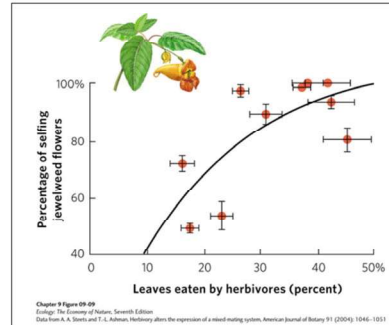


Grappling with problems: adventures in flipping the classroom to teach 3rd year ecology



SPARK 2023

Jenny McCune

Department of Biological Sciences

A grand challenge of teaching is to motivate students to engage actively with complex patterns, processes and theories – rather than just memorizing definitions. After their first two years in university, most biology students have mastered how to identify the correct answer from a list of choices, but many are not very good at explaining concepts in their own words, applying a theory to a new situation, or evaluating evidence. For the past four years, I have used the ‘flipped classroom’ idea to teach ecology at the third year level. Rather than listening to a lecture, the students spend most of the class time working together in small groups to answer problem sets made up of challenging questions based on assigned readings. I will share what I have learned about how to motivate students to do the assigned reading, facilitate collaborative group work, and respond to the discontented (e.g. “I don’t learn well by reading”, and “why can’t you just lecture?”). While not all students are fans, many appreciate the chance to grapple with the sorts of questions they will see on exams. Taking this approach has been challenging – especially during the COVID-19 pandemic. However, watching the look on a students’ face when they finally grasp a challenging concept, or overhearing one student clearly explain a famous theory to another, has been immensely rewarding.

Why is **ecology** important?

I think it is important for people to have a basic understanding of ecology, even if they are not going to be a professional ecologist. Every day society is making decisions and facing issues related to ecology.

Why is ecology important?

North America has lost 3 billion birds since 1970



Biggest losses were among common species such as sparrows, warblers, starlings

[Emily Chung](#) - CBC News - Posted: Sep 19, 2019 12:00 PM MDT | Last Updated: September 20, 2019



For example, understanding why some species are declining.

Why is ecology important?

North America has lost 3 billion birds since 1970

Ottawa to close 60 per cent of commercial salmon fisheries in B.C., Yukon to conserve stocks

Biggest k
Emily Churn

Data from an international commission shows global 2020 catch was lowest since 1982

The Canadian Press - Posted: Jun 29, 2021 4:35 PM MDT | Last Updated: June 29, 2021



And how to prevent and reverse declines of species we care about and/or rely upon for food.

Why is ecology important?

North America has lost 3 billion birds since 1970

Ottawa to close 60 per cent of commercial salmon fisheries in B.C., Yukon to conserve stocks

Biggest k
Emily Chur

Environmental groups push for protection of B.C.'s at-risk spotted owls

Data from
1982
The Canadian

f t e r in

Only 3 of the tiny owls known to be in the wild in B.C., with a 4th recovering at a rehabilitation centre

The Canadian Press · Posted: Feb 23, 2023 2:22 PM MST | Last Updated: February 23



How we can recover highly endangered species.

Why is ecology important?

North America has lost 3 billion birds since 1970

Ottawa to close 60 per cent of commercial salmon fisheries in B.C., Yukon to conserve stocks



Biggest k
Emily Chur



Data from
1982

The Canadian

Only 3 of
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The Canadia



Environmental groups push for protection of B.C.'s at-risk spotted owls



Winds helping fight against out-of-control wildfire in northwestern Alberta



Wildfire burning northwest of hamlet of Zama City has grown to 3,000 hectares

CBC News - Posted: Jun 05, 2022 1:22 PM MDT | Last Updated: June 5, 2022



How climate change and human actions can affect wildfire frequency and severity.

Why is ecology important?

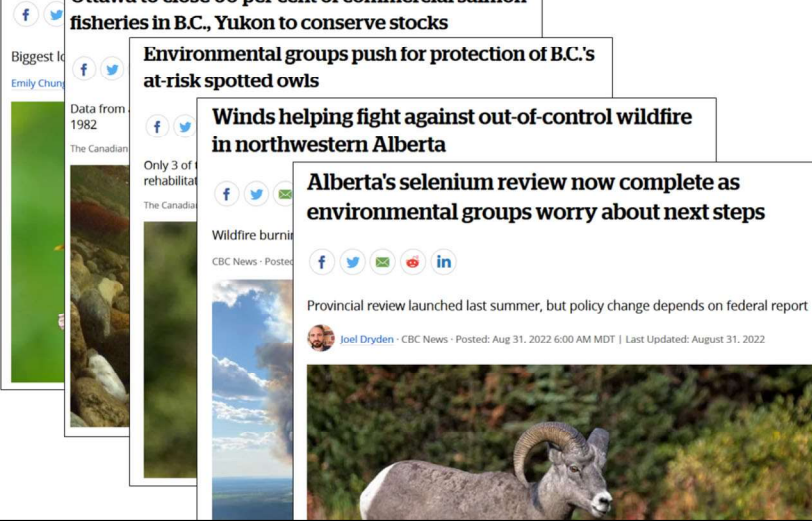
North America has lost 3 billion birds since 1970

Ottawa to close 60 per cent of commercial salmon fisheries in B.C., Yukon to conserve stocks

Environmental groups push for protection of B.C.'s at-risk spotted owls

Winds helping fight against out-of-control wildfire in northwestern Alberta

Alberta's selenium review now complete as environmental groups worry about next steps



How industrial pollution affects our air, water, and land.

Nfld. & Labrador

Does N.L. need a seal cull? It depends on which political party you ask



CBC News · Posted: Mar 10, 2021 10:33 AM MST | Last Updated: March 10, 2021
25 comments

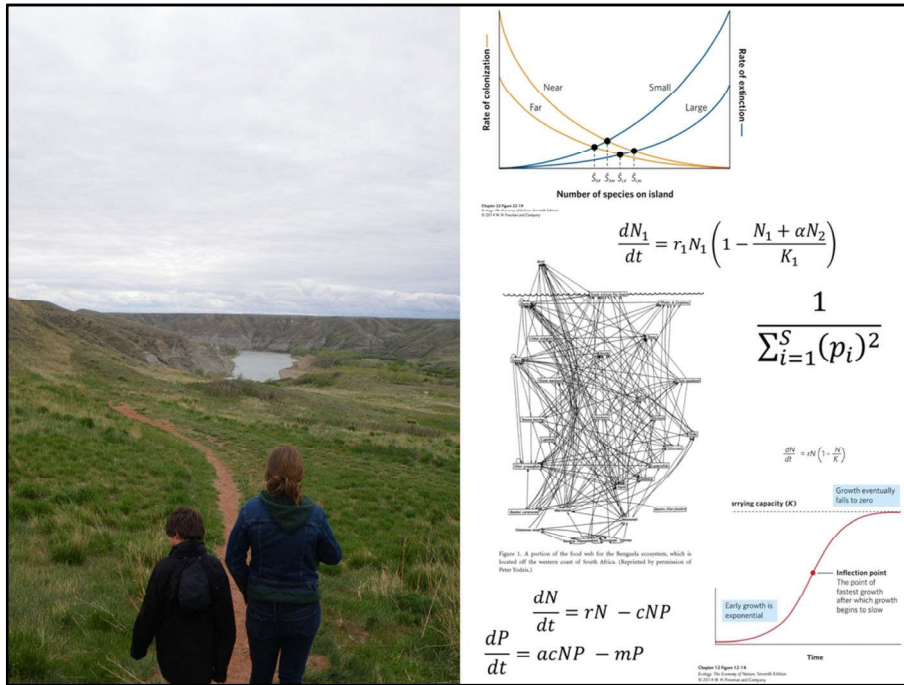


The seal hunt has long been debated, perhaps not more famously than when then premier Danny Williams and Paul McCartney appeared on Larry King Live in 2006. (NOAA Fisheries)

And decisions related to ecology can get political – another reason why it is important to have voters with some understanding of ecological systems and how they work.




Now... a person might think that ecology has an advantage over other subjects in biology: it deals with systems we can SEE and even HOLD in our hands. Here in Lethbridge nature is all around – we can witness a hawk preying on a ground squirrel in our everyday lives, in a way that we cannot witness cells dividing or proteins being synthesized inside of cells.



On the other hand – ecosystems are complex, and the tools that ecologists use to understand how they work involves a lot of mathematics and complex concepts and models. So some students might come in expecting ecology to be the ‘easy’ biology course.



When I was a graduate student, I took a workshop on teaching. The facilitator asked us to draw our 'ideal classroom'. Here is what I sketched: me in a forest with a circle of happy students learning about ecology. This situation does exist, but... in real life often we are inside, with many more students.

 **COMMUNITY ECOLOGY**
SPRING 2023 - BIOL 3720

Welcome to the University of Lethbridge!
Our University's Blackfoot name is *Iniskim*, meaning Sacred Buffalo Stone. The University is located in traditional Blackfoot Confederacy territory. We honour the Blackfoot people and their traditional ways of knowing in caring for this land, as well as all Aboriginal peoples who have helped shape and continue to strengthen our University community.

The goal of this course is to help you to get to know and interact with the theories that ecologists have developed to explain the **generation, maintenance, and distribution of biodiversity in space and time.**

In 2020 I developed a course in Community Ecology – for the 3rd year level. The goal of the course is to help students INTERACT WITH theories that ecologists have developed (not just MEMORIZE them – but USE them and EVALUATE them).

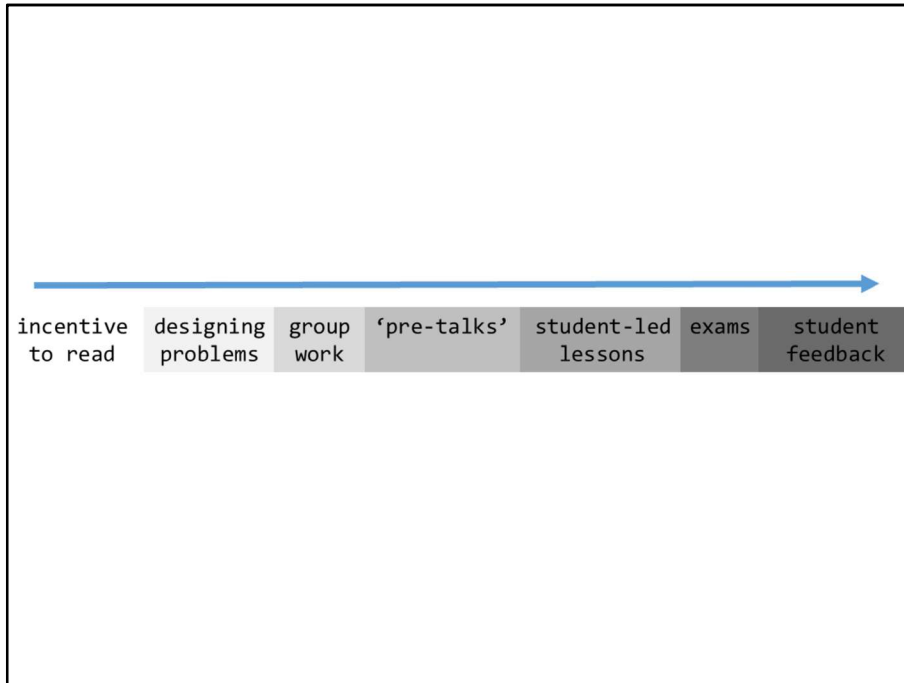
COURSE LEARNING OBJECTIVES:

By the end of this course we hope you will be able to...

- **Explain** key ecological processes, theories, patterns, and concepts in your own words, and use real-life examples to illustrate them.
- **Use data** presented in graphs and tables to **evaluate** whether or not the data support a given pattern, process, or hypothesis.
- **Design experiments** to test hypotheses about ecological communities.
- **Discuss** some of the most well-known scientific papers in Community Ecology, and explain why they are important.
- **Analyze** community composition using **ordination, cluster analysis, indicator species analysis, permutational MANOVA**, and other techniques.

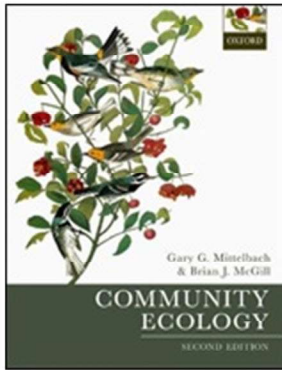
My course learning objectives were designed to emphasize higher-level learning skills, like evaluating data, and designing experiments. The last learning objective is taken on by the lab portion of the course (now taught by Dr. Tegan Barry).

I decided I didn't want to stand up and lecture every class, so I tried a 'flipped classroom' approach, where I did not lecture at all, but students worked in groups of 3 to solve problem sets, and I rotate around helping them.



An outline of the rest of the talk....

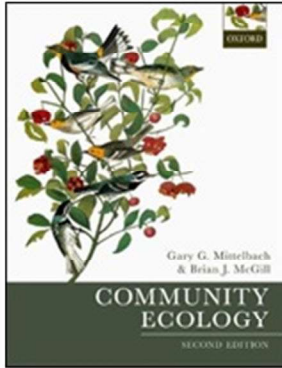
How to get students to read?



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| incentive to read | designing problems | group work | 'pre-talks' | student-led lessons | exams | student feedback |
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First challenge: how to get students to READ? I find myself saying slightly ridiculous things to try to get students to appreciate the value of reading, like: "Guys! Reading is like MAGIC! If I were to stand up here and TELL you everything in Chapter 2, that would be a 7 hour lecture! But you can read it in 1-2 hours!"

How to get students to read?



Pre-reading Assignments

Etkina, E., & Ehrenfeld, D. 2000.
Helping ecology students to read:
the use of reading reports.
BioScience, 50(7), 602-608.

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Based on this article – I used something called ‘pre-reading assignments’ to incentivize reading before coming to class. If students have NOT done the reading, the ‘flipped classroom’ idea doesn’t work as well, because they have no basis upon which to try the problems.

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Please complete on paper (handwritten) and bring to class

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In the first few years (COVID) students typed these and handed in via email, and then Crowdmark. But this year I insisted that they handwrite them. I have a theory that when you write something down by hand it sticks in your brain better.

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Please complete on paper (handwritten) and bring to class

“... children who handwrote notes had greater conceptual understanding one week after viewing their lesson, compared to those who typed notes.”

Horbury, S. R., & Edmonds, C. J. (2021). Taking class notes by hand compared to typing: Effects on children's recall and understanding. *Journal of Research in Childhood Education*, 35(1), 55-67.

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| incentive to read | designing problems | group work | 'pre-talks' | student-led lessons | exams | student feedback |
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And I discovered there is actually some evidence that backs this!

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Please complete on paper (handwritten) and bring to class

1. Define **in your own words** all terms in **bold** lettering and any other term that is new to you.

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The first task is always to define terms IN THEIR OWN WORDS.

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Please complete on paper (handwritten) and bring to class

1. Define **in your own words** all terms in **bold** lettering and any other term that is new to you.
2. Take a look at Figure 2.2 in your text book. Describe what the panel for body size is indicating. Does the Global Latitudinal Diversity gradient apply to small-bodied species?

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| incentive to read | designing problems | group work | 'pre-talks' | student-led lessons | exams | student feedback |
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Then I usually have a question or two that encourages them to look carefully at figures or tables in the textbook, to really try to grasp what they mean.

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Please complete on paper (handwritten) and bring to class

1. Define **in your own words** all terms in **bold** lettering and any other term that is new to you.
2. Take a look at Figure 2.2 in your text book. Describe what the panel for body size is indicating. Does the Global Latitudinal Diversity gradient apply to small-bodied species?
3. At a local scale, many studies have found a hump-shaped relationship between productivity and species richness.
 - (a) Draw a graph showing this.
 - (b) Explain how Grime explained this pattern.

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I also have learned that putting a few of the SAME questions that will be on the problem set is a good idea – and students appreciate having had the change before class to think about some of them.

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Please complete on paper (handwritten) and bring to class

1. Define **in your own words** all terms in **bold** lettering and any other term that is new to you.
2. Take a look at Figure 2.2 in your text book. Describe what the panel for body size is indicating. Does the Global Latitudinal Diversity gradient apply to small-bodied species?
3. At a local scale, many studies have found a hump-shaped relationship between productivity and species richness.
 - (a) Draw a graph showing this.
 - (b) Explain how Grime explained this pattern.
4. Write down the thing/concept/idea you found most interesting in this chapter.
5. Write down the thing/concept/idea you found most confusing in this chapter.

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The last two questions are to encourage students to think about what things they found interesting, and what things most challenging. In the first few years I would always pay most attention to these – and I read/skimmed everybody's pre-reading assignments, so I got a good idea of what students found confusing. This year, I had 40 students and a Teaching Assistant checked these assignments, so I didn't get as much of a feel from this.

How to get students to read?

Reading Assignment for Chapter 2: Patterns of biological diversity

Grading

0 = not done

1 = only partly done or not enough detail

2 = complete

4. Write down the thing/concept/idea you found most interesting in this chapter.

5. Write down the thing/concept/idea you found most confusing in this chapter.

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The grading of these assignments is for COMPLETION and THOROUGHNESS – NOT for correct answers. So when I check them, if I notice an answer is way off base, I might say to a student (or leave a note) saying 'check this'. But it doesn't affect the grade. The grade is for completion. Altogether these pre-reading assignments are only worth 5% of the final grade – I was aiming for enough to provide an incentive, but not so much that students would be afraid to miss one or two.

Designing problems to encourage
integration and **understanding** (not
just memorizing)

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The second challenge (and major time commitment – especially at the stage of designing a 'flipped classroom' course) is designing effective problems for students to work on.

Designing problems to encourage
integration and **understanding** (not
just memorizing)

BASIC

INTERPRETIVE

CREATIVE

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I designed all the problems I use, and I've realized they fall into 3 main categories... I'll use an example to illustrate these.

Designing problems

Ontogenetic niche shift: an ecological phenomenon where an organism changes its habitat or diet requirements during its ontogeny

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Here is a concept we discuss in class – and the ‘textbook definition’.

Designing problems

BASIC

Define the term 'ontogenetic niche shift' in your own words. (2 marks)

incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

A 'basic' question might ask the students to define the term in their own words. I always caution them that if they quote verbatim from the textbook, they won't get full marks. Another way I ask these types of questions might be: "explain the concept of an ontogenetic niche shift to your friend who is an art major", or "explain the concept of an ontogenetic niche shift as you would explain it to your 9 year old cousin".

Designing problems

INTERPRETIVE

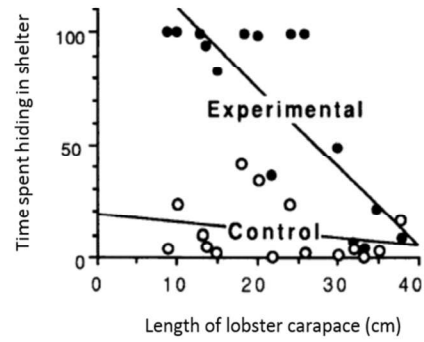
Wahle et al. (1992) measured the amount of time lobsters spent in shelters in the presence and absence of a predator. In the graph below, the black dots (Experimental) indicate that a predator was present, the open dots (Control) indicate the absence of any predator.

incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

With interpretive questions, I like to show the students REAL DATA (from real studies) and ask them to determine whether or not the data support the concept or theory.

Designing problems

INTERPRETIVE



incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

Designing problems

(a) Describe the patterns shown in the graph. (2 marks)

INTERPRETIVE

(b) Do the data show support for an ontogenetic niche shift in lobsters? Explain how you know, based on the graph. (3 marks)

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I learned that I had to ask them to 'describe the pattern shown in the graph', not 'describe what the graph shows', because with the latter, many students will write "the graph shows the relationship between y and x", but not what the SHAPE or PATTERN of the relationship is!

Designing problems

CREATIVE

Logan is an MSc student in biology at the University of Lethbridge. She hypothesizes that, due to their susceptibility to predators, young ground squirrels will tend to forage near burrow entrances, while older ground squirrels will forage farther away. Design an experiment to test this hypothesis. (6 marks)

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In a 'creative' level problem, I might ask students to design their own experiment to test the concept or theory.

As you can imagine, designing problems takes a VERY long time – especially delving into the ecology literature to find good datasets that aren't TOO hard for students to evaluate.

But... many students don't appreciate how much time that takes:

Designing problems

Jenny is the worst instructor I've had in my entire academic career. [...] She amassed maybe an hour of lecture in three months and she completely relies on students to teach themselves, without outlining any important concepts. [...] The textbook was the instructor, she did less work than a T.A

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How facilitate **productive**
group work?

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How facilitate **productive** group work?



scribe



timekeeper



moderator

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One thing I do to try and help facilitate productive group work is to model – on the first day, and every session – how each student has a role to play.

How facilitate productive group work?

Chapter 4 Problem Set
2023-01-23

Scribe: _____
Timekeeper: _____
Moderator: _____

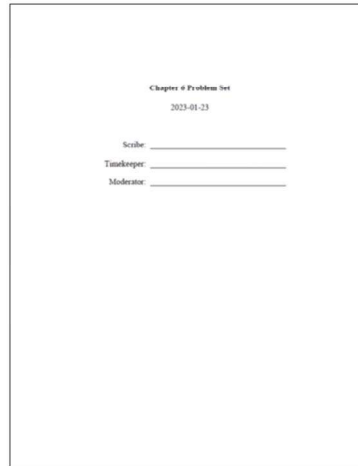
incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

So... in each session, I distribute a problem set to groups of 3 students.

How facilitate productive group work?

1 for each chapter

All problem sets = 10% of final grade



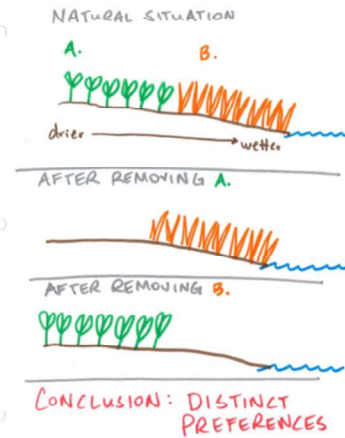
Chapter 4 Problem Set
2023-01-23

Scribe: _____
Timekeeper: _____
Moderator: _____

incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

There is one problem set for each chapter, we do them for 15 chapters, and all the problem sets together are worth 10% of the final grade. I try to impress upon students who are worried about getting lower grades than they might like on the problem sets – that these are PRACTICE – and that each one is worth less than 1% of their total grade, so if they have to miss class, or if they have a poor one –it is not the end of the world.

How facilitate productive group work?



incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

In the first year, I did not do a formal lecture at all. I circulate around to all the groups (or among breakout rooms in Zoom – which isn't as nice). And sometimes I draw things on the board like this – to try and help them grasp concepts.

How facilitate productive group work?

Overall this was this was my favourite biology class that I have taken so far! Even though it was a LOT of work I enjoyed the problem sets almost every class. [...] Also thanks for all the feedback on the problem sets, I know that this must take a long time.

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I give extensive feedback on the problem sets. This became easier when I learned how to use Crowdmark and could just drag and drop previous comments on to the assessment. Crowdmark is also great because every student can download a copy of the problem set – rather than handing back a paper copy that the 3 students in the group then have to try and share somehow.

Some students really liked this problem-based set up – and even appreciated the time I took to give such detailed feedback.

Yes, it DOES take a long time. Usually 3-4 hours of grading per week.

How facilitate **productive**
group work?

to shuffle or not to shuffle?

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In the first year: I randomly sorted students into groups on the first day, and they stayed in the same group all semester. Most groups were productive. Some were extremely productive. Only one (out of 9) was pretty dysfunctional.

How facilitate productive group work?

[...]

I also think it would be better to switch groups every week or allow students to choose their groups.

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But... the second year had more than one very dysfunctional group, and I got a lot of comments suggesting shuffling groups, or allowing students to choose.

Okay, maybe a little lecture

The content in this course was useful, however the delivery was insufficient. I felt the entire course was self-taught. [...] This structure made it really difficult to learn as I learn best from instruction, not reading and attempting to comprehend. Though the content was interesting, I can't help but ask, what did I pay for?

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Some were VERY disgruntled.

Okay, maybe a little lecture

The content in this course was useful, however the delivery was insufficient. I felt the entire course was self-taught. [...] This structure made it really difficult to learn as I learn best from instruction, not reading and attempting to comprehend. Though the content was interesting, I can't help but ask, what did I pay for?

A review of the chapter either before or after the problem sets would be helpful. Just to focus on the main points and understand those concepts better.

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Others were more constructive, and I thought: okay, I could give little 'mini lectures', just on the things that most students tend to find confusing.

Okay, maybe a little lecture

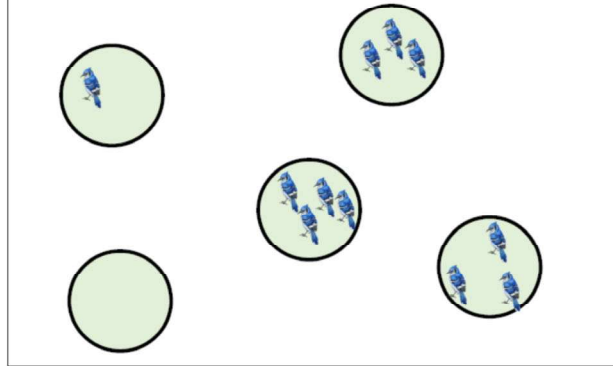
Chapter 14 –
Metacommunities

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So, starting in the second year I taught the course, I would give a little 'pre-talk' at the beginning of each session. Each was only 7-15 minutes or so.

Okay, maybe a little lecture

reminder Chapter 13:
Metapopulations

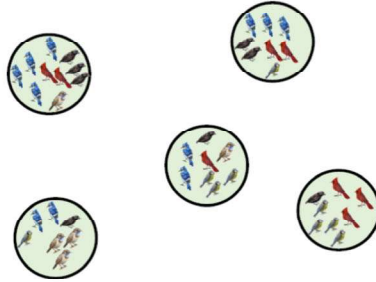


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On Zoom, I would give them using a tablet, so I could share the screen, and scribbling diagrams on top of the slides. Back in person, I use a printed page and a document camera to demonstrate things as a talk.

Okay, maybe a little lecture

Metacommunities



metacommunity: a set of local communities linked by the dispersal of one or more of their species

incentive
to read

designing
problems

group
work

'pre-talks'

student-led
lessons

exams

student
feedback

COURSE LEARNING OBJECTIVES:

By the end of this course we hope you will be able to...

- Explain key ecological processes, theories, patterns, and concepts in your own words, and use real-life examples to illustrate them.
- Use data presented in graphs and tables to evaluate whether or not the data support a given pattern, process, or hypothesis.
- Design experiments to test hypotheses about ecological communities.
- Discuss some of the most well-known scientific papers in Community Ecology, and explain why they are important.
- Analyze community composition using ordination, cluster analysis, indicator species analysis, permutational MANOVA, and other techniques.

incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

I haven't yet talked about how I tried to accomplish this learning objective...

Student-led lessons

Vol. 112, No. 983

The American Naturalist

January-February 1978

PLANT SPECIES DIVERSITY IN A MARINE INTERTIDAL
COMMUNITY: IMPORTANCE OF HERBIVORE
FOOD PREFERENCE AND ALGAL COMPETITIVE ABILITIES

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incentive to read designing problems group work 'pre-talks' student-led lessons exams student feedback

To expose students to the primary literature, I selected 9-13 'classic papers' in ecology. Students choose their own group of 3 students, and each groups presents a 'student-led lesson' on one of these papers. The idea is not for them to do a 'presentation' on the paper, but to design a lesson using the BOPPPS lesson plan format, with active learning, to engage their peers.

Student-led lessons

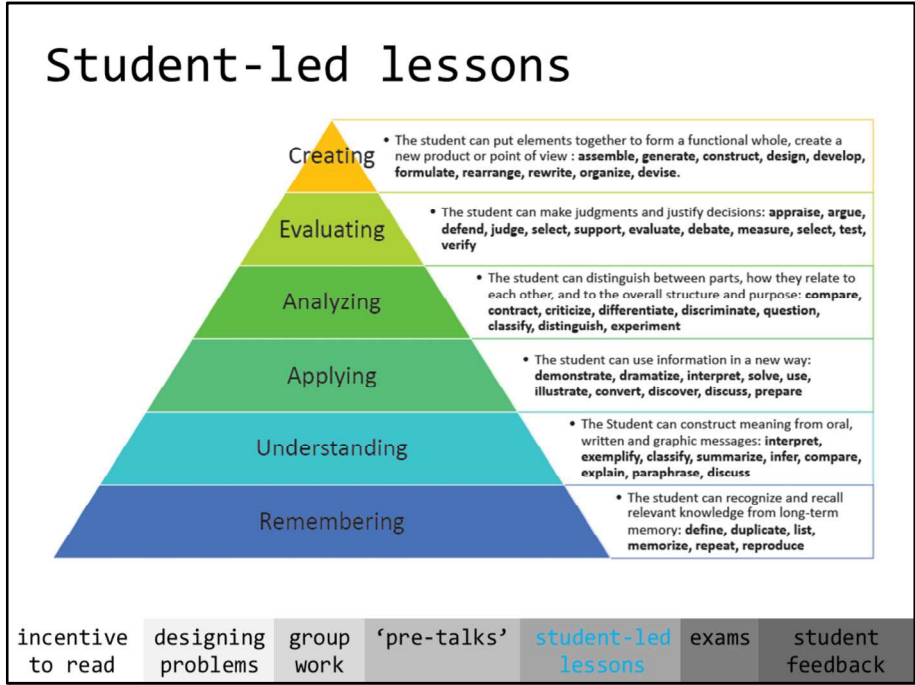
Classic Paper Title: Plant Species Diversity in a Marine Intertidal Community: Importance of Herbivore Food Preference and Algal Competitive Abilities

| Segment | time (minutes) |
|---|----------------|
| <p>B - Bridge In: <i>A story, an interesting fact related to your content, a question, a statement relating this lesson to something else we have discussed in class, a short video clip, etc. Be creative! But it doesn't have to be fancy.</i></p> | |
| <p>Introducing ourselves and the paper we are discussing. This paper is about the periwinkle snails' effect on algal composition of intertidal pools A video showing an experiment with periwinkle and grass: https://www.youtube.com/watch?v=6Kr2wF45L8g&ab_channel=WFSUPublicMedia Fun fact: adult <i>Littorina</i> lay between 10,000-100,000 eggs a year</p> | 4mins |
| <p>O – Learning Objectives: <i>State what students should be able to do by the end of the lesson. Include 3-5 learning objectives. They must include action verbs and be specific. e.g. "Students will be able to explain the term 'trophic cascade' in their own words", NOT "Students should know the main points of the paper".</i></p> | 1 min |
| <p>Students should be able to explain the relationship between the predator and prey in the paper, and how the predators preference can alter the community composition and competitive ability of the prey</p> <p>Students should be able to interpret graphs A & C in figure 3 of the paper.</p> | |



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As part of the assignment, they have to hand in their lesson plan – I give them the template.



For their learning objectives, I challenge them to use higher-order learning verbs. To emphasize what students should be able to DO – not what they should know. This is a version of Bloom’s taxonomy of learning objective verbs – which I provide to the students to use. Many of them come up with very creative participatory learning activities – games, participatory simulations – sometimes a bit too much ‘Kahoot’ quizzes.

A quick note on exams...

Midterm: 15%

Final Exam: 20%

- Questions include many directly from the problem sets
- *also* interpretations using same concepts, but with different data

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I DO use exams – which students do individually. These are very traditional, but they include MANY Of the problems on the problem sets – so students are rewarded for checking my comments on their problem sets. I also like to ask interpretive questions – but with a different data set than the one I used on the problem set.

Student feedback ...
mostly bipolar

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Often I get VERY diverging evaluations – the students who do the evaluations seem to be those that either LOVED the course (and me), or HATED THE COURSE VEHEMENTLY (and also me).

Student feedback ... mostly bipolar

*I really enjoyed this class and its structure. I did find **some aspects of the course challenging** (i.e. adjusting to a format with no formal lectures) but I think that overall it **helped me be more engaged** in the material and have to **think critically to fully understand it** - rather than just memorizing lectures.*

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The ones I appreciate most are the constructive 'middle ground' ones – that show that the course was challenging, but that the student realized what I was trying to do.

Student feedback ... mostly bipolar

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These types of reviews are very rewarding.

The End

*I really enjoyed this class and its structure. I did find **some aspects of the course challenging** (i.e. adjusting to a format with no formal lectures) but I think that overall it **helped me be more engaged** in the material and have to **think critically to fully understand it** - rather than just memorizing lectures.*



Questions and Feedback Welcome

Grade breakdown

Pre-reading assignments: 5%

Problem sets (1 for each chapter): 10%

Participation (lecture and lab): 5%

Midterm: 15%

Lesson on a Classic Paper: 15%

Lab assignments: 10%

Lab final project: 20%

Final Exam: 20%

In case people wondered: the grade breakdown.