Supporting Case-Based Student Writing and Logical Reasoning

Three Different Scaffolding Approaches and their Outcomes

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Why are we here?

- We've been working on a 3rd year cell physiology course for the past few years.
  (1 section, ~50-100 students, primarily BIOL majors)
- The course focusses on conceptual learning & skills development within the context of cell physiology

Why are you here?

- What do you want to get from this workshop?
- Is there a specific assignment that you want to provide better support for?

HANDOUT: Scaffolding Worksheet

Take a second to answer Question 1 on the worksheet

The Plan for Today

- What is logical reasoning?
- Why is it important for students to learn?
- How did we try to teach it?
- How can we best support students learning?

What is logical reasoning?

- What do you think?
- Logical Reasoning: Ability to draw a logical conclusion given a set of premises (ie. Ability to make and support an argument).
  Wikipedia
- Argument: "A series of premises and conclusions subject to the rules of science and of informal logic."
  Wisehart & Mandell (2008)
- Informal Logic: The logic used in everyday language to support claims and arguments.
  Stanford Encyclopedia of Philosophy

Be aware that different disciplines define arguments differently (Lea & Street, 1998). This is a biologists definition.

Why should students learn logical reasoning?

- What do you think?
- "The central point of education is to teach people to think, to use their rational powers, to become better problem solvers."
  Gagne (1980) p85
- Reasoning, critical thinking and problem solving are fundamental STEM skills which form the basis for acquiring more advanced skills.
  The Council of Canadian Academies (2015)

Learning Objective: Students will learn how to formulate and defend an argument using logical reasoning.

How do we teach this?
The Case-Study Assignments

- The students work in groups to complete the assignment during class time (85 min)
- They are given 3 to 5 pieces of data and are asked to draw a connection between the data and a big-picture problem
- Each group writes a 'hypothesis' and a 'rationale'
  - The Hypothesis: An argument, or model, that answers the question posed. 1-2 sentences.
  - The Rationale: A justification or defence of the hypothesis, using the data provided. 1-2 paragraphs.
- The students complete 4 case studies, with different data and questions, throughout the term

HANDOUT: The First Case Study

"I liked the case studies. Both for the fact that we're learning to build a proper hypothesis and for the team bonding."

" [The case studies] didn't necessarily help too much with learning the material presented in class (although they did a little), but they were really useful in practicing the problem solving skills also needed in midterms and the final."

"I think that the emphasis on wording and logical flow was good because I think it's really important to be able to state all the steps you are taking to get to your conclusion (not just in this class of course)."

"[The case studies] made me think critically about what we learned in class and put the material from different lectures together."

"The case studies were interesting but the criteria for what was expected was way too vague."

"Didn't like [the case studies]. Not sure if they are helpful for learning. Felt like an arbitrary way of thinking, didn't increase creativity."

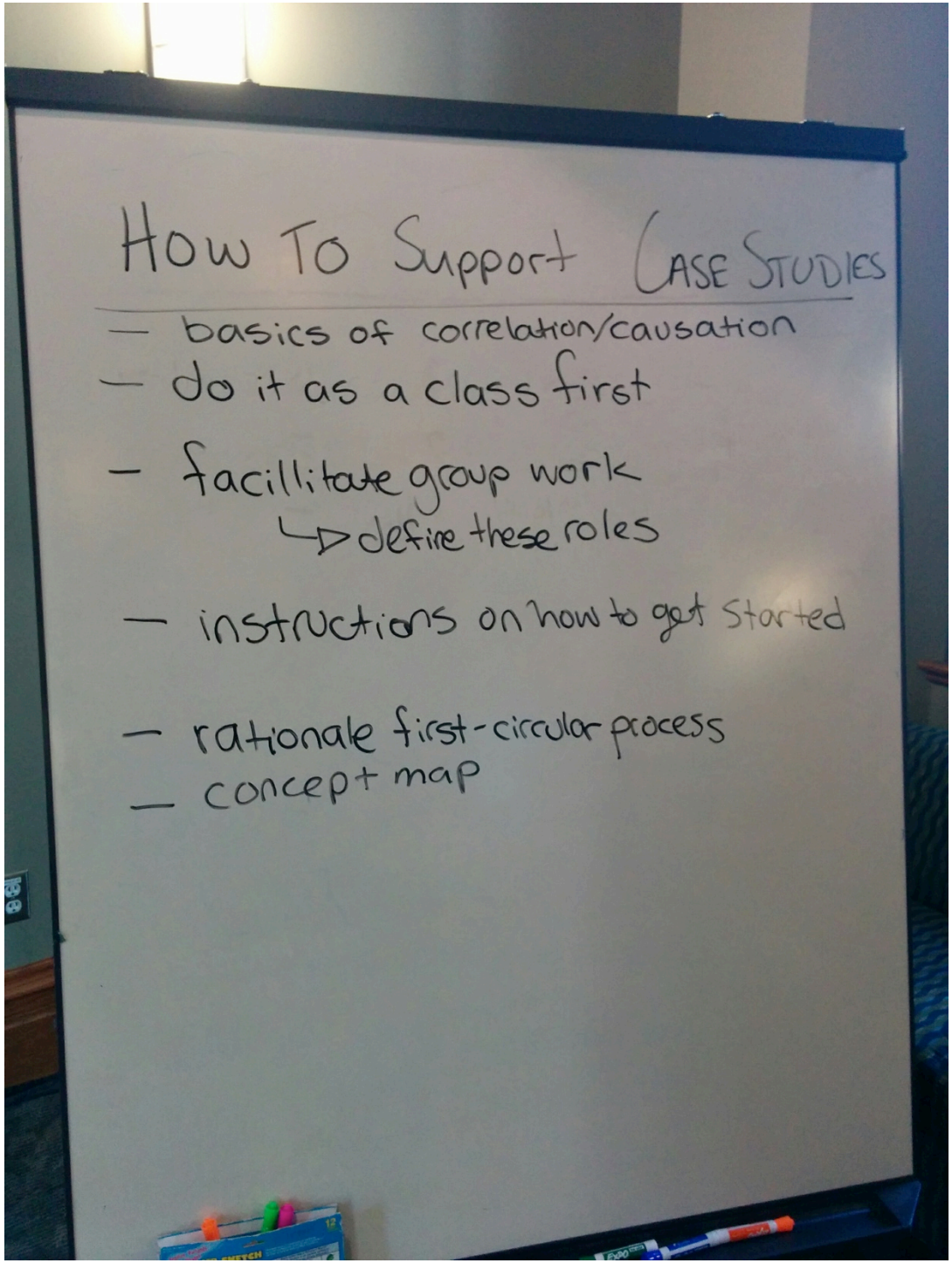
"The case studies seemed to be more difficult than they should be, it was hard to know what to do to improve."

"I did feel that the grades my group received did not accurately reflect our comprehension of the material … I believe we were frustrated because learning how to quickly and clearly communicate newly comprehended material takes much longer (years) than mentally or verbally forming rationales behind the data.

How would <u>you</u> support student learning?

- What would you do to help your students complete this assignment successfully?

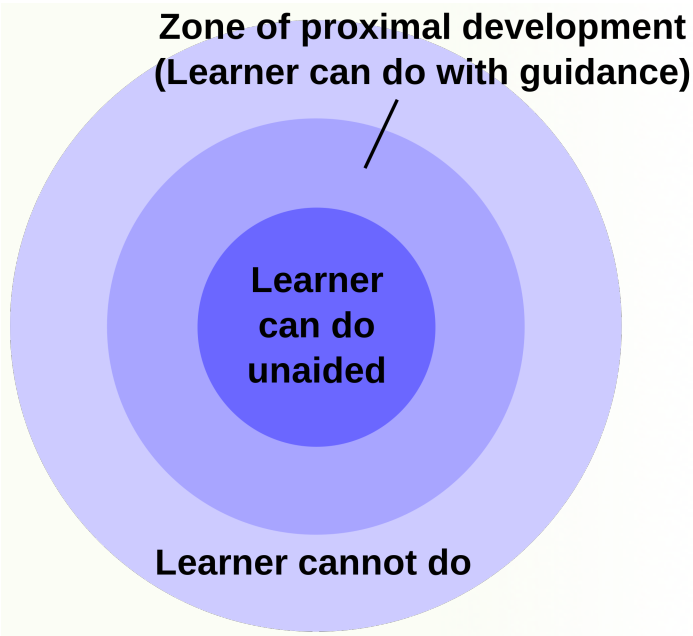
Shown right is the list we came up with during the workshop



Why do we provide scaffolding?

Zone of Proximal Development

Vygotsky (1978)



Wikipedia

Transformative Learning

Mezirow (1991)

Level of Challenge			
High	**ANXIETY** frustration	**GROWTH** engagement	
Low	**STAGNATION** pointlessness boredom	**DEPENDENCY** busy work dumbed down	
	Low	High	
	Level of Support		

Modified from Wilson & Devereux (2014)

Types of Scaffolding

Built-In

- Designed into the assignment itself.
- Often designed to catch and correct misconceptions from the start.
- Helps motivate students to persevere with challenging tasks.

Contingent

- Support that is not planned, but offered as needed.
- Relies on in-the-moment interactions between teachers and students.
- Can address unexpected issues not covered by built-in scaffolding.
- Can be used to make connections to prior knowledge, draw concepts together, and highlight key points.

Take a minute and complete Worksheet Questions 2+3

Modified from Wilson & Devereux (2014)

The 3 Approaches We Used

- ‘Traditional’
  - students are given instructions before each case study
  - instructor/TAs answer questions during the assignments
  - TAs mark and give individual and general written feedback on answers
- ‘Step-by-Step’ (same as traditional plus…)
  - students are given a worksheet deconstructing the thought processes experts use when doing the assignment
  - the whole worksheet is marked in the first case study, but only the final hypothesis and rationale are marked subsequently
- ‘Student Marking’ (same as traditional plus…)
  - in the first case study only, students try writing a hypothesis, but this is not collected or marked
  - instead, students are shown example hypotheses and rationales, and given a rubric for marking them

Handout Scaffolding Examples

Types of Scaffolding

Built-In

- Students do the assignment four times
- Pre-assignment resources explain hypotheses
- Assignment instructions and background provided
- Students work in groups
- Big picture problem highlights importance
- Step-by-step worksheet breaks down the process
- Student marking worksheet

Contingent

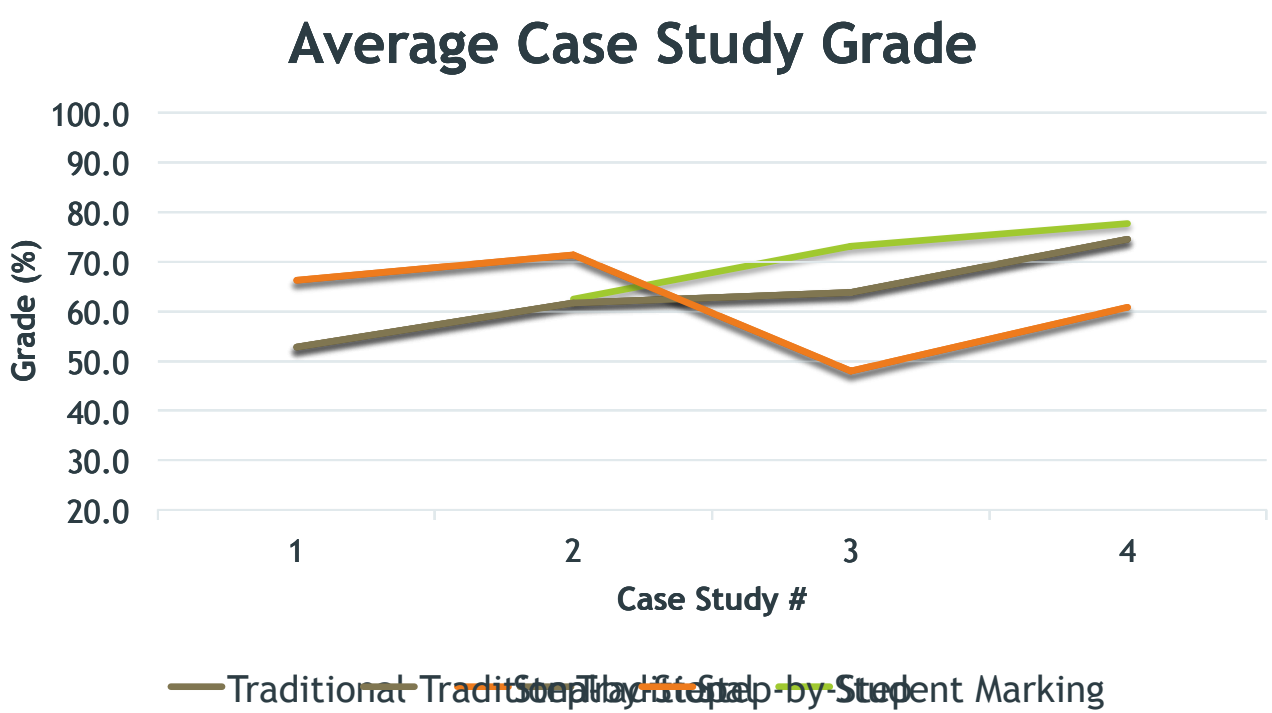
- Answer questions during class
- Provide detailed individual feedback
- Provide general feedback on common issues
- Share examples of good answers with comments
- One-on-one feedback with groups when requested

What do you think happened?

- Which type of scaffolding resulted in the biggest improvement in student performance?
- Which approach did students like best, and why?

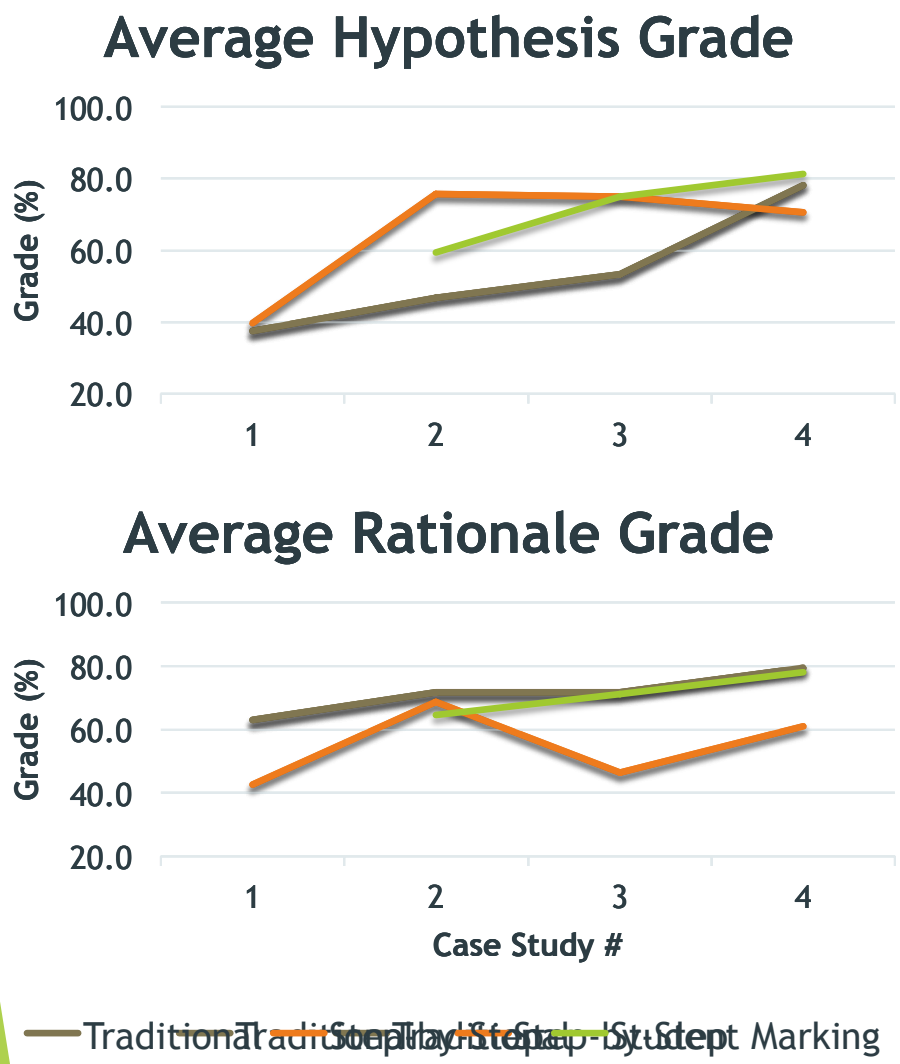
Traditional Step-by-Step Student Marking

Part 1: Grades



Step-by-Step: Students did better on the first case study, but could not sustain this when support was removed.

Student Marking: Students improved faster than with the 'Traditional' approach, and did as well on the second case study, despite not writing the first case study.

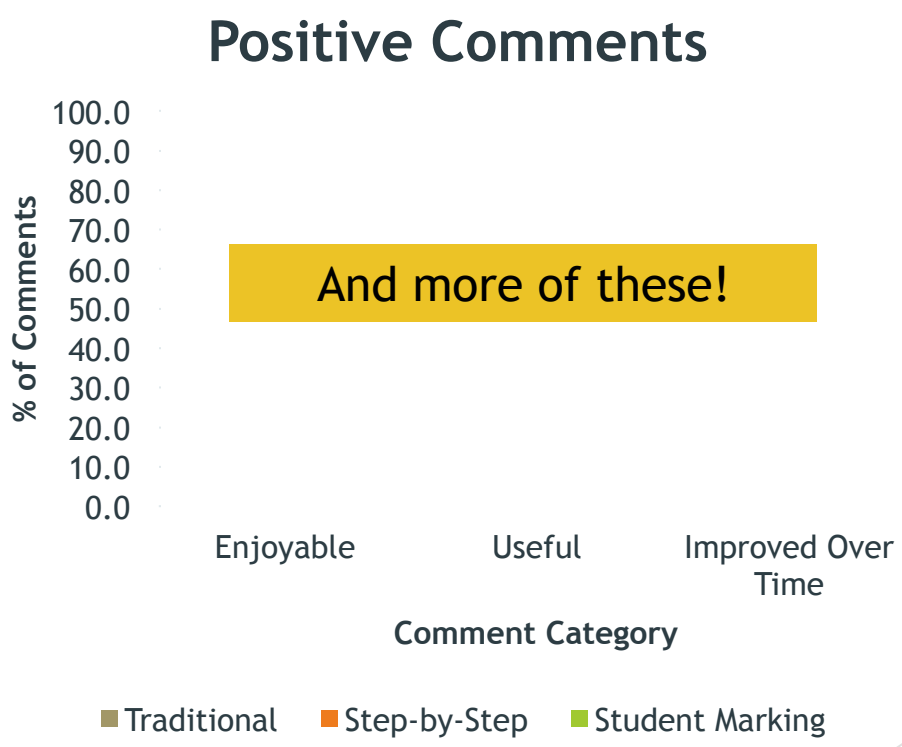


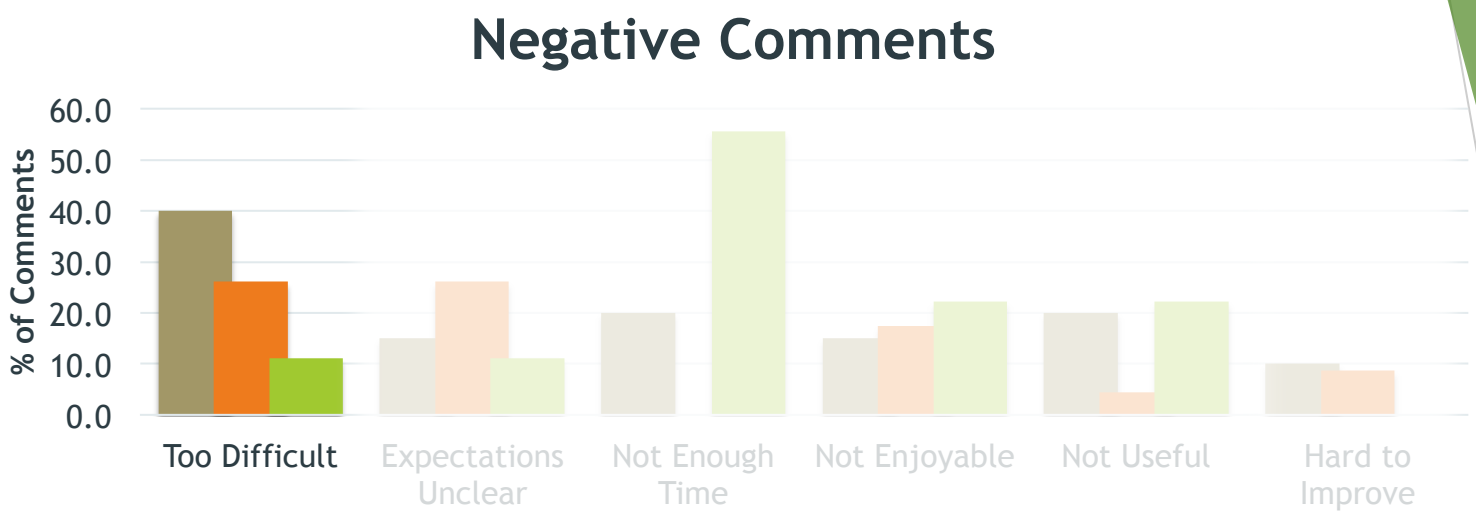
Step-By-Step: Student hypotheses improved faster when the steps were broken down, but the rationales were disjointed and did not improve in quality

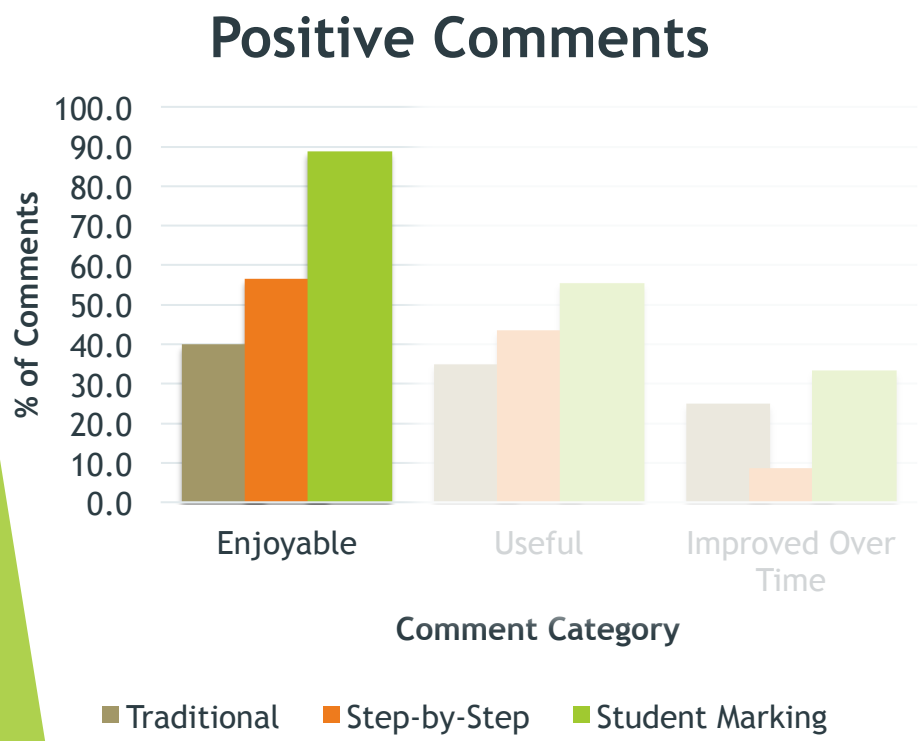
Student Marking: Student hypotheses improved faster, despite not completing the first assignment.

Part 2: Student Feedback

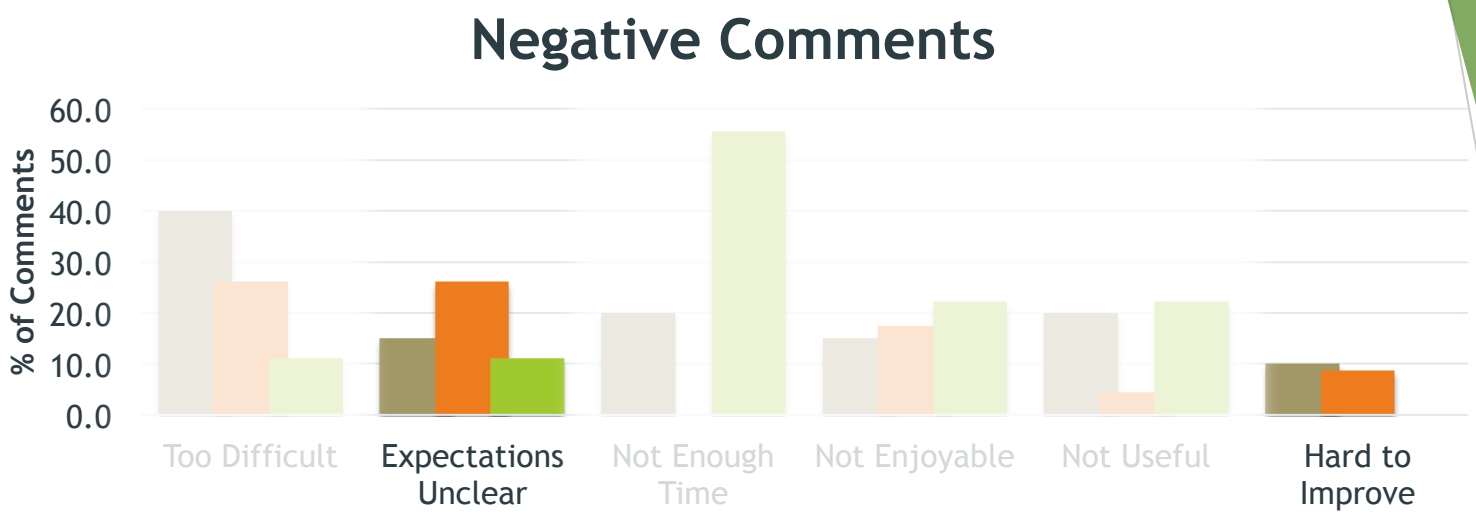

Negative Comments
We want fewer of these!
% of Comments
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Too Difficult
Expectations Unclear
Not Enough Time
Not Enjoyable
Not Useful
Hard to Improve

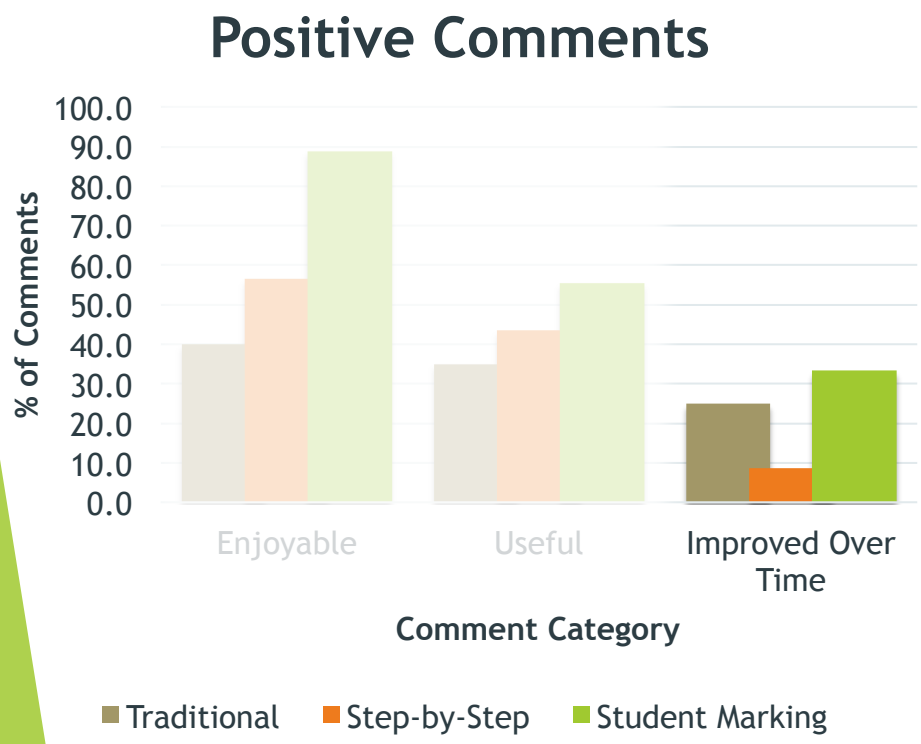

Positive Comments
And more of these!
% of Comments
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Enjoyable
Useful
Improved Over Time
Comment Category
Traditional
Step-by-Step
Student Marking



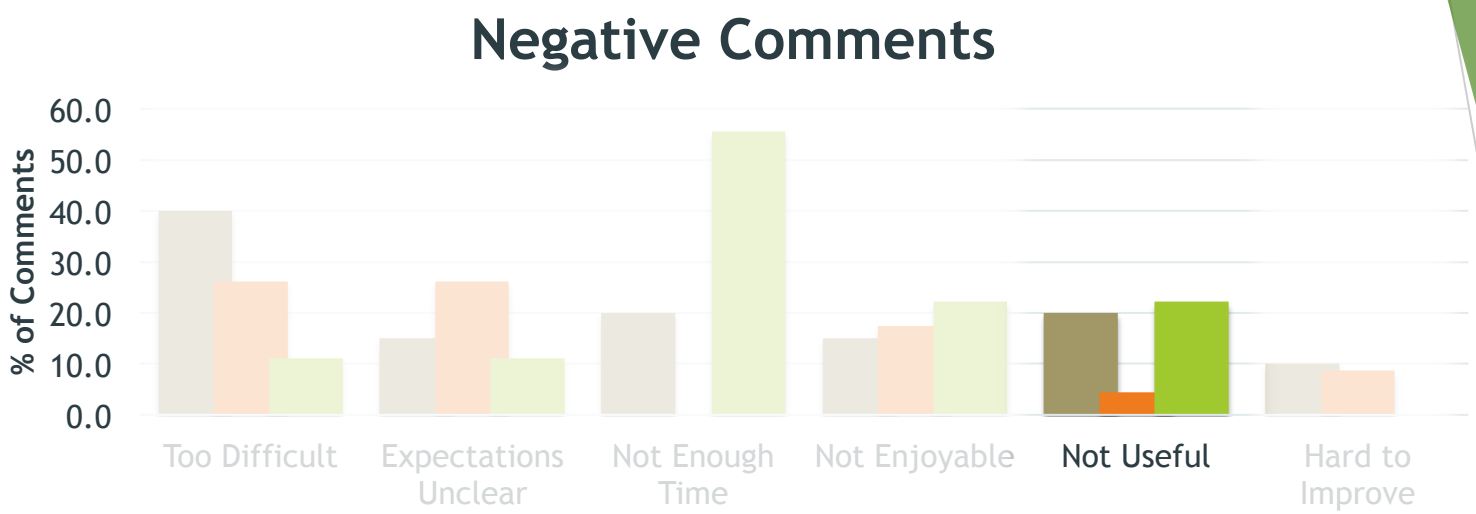


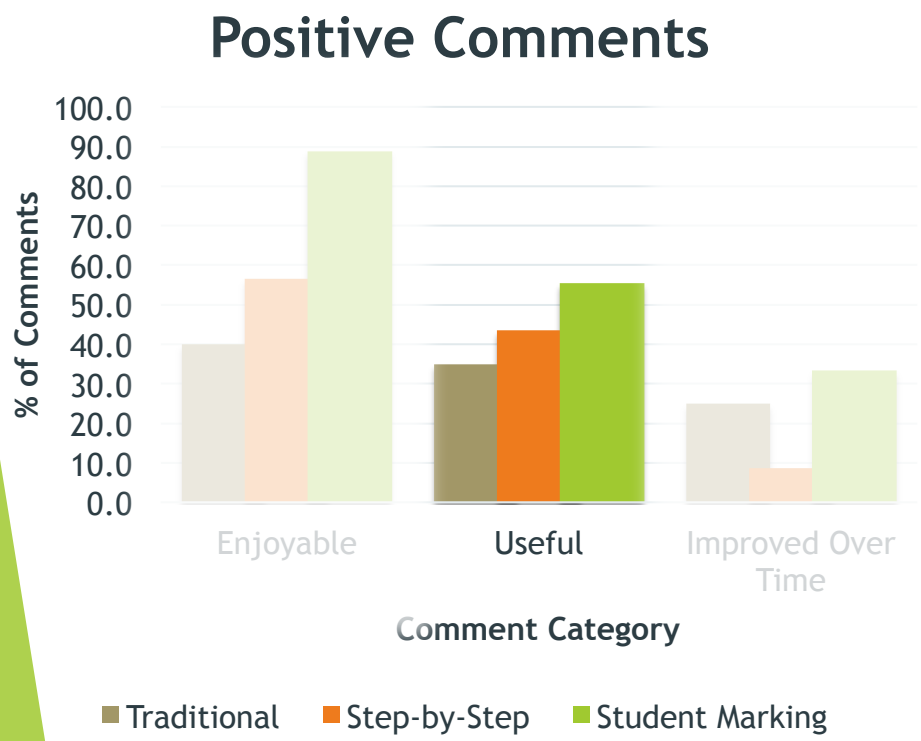
Students found the assignments less difficult and more enjoyable with both the Step-by-Step and Student Marking scaffolding.





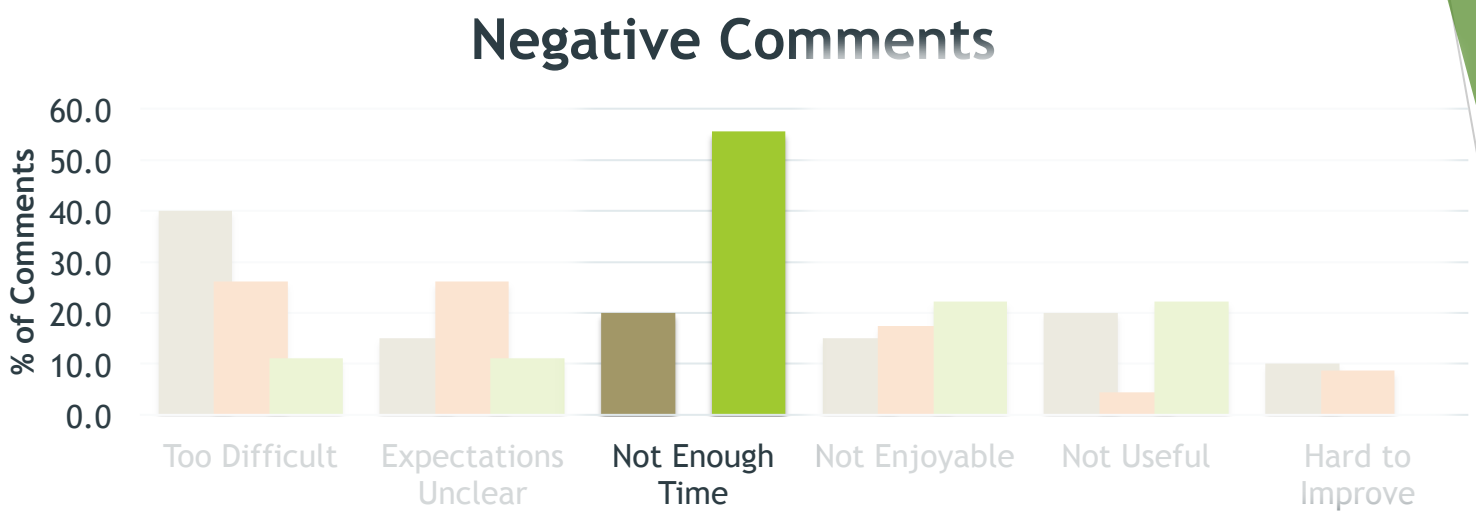
Students seem to have found it harder to improve over time with the Traditional and Step-by-Step approaches, compared to the Student Marking scaffolding. This agrees with the trend in grades.

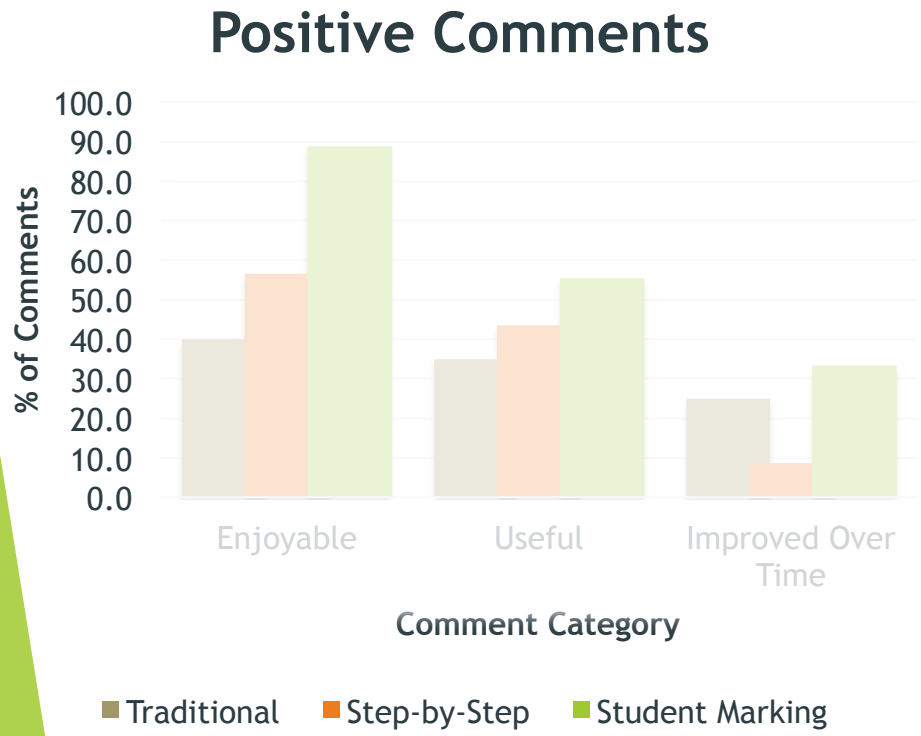




Complaints about 'usefulness' tended to center around the assignment's focus on communication/writing.

This may indicate a misunderstanding of the learning objective and/or its importance for their education.





Students complained about time constraints only for the Traditional and Student Marking approaches.

This likely reflects less time spent working on constructing and organizing their arguments, as the Step-by-Step approach tended to provoke lower quality responses.

Conclusions from the Data

- Breaking down the process **Step-by-Step** hurt student learning more than it helped them. While we felt that students felt more supported initially, students did not feel this way by the end of term.
- Students performed as well with the **Student Marking** scaffolding, but seemed to feel better supported than with the **Traditional** approach.

Types of Scaffolding

Built-In

- Students do this type of assignment four times
- Pre-assignment resources explain hypotheses
- Assignment instructions and background provided
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Contingent

- Answer questions during class
- Detailed individual feedback
- General feedback on common issues
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Part 3: Instructor Feedback

How did the feedback change?

First Year

Hyper-phosphorylation of the microtubule-associated protein Tau results in the inability of Tau to stabilize microtubule networks in the cell (how?), and causes abnormal neurofibrillary tangles in the brain cells (why?) of patients with Alzheimer's disease. **The microtubule networks are essential for normal cell functioning. Without the stabilization of these networks in the cell, these cells undergo massive death in Alzheimer's disease patients, resulting in shrinkage of the brain.** (I'm not sure what this adds to the hypothesis)

This hypothesis is too general and needs to contain more specific information.

Second Year

The hyper-phosphorylation of Tau results in fewer correctly aligned microtubules (how are these connected?), causing neurofibrillary tangles (are you saying the incorrectly aligned microtubules cause the tangles? This is incorrect) which leads (are you saying the tangles themselves lead to the neurodegeneration?) to the neurodegeneration characteristic of AD and CTE.

Third Year

The pathogenic plant bacterium *Pseudomonas sp.* is able to avoid detection by plant cells by secreting the protein AprA, which degrades flagellin monomers, preventing the~~m~~ monomers (it wasn't clear to me if you were talking about flagellin or AprA binding to FLS2) from binding the FLS2 receptor on the plant cell and ~~as a result~~ which would (as written it implied that LACK of flagellin binding triggered immunity, rather than binding) activate~~ing~~ the plant's immune response. By degrading these monomers before they can bind to this receptor, the bacterium evades detection. (I'm not sure this last sentence is necessary as it seems to be repeating part of the first sentence.)

Your hypothesis contains all the important pieces of information, and I find it pretty easy to follow. I've included some wording suggestions to improve clarity. These may seem minor, but as written it's not always clear to me exactly what you mean.

7 Ways to Improve Feedback

1. **Use in-text Feedback**
   Tell students exactly where they can improve
   "A changes B (how?)."
2. **Use "I" Statements**
   Avoid absolutes, but give an expert's opinion
   "I find…"
3. **Focus on the Logic**
   Feedback should focus on the learning objective
   "I find it hard to follow your logic"
4. **Explain Why**
   Help students decipher your feedback
   "I find it hard to follow your logic because the way you've worded this the relationship between A and B is ambiguous (ie. A changes B)"

7 Ways to Improve Feedback

5. **Give a Better Alternative**

   Provide specific ways to improve

   "I find it hard to follow your logic because the way you've worded this the relationship between A and B is ambiguous (ie. A changes B), it would be clearer if you said A causes the loss of B."

6. **Provide Summary Feedback**

   Highlight the key points

   "Overall, you are describing the data well, but your connecting logic is a bit too vague (see in-text comments)."

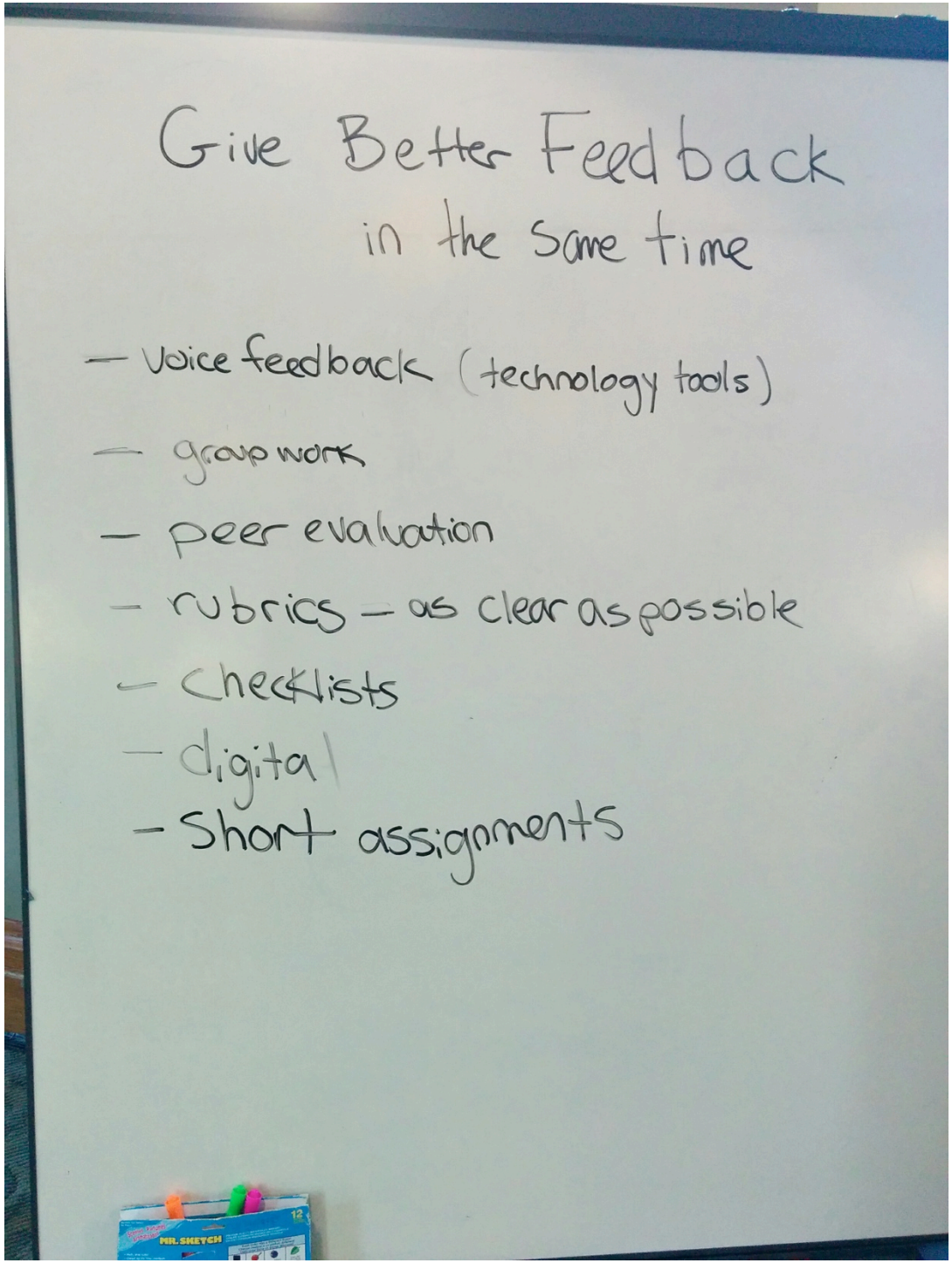
7. **Explain What is Done Well**

   Encourage them to continue good practices

   "I liked how you incorporated the background information at the beginning, it gives a good context, and helps me understand how the data supports your argument."

Dealing with Time Constraints

- But! This kind of detailed feedback is a big time commitment.
- How can you get good feedback with a time limit?

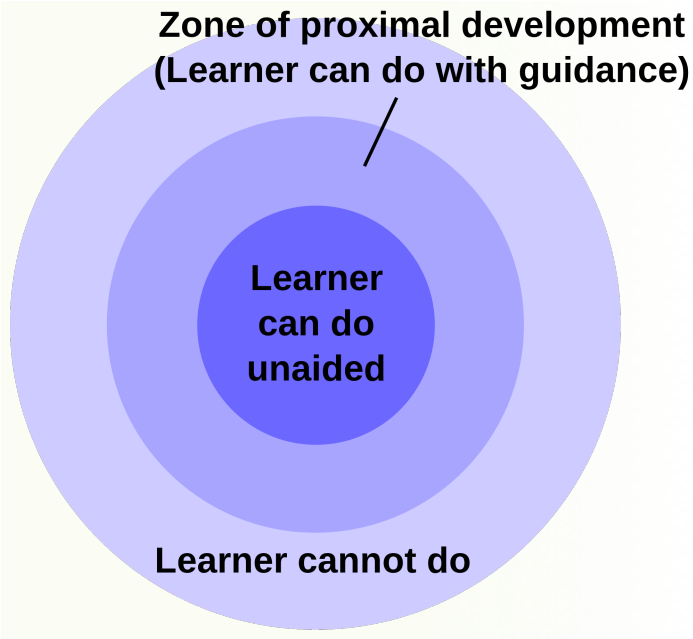


What are the take-home messages?

1. Students learn best when pushed out of their comfort zones, but well supported

- Assignments should be challenging enough that students need to work at it.
- But you need to provide support, to avoid student frustration and maximize learning.

Vygotsky (1978)



Mezirow (1991)

Level of Challenge		Level of Support: Low	Level of Support: High
	High	**ANXIETY** frustration	**GROWTH** engagement
	Low	**STAGNATION** pointlessness boredom	**DEPENDENCY** busy work dumbed down

Modified from Wilson & Devereux (2014)

2. Providing examples of writing is more powerful than trying to explain what 'good' writing is

- Identifying 'good' writing is easier for students than trying to explain <u>why</u> it's 'good'.
- One way to help student do this is to provide specific examples of what we consider good writing.
- This can also reduce student anxiety by demystifying the assignment and clarifying the meaning of the terminology used
  - eg. critique, evaluate, synthesize, hypothesize, demonstrate, argue, rationalize, conclude, justify, explain, summarize …

Student Feedback on Case Studies

"The marking of the hypotheses and rationale in the first case study was useful in figuring out how to write hypotheses and rationales. What was perhaps more useful in determining how to write the hypotheses and rationales, though, was the feedback and examples of good and bad hypotheses and rationales."

3. Better support is more powerful than more support

- How can you give better built-in support?
  - Make your expectations clear and explicit
  - Give multiple opportunities to practice
  - Encourage students to work together
  - Provide example answers
  - Build-in check points for sub-tasks
  - Don't deconstruct the thought process too much
- How can you give better feedback?
  - Focus on 'elaboration feedback' rather than 'verification feedback' (Hattie & Timperley, 2007)
    - Verification: Allows students to identify whether their answers are accurate. Often over-emphasized by students.
    - Elaboration: Explains why an answer is correct or incorrect.
  - Try some or all of our seven suggestions!
    - Give TAs feedback training

Make a Plan!

How Can You Improve Support of Student Learning?

- Complete Worksheet Questions 4+5

Are there any questions?

Annotated References
(Key Literature)

- Hattie & Timperley (2007) The Power of Feedback. Rev. Ed. Research 77(1):81-112
  Very thorough summary of the literature around feedback and how to give it effectively.
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  Outlines the theoretical framework behind different types of scaffolding (i.e. conceptual, strategic, procedural, metacognitive) and tests their implementation in an online biology problem-solving tutorial.
- Lea & Street (1998) Student Writing in Higher Education: an academic literacies approach. Studies in Higher Ed. 23(2): 157-172
  Contrasts instructor and student perspectives of writing requirements. Identifies inconsistencies in what different instructors mean when talking about 'structure' and 'argument'.
- Mezirow (1991) Transformative Dimensions of Adult Learning. San Francisco, CA: Jossey-Bass.
  Describes the dichotomies of high and low levels of challenge and support and how they interact and affect the learning experience of students.
- Vygotsky (1978) Mind in Society: The development of higher psychological processes. Cambridge MA: Harvard University Press
  Introduces the theory behind the zone of proximal development.
- Wilson & Devereux (2014) Scaffolding theory: High challenge, high support in Academic Language and Learning (ALL) contexts. J. Acad. Lang. & Learn. 8(3):A91-A100
  Excellent introduction to the theory behind scaffolding and how to use it to support student writing.
- Wisehart & Mandell (2008) Problem Solving in Biology: A Methodology. J. College Sci. Teaching. 2:24-29
  Outlines a procedure biology students can use to construct an argument based on data.

The End!