat stress response in *Arabidopsis*

Increase in Research Proposal Scores After Implementation of Rubric/Peer-Review



Average total score on research proposals increased from 76% to 82%

Findings

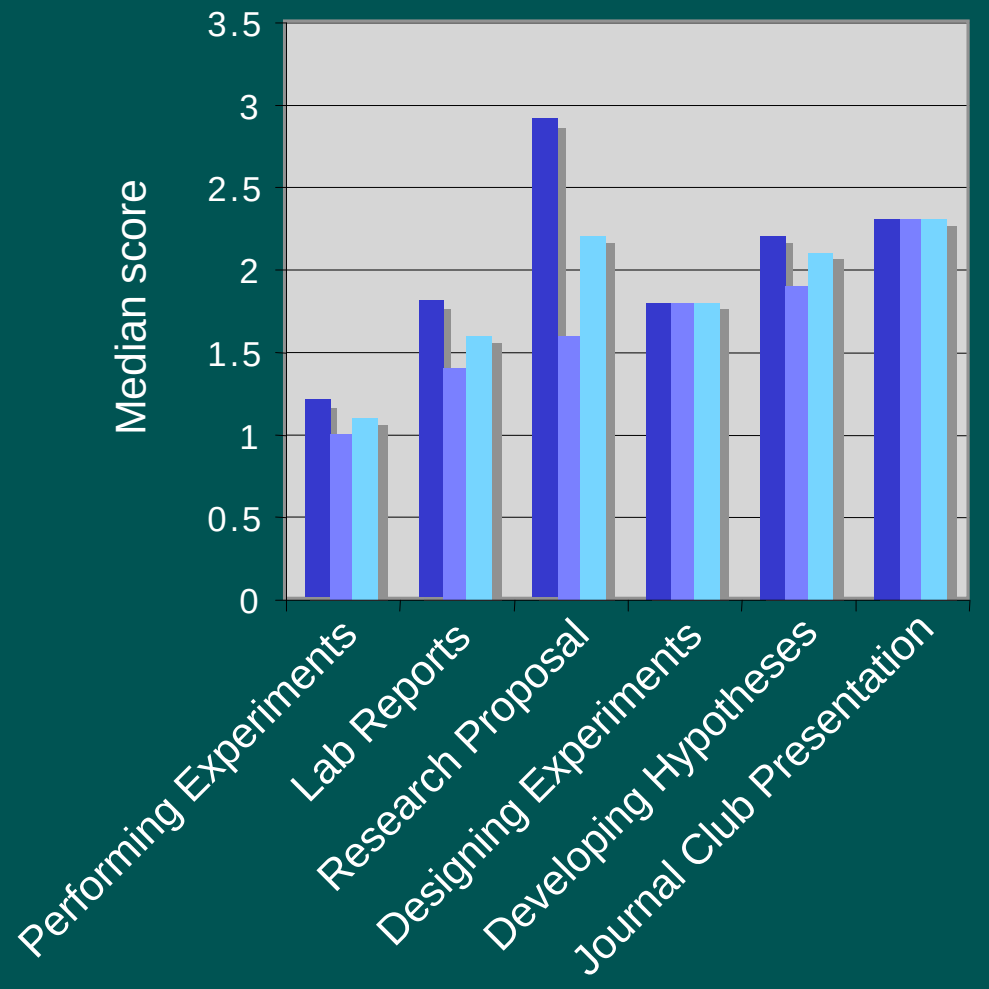
Students performed best on writing assignments that required a knowledge and/or comprehension level of understanding

Students had the most difficulty with writing assignments requiring synthesis of new ideas and/or critical evaluation of data

Introduction of peer review and grading rubric coincided with an overall increase in student writing performance, particularly on assignments requiring higher levels of thinking

Student Evaluation of Course Activities:

How beneficial was this course activity to your learning?



1 = very beneficial
2 = somewhat
3 = no effect
4 = detrimental

Winter 2007

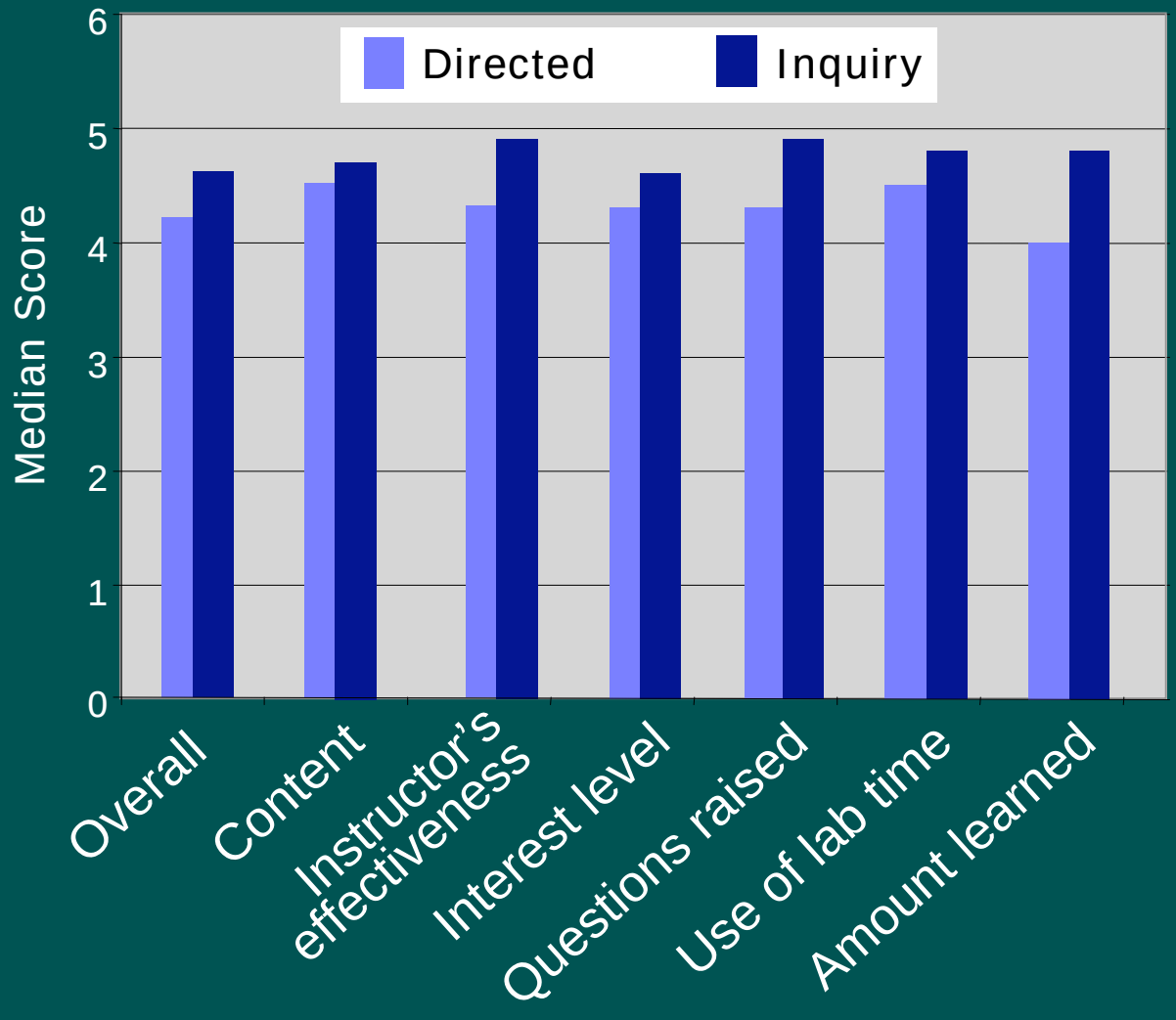
Student Assessment of Teaching Strategies

Strategy	How effective?
Written Feedback	1
Group Work	1.2
Numerical Feedback	1.5
Grading Criteria	1.6
Review Panel	1.9
Peer TA	2.0

1 = Very beneficial
2 = Somewhat
3 = Not effective
4 = Detrimental

Winter 2007

Course Evaluation
Directed Lab vs. Inquiry-Based Lab



5 = Excellent
4 = Very Good
3 = Good
2 = Poor
1 = Very Poor

Concluding Comments

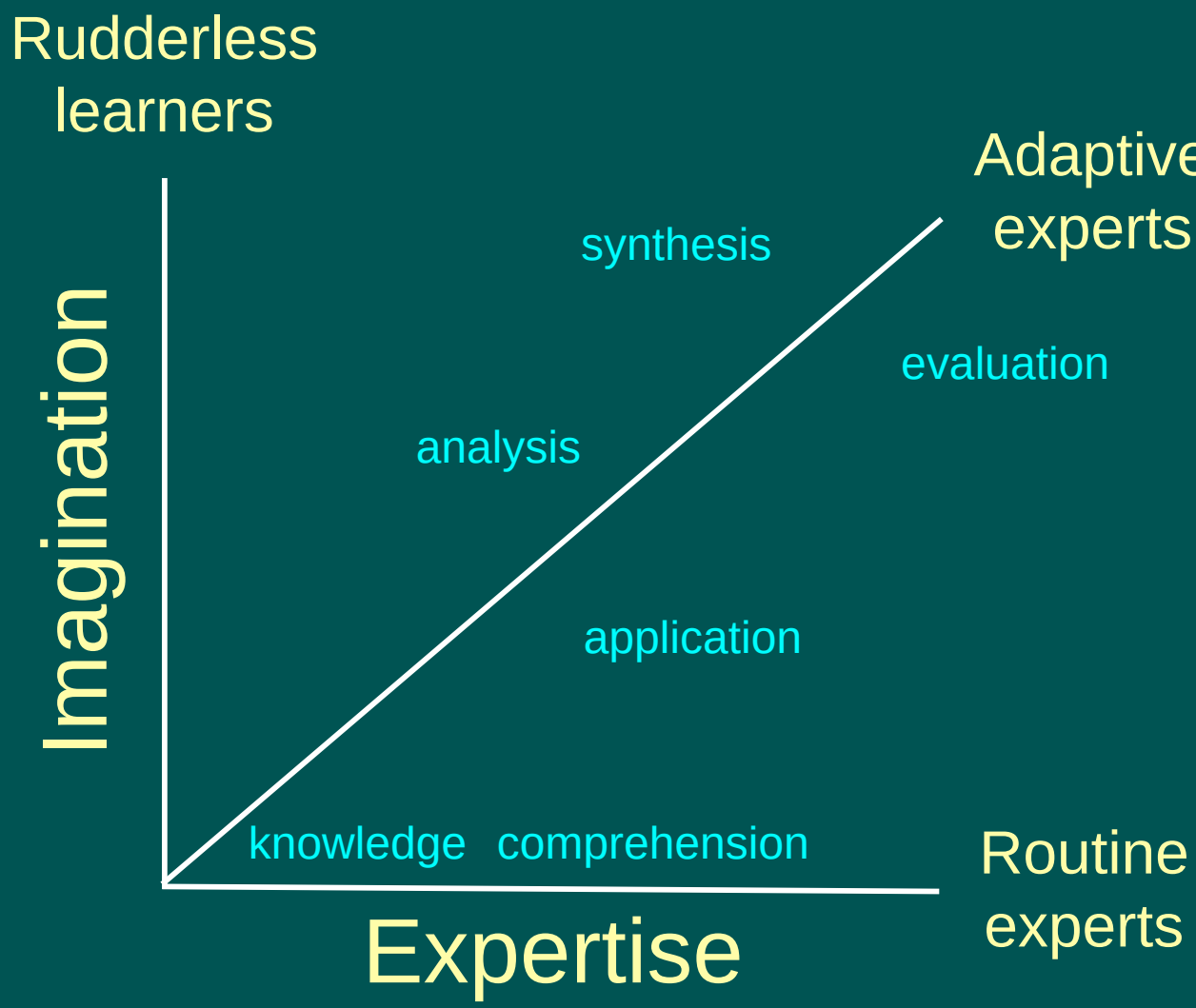
Students find this integrated experience to be more “complete” and “rewarding” than that of a typical laboratory class

Making writing an integral component of the laboratory greatly increases the time students spend thinking about their research projects outside of class

Draft process enables students and instructor to recognize and address conceptual difficulties early in the quarter

Having students participate in all aspects of the research process (doing, thinking and writing) provides students with a very challenging yet “safe” real research experience

How People Learn



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