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About the Presenters:

Nandini Bhattacharya - CITL Associate Director for Teaching & Lecturer in Mathematics

Nandini Bhattacharya received her Bachelor's degree in Mathematics from Bryn Mawr College, and Master's in Mathematics and Post Graduate Certification in Education from UC Santa Cruz. She joined the Academic Excellence (ACE) Program at UC Santa Cruz when it first started in 1987, and worked there as a Mathematics Coordinator for 20 years. Since 2007, Nandini has been a lecturer in Mathematics, mostly teaching the initial gateway courses College Algebra, Precalculus, and Differential Calculus, where a large number of enrolled students are from underserved or under-represented backgrounds. Compelled to serve these students better, she partnered with the Hispanic Serving Institution (HSI) Initiatives team to redesign the first two Math gateway courses. She received the UC Santa Cruz Excellence in Teaching Award in 2012, Excellence in Diversity Award in 2005 and 2013, and the Hero Award from the Educational Opportunity Program in 2016.

Pablo - Associate Vice Chancellor for Student Achievement and Equity Innovation

Pablo Guillermo Reguerín currently serves as the Associate Vice Chancellor for Student Achievement and Equity Innovation at the University of California, Santa Cruz, providing leadership and oversight to student services offices charged with retaining and graduating students with a focus on educational equity.

Elizabeth Gonzalez - Project Director for the Cultivamos Excelencia

Dr. Gonzalez serves as the Project Director for the Cultivamos Excelencia Hispanic Serving Institution (HSI) initiative, a cross-institutional partnership between San José City College and UCSC, aimed at building equitable educational and career pathways for transfer and graduate students who have been historically underserved in higher education. During her time at UCSC, Dr. Gonzalez has served as an instructor of Psychology and Latin American and Latino Studies, founding member of the Diversity, Equity, and Inclusion Committee in Psychology, and coordinator of the Pathways to Research Program for EOP's Graduate Information Program. Beyond UCSC, she has served as a research associate for the California State University, San Marcos, as a consultant for faculty pedagogy development and as an expert witness in immigration cases. Dr. Gonzalez's longstanding commitment to social justice and equitable education grew from the institutional and social exclusion she witnessed against her community - first-generation college students and undocumented Mixtec migrant from southern Mexico. In her work with faculty, undergraduate and graduate students, Dr. Gonzalez fosters their development of a critical consciousness, research and evaluation skills, graduate school attainment, and culturally responsive pedagogy development.

Jody Greene - Associate Vice Provost for Teaching and Learning, Founding Director of CITL

Jody Greene came to UC Santa Cruz in 1998 and has served as Professor of Literature, Feminist Studies, and the History of Consciousness. Her research interests include seventeenth- and eighteenth-century British literature; non-dualist Western philosophy, especially the work of Spivak, Derrida, and Nancy; human rights and international law; queer studies; and the history of literary discourse and literary institutions. Her forthcoming collection, co-edited with Sharif Youssef, is *The Hostile Takeover: Human Rights after Corporate Personhood*. She is the recipient of the UC Santa Cruz Humanities Division John Dizikes Teaching Award (2008), the Disability Resource Center Champion of Change Award (2018), and, twice, of the UC Santa Cruz Academic Senate Excellence in Teaching Award (2001, 2014). In 2016 she was appointed as the Founding Director of the Center for Innovations in Teaching and Learning and she now serves as UC Santa Cruz's first Associate Vice Provost for Teaching and Learning.

Rebecca Covarrubias - Assistant Professor in Psychology

Dr. Covarrubias graduated with a Bachelor of Science from The University of Arizona, where she was also a Ronald E. McNair Achievement Scholar. She continued at The University of Arizona to earn a Master's and Ph.D. in Social Psychology. After graduating, she was hired by the Department of Psychology to teach courses in Orvieto, Italy through the Arizona in Italy Study Abroad Program. Dr. Covarrubias then became a University Diversity Initiative Postdoctoral Fellow for the Center of the Study of Diversity and the Department of Psychological and Brain Sciences at the University of Delaware. She joined the Department of Psychology at UCSC in fall 2015.

Kendra Dority - CITL Associate Director for Programs

Kendra Dority has been an engaged member of the teaching and learning community at UC Santa Cruz since 2009, serving as a Teaching Fellow and Teaching Assistant in the Literature Department and as a Lecturer at Porter College before joining the Center for Innovations in Teaching and Learning in 2017. With CITL, she develops and coordinates programs that build communities of practice, support equity-minded teaching, and promote active learning, and she leads up the Center's professional development opportunities for graduate students. Both within and outside of the university, she champions public humanities and arts education. As a school museum guide at SFMOMA, she encourages hands-on, inquiry-focused learning for Bay Area students in grades 3-5. She received her PhD in Literature from UC Santa Cruz, with research on literacy, reading practices, language politics, and ethics in ancient Greek and contemporary U.S. Latinx literatures.

Robin Dunkin - Ph. D. - Assistant Teaching Professor

Robin is a teacher-scientist. She studies the physiological ecology of large marine and terrestrial vertebrates and now applies the scientific method to improving undergraduate science education. Robin completed her master's degree at the University of North Carolina with Dr. Ann Pabst and Bill McLellan. She then studied African and Asian elephant physiology for her dissertation with Dr. Terrie Williams at U.C. Santa Cruz. After finishing a postdoc with NOAA and working closely with the STEM teaching community, Robin was hired as an Assistant Teaching Professor at UCSC. Robin is keenly interested in incorporating STEM practices into both large lecture and active learning versions of her courses to help all students improve core science process skills, bolster STEM identity, and reach their full potential.

Charis Herzon - LSS & HSI Initiatives Director

Charis Herzon's Bio: I have been working with Learning Support Services since 2000, when Modified Supplemental Instruction (MSI) was first piloted at UCSC. Currently, I serve as the Director Learning Support Services (LSS)/Director Hispanic Serving Institution (HSI) Initiatives. LSS offers undergraduates peer assistance via MSI, Small Group Tutoring, amd Writing Tutoring in addition to Drop-In Services and Peer Mentoring. I work with the campus HSI team. We take a data driven, inquiry approach toward educational equity, which informs our initiatives and monitors their outcomes. We work with students, faculty, staff, administration, alumni, and community partners towards our common goals, one of which is to provide support and opportunities that will build the academic pipeline.

Nicholas Demello - STEM Learning Skills Coordinator & ACE Learning Skills Adviser

As a science educator, Nick aims to increase the diversity of students graduating with STEM degrees at UCSC. Nick's main goal is to provide undergraduate students with opportunities develop critical-thinking, interpersonal, and communicational skills required for academic and professional growth at UCSC and beyond. Nick's specialty is designing, implementing and facilitating active/collaborative learning experiences, both for students and for peer educators. Upon graduating from UCSC with a B.A. in Chemistry, Nick began working with the Academic Excellence (ACE) Program here on campus. During this time, Nick began developing his pedagogical framework, helping students succeed in their undergraduate chemistry courses through active learning and peer mentorship. In 2017, Nick completed the M.A. Ed/Teaching Credential program here at UCSC. With a refined outlook on education, Nick has returned to the professional workforce at UCSC, working both with LSS and ACE. Through HSI initiatives, Nick is excited to continue to have the opportunity to actualize educational equity andpositively impact students' experiences at UCSC.

Susanna Honig, Ph.D. - ACE Program Director

Susy Honig is the Director of the Academic Excellence Program, which is dedicated to increasing the diversity of students earning bachelors' degrees in Science, Technology, Engineering, and Mathematics at UC Santa Cruz. Before taking her position at ACE, Susy worked to transform the introductory biology courses at UC Santa Cruz into active learning versions as a teaching-focused postdoc working for the Howard Hughes Medical Institute (HHMI) Active Learning Initiative. She has been the instructor of record for Biology 20A- Introduction to Cell and Molecular Biology and Biology 140- Behavioral Ecology. She holds a PhD in Ecology & Evolutionary Biology from UC Santa Cruz, where she served as a TA for thirteen quarters. Her goal is to support student success in STEM using current best practices in evidence-based pedagogy.

Day 1 - Active Learning Teaching, Evaluation, & Practices

Date: September 20, 2018
Time: 9:00 AM - 4:00 PM
Location: Active Learning Classroom in S&E Library

Time	Topic - Workshop	Binder Tab	Presenters
8:30 - 9:00	Breakfast	N/A	
9:00 - 9:20	Introductions	N/A	Nandini & Maya
9:20 - 10:00	What does it mean to be an HSI?	N/A	Pablo, Elizabeth
10:00 - 10:20	The bigger picture on PD and your Graduate career: More opportunities to be involved in teaching	Tab 1	Jody
10:20 - 10:30	Break	N/A	
10:30 - 12:00	Motivational factors in in teaching and learning: Each student comes with their own experiences What might be assumed as standard prerequisites? Sociocultural learning theory Stereotype Threat; Interest; goal orientation	Tab 2	Becca and Nandini
12:00 - 12:45	Lunch	N/A	
12:45 - 1:45	Introduction to Active Learning	Tab 3	Susy
1:45 - 1:50	Break	N/A	
1:50 - 2:50	The Role of Assessment	Tab 4	Nick and Charis
3:00 - 4:00	Fostering Sense of Belonging & Inclusive Learning Environments	Tab 5	Kendra

Day 2 - Scaffolding Pedagogy, and Classroom Activity

Date: September 21, 2018
Time: 9:00 AM - 4:00 PM
Location: Active Learning Classroom in S&E Library

Time	Topic - Workshop	Binder Tab	Presenters
8:30 - 9:00	Breakfast	N/A	
9:00 - 10:15	Cognitive Science on Learning	Tab 6	Robin, Nandini
10:15 - 10:30	Morning Break	N/A	
10:30 - 11:45	Using the Active Learning Toolkit (refer to printed materials in "Active Learning Toolkit" from Day 1)	Tab 7	Susy, Nandini & Nick
12:00 - 1:00	Lunch	N/A	
1:00 - 4:00 PM	Culminating Activity: Design a section / session (using a list of provided topics participants choose one topic of interest and design their lesson plans) Know how of excellent boardwork. How to manage physical space during teaching. How to ask and respond to questions Rate the Scenario	Tab 8	

INSIDE HIGHER ED
(https://www.insidehighered.com)

Study says "tension" between graduate training in research and teaching is false and that teaching training may build research output

Submitted by Colleen Flaherty on June 27, 2018 - 3:00am

Graduate school takes long enough already. That's one of the reasons, among others, why Ph.D. programs tend to focus on research over teaching. A new study [1] challenges assumptions that building teaching expertise has to come at the expense of research preparation, however.

Looking at a national sample of life sciences Ph.D. students, the study's authors considered how increased training in evidence-based teaching practices impacted students' confidence in their preparation for research careers, their ability to communicate about their research, and their publication counts.

In a challenge to conventional but previously untested wisdom, the authors found that the research confidence and output of Ph.D. students who "invested" time in learning evidence-based teaching, or EBT, practices did not suffer. In fact, data revealed what the authors called a "slight synergy" between investing in evidence-based teaching and research savvy. That is, learning about teaching actually appeared to benefit students' research skills.

The long-standing "tension" between developing research and teaching skills "may not be salient for today's graduate students," reads "The Trade-Off Between Graduate Student Research and Teaching: A Myth?" The study was published this week in *PLOS ONE*. "This work is proof of concept that institutions can incorporate training in EBT into graduate programs without reducing students' preparedness for a research career."

Although some institutions already bake pedagogical training into their programs, the authors note, "increasing these programs at scale, and including training in EBT methods could create a new avenue for accelerating the spread of evidence-based teaching and improved teaching across higher education."

The paper's message isn't necessarily new. Many academics and some professional associations have previously said that rounding out graduate training to build skills beyond research better prepares students for a variety of jobs inside and outside academe. But new here are data to back up that argument, the authors say. (And of course there's a major push for evidence-based teaching practices in science at the undergraduate leve [2]l [3], in part to encourage diversity in the field.)

Cutting Through the 'Tension'

"The tension between research and teaching has been investigated for decades for faculty, but we were interested in if there is data to support the trade-off between investing in research and in modern evidence-based teaching for graduate students," co-author Erin E. Shortlidge, an assistant professor of biology at Portland State University [4], said Tuesday. "I hope that this is only the beginning of research on the topic."

Shortlidge and her co-author, Sarah L. Eddy, an assistant professor of biology at Florida International University [5], developed their own survey instrument for gauging students' self-reported awareness of, training in and use of different evidenced-based teaching methods. To do so, they borrowed heavily from two published surveys of faculty and postdoctoral researcher awareness of such practices and shaped them based on various feedback. The survey instrument also asked students to rate their confidence and training in research, teaching and communication, and about how many papers they'd published.

The survey's ultimate set of evidence-based teaching practices was presented with written definitions, to include case studies, clickers, concept maps, discussion-based instruction or Socratic method, flipped classroom, problem-based learning and/or inquiry-based learning, process-oriented guided inquiry learning, and think-pair-share.

Student participants were recruited through professional scientific society Listservs, departmental Listservs and snowball sampling, or chain referrals. The final sample, which did not include first-year Ph.D. students who hadn't been studying long enough for their answers to be relevant, for example, was 338 students. They represented 19 subfields in what the authors call "traditional" life sciences (not biology education or philosophy of science, etc.).

Results

In an advanced analysis, increased training in evidence-based practices did not reduce students' confidence as researchers, but rather had a slightly positive effect. Training in EBTs also increased students' confidence in communicating their research.

Interestingly, teaching experience alone, as opposed to direct instruction in best practices, did not increase research communication confidence.

Controlling for whether students had earned a master's degree and year in their Ph.D. program, the analysis also found no negative relationship between number of papers published and investment in evidence-based teaching practices.

To the contrary, the paper says, "the trend actually hints at the potential for the opposite pattern: for each unit increase in a student's average training in EBT practices, they were 1.04 times more likely to have at least one additional paper." For example, students with the mean EBT training index had a 47 percent chance of having zero publications and students in the third quartile of the EBT training index were slightly less likely to have zero publications, or a 43 percent chance.

Shortlidge and Eddy wrote that, based on other research, many graduate students report having to seek out voluntary evidence-based teaching training and that training of one semester or longer is most effective in building lasting skills. They note that their study is based on self-reported data from self-selected students, and so may not be applicable across the life science graduate student population.

Still, Shortlidge told *Inside Higher Ed* that in her own experience, based on a forthcoming study, "graduate students perceive that their institutions generally only give lip service to professional development and teacher training -- that such training is not a real priority."

So maybe the new data will help convince institutions that investing in evidence-based teaching training won't negatively impact students' research, and even "render them more prepared for their future academic positions," she said.

Teaching and Learning [6]

Links:
[1] http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0199576
[2] https://www.insidehighered.com/news/2015/08/20/aaus-push-science-teaching-yielding-results
[3] http://www.insidehighered.com/news/2015/08/20/aaus-push-science-teaching-yielding-results
[4] https://www.insidehighered.com/college/209807/portland-state-university
[5] https://www.insidehighered.com/college/133951/florida-international-university
[6] https://www.insidehighered.com/news/focus/teaching-and-learning

Case Scenario Day 1

My colleague who usually teaches Thermodynamics was on leave for the semester, and I was assigned to take his place. I knew it would not be easy to teach this course: it has a reputation for being really hard, and engineering students only take it because it is required for the major. On top of that, my colleague had warned me that many students stop coming to lectures early on in the semester, and those who come to class often do not come prepared. It seemed clear that I needed a way to motivate students to work hard and keep up with the material. I recalled that when I was a student, any suggestion by the professor that I might not be up to the challenge really got me fired up and eager to prove him wrong. So I told my students on the first day of class, "This is a very difficult course. You will need to work harder than you have ever worked in a course and still a third of you will not pass." I expected that if my students heard that, they would dig in and work harder to measure up. But to my surprise, they slacked off even more than in previous semesters: they often did not come to class, they made lackluster efforts at the homework, and their test performance was the worst it had been for many semesters. And this was after I gave them fair warning! This class had the worst attitude I have ever seen and the students seemed to be consumed by an overall sense of lethargy and apathy. I am beginning to think that today's students are just plain lazy.

How can you incorporate active learning into your classroom?

The following list summarizes some of the many approaches.

- **Clarification Pauses**: This simple technique fosters "active listening." Throughout a lecture, particularly after stating an important point or defining a key concept, stop presenting and allow students time to think about the information. After waiting, ask if anyone needs to have anything clarified. Ask students to review their notes and ask questions about what they've written so far.
- **Writing Activities such as the "Minute Paper"**: At an appropriate point in the lecture, ask the students to take out a blank sheet of paper. Then, state the topic or question you want students to address. For example, "*Today, we discussed emancipation and equal rights. List as many key events and figures as you can remember. You have two minutes – go!"*
- **Self-Assessment**: Students receive a quiz (typically ungraded) or a checklist of ideas to determine their understanding of the subject. Concept inventories or similar tools may be used at the beginning of a semester or the chapter to help students identify misconceptions.
- **Large-Group Discussion**: Students discuss a topic in class based on a reading, video, or problem. The instructor may prepare a list of questions to facilitate the discussion.
- **Think-Pair-Share**: Have students work individually on a problem or reflect on a passage. Students then compare their responses with a partner and synthesize a joint solution to share with the entire class.
- **Cooperative Groups in Class (Informal Groups, Triad Groups, etc.)**: Pose a question for each cooperative group while you circulate around the room answering questions, asking further questions, and keeping the groups on task. After allowing time for group discussion, ask students to share their discussion points with the rest of the class.
- **Peer Review**: Students are asked to complete an individual homework assignment or short paper. On the day the assignment is due, students submit one copy to the instructor to be graded and one copy to their partner. Each student then takes their partner's work and, depending on the nature of the assignment, gives critical feedback, and corrects mistakes in content and/or grammar.
- **Group Evaluations**: Similar to peer review, students may evaluate group presentations or documents to assess the quality of the content and delivery of information.
- **Brainstorming**: Introduce a topic or problem and then ask for student input. Give students a minute to write down their ideas, and then record them on the board. An example for an introductory political science class would be, "*As a member of the minority in Congress, what options are available to you to block a piece of legislation?*"
- **Case Studies**: Use real-life stories that describe what happened to a community, family, school, industry, or individual to prompt students to integrate their classroom knowledge with their knowledge of real-world situations, actions, and consequences.
- **Hands-on Technology**: Students use technology such as simulation programs to get a deeper understanding of course concepts. For instance, students might use simulation software to design a simple device or use a statistical package for regression analysis.
- **Interactive Lecture**: Instructor breaks up the lecture at least once per class for an activity that lets all students work directly with the material. Students might observe and interpret features of images, interpret graphs, make calculation and estimates, etc.
- **Active Review Sessions (Games or Simulations)**: The instructor poses questions and the students work on them in groups or individually. Students are asked to show their responses to the class and discuss any differences.
- **Role Playing**: Here students are asked to "act out" a part or a position to get a better idea of the concepts and theories being discussed. Role-playing exercises can range from the simple to the complex.
- **Jigsaw Discussion**: In this technique, a general topic is divided into smaller, interrelated pieces (e.g., a puzzle is divided into pieces). Each member of a team is assigned to read and become an expert on a different topic. After each person has become an expert on their piece of the puzzle, they teach the other team members about that puzzle piece. Finally, after each person has finished teaching, the puzzle has been reassembled, and everyone on the team knows something important about every piece of the puzzle.
- **Inquiry Learning**: Students use an investigative process to discover concepts for themselves. After the instructor identifies an idea or concept for mastery, a question is posed that asks students to make observations, pose hypotheses, and speculate on conclusions. Then students share their thoughts and tie the activity back to the main idea/concept.
- **Forum Theater**: Use theater to depict a situation and then have students enter into the sketch to act out possible solutions. Students watching a sketch on dysfunctional teams, might brainstorm possible suggestions for how to improve the team environment. Ask for volunteers to act out the updated scene.
- **Experiential Learning**: Plan site visits that allow students to see and experience applications of theories and concepts discussed in the class.

Sources

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McKeachie, W.J. (2005). How to make lectures more effective. In *Teaching tips: Strategies, research, and theory for college and university teachers* (11th ed.) (pp. 52-68). New York: Houghton Mifflin Co.

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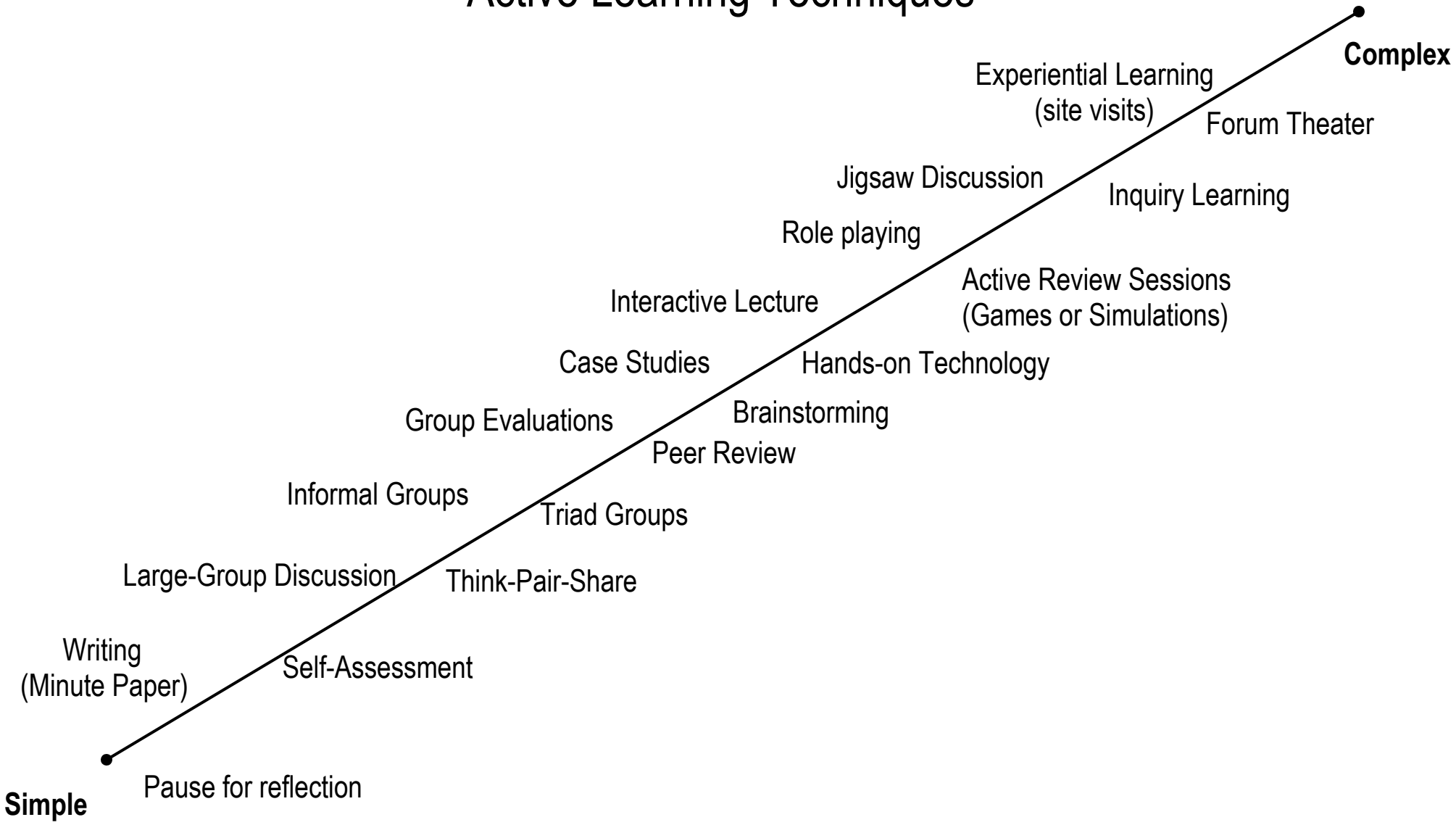
Active Learning Techniques



This spectrum arranges active learning techniques by complexity and classroom time commitment.

Prepared by Chris O'Neal and Tershia Pinder-Grover, Center for Research on Learning and Teaching, University of Michigan

Instructor Notes
Date:
Topic:

Class Schedule

Before-class Assignments

Materials

Key Concepts

Learning Outcomes

(Use backward design toolkit for help here)

Skills Practiced

Description of each activity

HW Assigned

Instructor Notes
Thursday April 7 2016

Class Schedule

5 minutes: Introduction to diffusion/osmosis
5 minutes: Index card solution activity
10 minutes: Synthesize solutions
10 minutes: Salmon discussion
30 minutes: Lecture on the anatomy of the kidney
35 minutes: Peer teaching
10 minutes: Synthesis (What did we learn and Assign HW)

Before-Class Assignments

- Read Chapter 52
- Watch online videos

Learning Outcomes

- Students should understand that animals can break nitrogen waste down into different products, and there is a cost/benefit tradeoff to breaking down wastes based on energy expenditure and water saving.
- Students should understand that different osmotic adaptations depend on the environment animals are from.
- Students should understand how to use the terms hypoosmotic and hyperosmotic.
- Given a novel organism and the osmolarity of the body and the environment, students should be able to predict which way water would move and several mechanisms the animal would use to deal with it.
- Students should be able to draw a juxtamedullary nephron.
- Students should be able to explain why a fish cannot concentrate its urine beyond its body fluid osmolarity, but a bird or mammal can.
- Students should be able to explain why the length of the Loop of Henle correlates with the concentrating ability of the Loop of Henle.
- Students should be able to explain the outcome of the effect of alcohol, ADH, and furosemides on urine output.

Materials

- Index cards with solutions to osmotic challenges on them
- Posters with different environments (marine vs. terrestrial vs. freshwater) titles.

Key Concepts

- Review of Osmosis and Diffusion
- What is osmoregulation?

- Osmotic challenges across habitats
- Kidney structure and function
- Regulation of kidney function
- Extreme kidneys…life in deserts & oceans

Skills Practiced

- Interact with students to learn specific facts and then recall them in an oral game.

5 minutes: Introduction to diffusion/osmosis

Introduce students to the concept of diffusion and osmosis to make sure they understand the underlying challenge associated with osmoregulation and salt balance for animals.

5 minutes: Index card solution activity

Hand out index cards to pairs of students with osmotic solutions to extreme environments written on them. For example, one index card might say "This animal has salt glands in its nose to remove excess salt." Students should place their index card (or post-it) underneath either "marine" "terrestrial" or "freshwater" lists that will be in the front and back of the class. They will need to get up and move to do this!

10 minutes: Synthesize solutions

Spend a few minutes going over a complete table of the solutions, and have students copy this down in their notebooks.

10 minutes: Salmon discussion

Show a brief (2 minute) video outlining the life history of salmon as they are born in freshwater streams, migrate out to the ocean and stay there for most of their adult life, and finally return to freshwater habitats to spawn and ultimately die. Give students about 8 minutes to have a discussion with their neighbor to discuss key questions that are put up on the slide. For example, what are the osmotic challenges these animals face? How might they get around these challenges?

30 minutes: Active Lecture on the anatomy of the kidney

Spend half an hour discussing the anatomy of the kidney with an emphasis on juxtamedullary nephrons and the mechanism in which urine is concentrated. Discuss literature pertaining to the length of the loop of Henle across taxa (paper with birds for example), including students in clicker questions and think-pair-shares.

35 minutes: Peer teaching

Turn it around to students to have them peer-teach one another the anatomy of the kidney. This should be done in an organized fashion so that different groups are specializing on different areas of osmoregulation and then are given a portion of this time to present.

10 minutes: Synthesis (What did we learn and Assign HW)

Synthesize the most important parts of the day and have students write these points in their notebooks.

HW Assigned

- Read Chapter 50
- Online Lectures: Blood Pressure, Heart Anatomy
- Bozeman Science: http://www.bozemanscience.com/circulatory-system/
- Take Quiz 3 (Due Monday April 11 before midnight)

Prompt: Use the space below to ***Brainstorm*** what you would need to come up with the following components of an active learning discussion section or problem solving session

Learning Outcomes
Schedule
Key Topics
Rubric
Materials
1 or 2 activities
Assessment
Synthesis
Mini-lecture on content

Stage 1 – Identify Desired Results (Goals and Enduring Understandings)	
Goals What relevant goals will this design address (e.g., course objectives, learning outcomes)?	
Understandings: ▪ What are the big ideas students should understand? ▪ What are the enduring understandings that are based on the big ideas, and give content meaning & connect the facts & skills? ▪ What misunderstandings are predictable?	Students will understand …
Essential Questions: ▪ What provocative questions will foster inquiry to understand the big ideas and transfer learning?	Students construct meaning as they wrestle with the following questions…
Knowledge & Skills: ▪ What key knowledge and skills will students acquire as a result of this unit? ▪ What should students eventually be able to do as a result of such knowledge and skills?	Students will know … Students will be able to …
Stage 2 – Assessment Evidence	
Assessment Tasks: ▪ Through what tasks, which offer multiple opportunities to explain, interpret and apply their thinking, will students demonstrate their understandings? (e.g., quizzes, discussions, tests, observations, homework, journals)? ▪ By what criteria will understanding be judged? ▪ How will students reflect upon and self-assess their understanding?	Students demonstrate their understanding with the following tasks… Students self-assess their understanding through the following tasks…
Stage 3 – Learning Plan & Activities	
Learning Activities: What learning experiences and instruction will enable students to achieve the desired results?	
▪ How will students know where the unit is going and what is expected? ▪ How will instruction and tasks activate and connect students' prior knowledge? ▪ How will instruction and tasks engage students & sustain their interest? ▪ How will instruction and tasks encourage students to experience and explore the big ideas and enduring understandings? ▪ How will instruction and tasks offer students the opportunities to think about and discuss ideas with peers, and others more knowledgeable? ▪ How will instruction and tasks allow students to reflect on, evaluate, and revise their work? ▪ How will instruction and tasks be inclusive to the different needs, motivations/expectations, attitudes/beliefs, and abilities of learners?	

This template is modified from a version created by the Tasmanian Department of Education using Wiggins and McTighe's (2005) *Understanding by Design.*
https://www.wku.edu/library/dlps/infolit/documents/designing_lesson_plans_using_backward_design.pdf

AVID
Decades of College Dreams

Bloom's Taxonomy: Science and Math

KNOWLEDGE
recalling information

- What information is given?
- What are you being asked to find?
- What formula would you use in this problem?
- What does _____ mean?
- What is the formula for . . . ?
- List the . . .
- Name the . . .
- Where did . . . ?
- What is . . . ?
- Who was/were . . . ?
- When did . . . ?

COMPREHENSION
understanding meaning

- What are you being asked to find?
- Explain the concept of . . .
- Give me an example of . . .
- Describe in your own words what _____ means.
- What (science or math) concepts does this problem connect to?
- Draw a diagram of . . .
- Illustrate how _____ works.
- Explain how you calculate. . . results.

APPLICATION
using learnign in new situations

- What additional information is needed to solve this problem?
- Can you see other relationships that will help you find this information?
- How can you put your data in graphic form?
- What occurs when . . . ?
- How would you change your procedures to get better?
- Does it make sense to . . . ?
- What method would you use to . . . ?

ANALYSIS
ability to see parts and relationships

- Compare and contrast _____ to _____.
- What was important about. . .?
- Which errors most affected your results?
- What were some sources of variability?
- How do your conclusions support your hypothesis?
- What prior research/formulas support your conclusions?
- How else could you account for. . .?

SYNTHESIS
parts of information to create new whole

- Design a lab to show. . .
- Predict what will happen to _____ as _____ is changed.
- Using a principle of (science or math), how can we find. . .?
- Describe the events that might occur if. . .?
- Design a scenario for. . .
- Pretend you are. . .
- What would the world be like if. . .?

EVALUATION
judgment based on criteria

- How can you tell if your answer is reasonable?
- What would happen to _____ if _____ (variable) were increased/decreased?
- How would repeated trials affect your data?
- What significance is this experiment/formula to the subject you're learning?
- What type of evidence is most compelling to you?
- Do you feel _____ experiment is ethical?
- Are your results biased?

SSample worksheet schema that addresses language scaffolding with word problems

What you can do	What you can say
Identify what the problem is asking.	The unknown in this problem is …
	The units of the unknown are …
	Reasonable values for the unknown would be …
Identify the given data and constraints.	The variables or quantities in this problem are …
	The values given in the problem are …
	This problem assumes that …
Draw a picture or model to represent the problem in a different way.	I can show this problem by …
	A model that represents this problem is …
	I can represent this part of the problem with …

Assessment Workshop

Learning Outcomes

Attendees will…

- *Recall* and *Articulate* their prior knowledge of assessment and the role(s) of assessment in education.
- *Differentiate* between the roles of formative and summative assessment in student-centered learning and student-centered teaching practices.
- *Make sense of and Respond to* students' written work and student-to-student discussions
- Utilize wait-time and checking for understanding or prompt mathematical reasoning via formative assessment questions
- Assess students' learning and use reflection to inform instructional decisions by creating entrance and exit tickets.

Major Themes/Topics/Vocab

- Types of Assessment
    - Formative Assessment
    - Summative Assessment
    - Self-Assessment/Metacognition
- Collaborative/Peer-Based Learning
- Student Learning Outcomes
- Entrance/Exit Ticket

Resources/Handouts

- Role of Assessment (Print Copies)
- Measuring Student Learning (Print Copies)
- Entrance and Exit Ticket Resource (Print Copies)
- Math Problems (Print Copies)
- Feedback as an Assessment tool Chapter 5 Ambrose: What Kind of Practice and Feedback Enhances Learning
- Conferring Instructional Activity Structure

Materials

- Large Sticky Note Pads
- Sticky Notes (2 colors)
- Calculators

Agenda

Time	Segment	Active/Collaborative Learning Technique	Instructions
3 min	Warm Up	Brain Dump	Take 3 minutes to write down at least 5 things that you associate with assessment. Consider when, why, and how assessment might be used within an educational context. (Yellow Sticky Notes)
22 min	Workout Pt. 1	Affinity Grouping Pt. 1	With your team, group your associations together and/or make connections between them. Be ready to explain your team's logic. Make sure that all unique associations are included.
		Group Reading	Read through: - Role of Assessment - Measuring Student Learning - Entrance and Exit Ticket Resource
		Affinity Grouping Pt. 2	Each group will come up with another 10-15 unique words, etc. and reorganize their affinity map or create a second map (Blue Sticky Notes).
25 min	Workout Pt. 2		Brief Overview Activity In groups of 5 select one person to be the Leader, 4 will be students. ● Leader takes a minute to look over the problem ● Students work on the problem assigned at a board. Leaders observe students 2-3 minutes ● 8 minutes: checking for understanding; mathematical/scientific reasoning questions 8 Minutes Group reflection on student learning
5 min	Cooldown	Exit Ticket	Based on the group activity create an entrance ticket to bridge today's problem solving session to your "next session" Create an exit ticket that could have been used from the problem solving session.

UCD TEACHING AND LEARNING/ RESOURCES

Teaching Toolkit

Role of Assessment

Author: Paul Surgenor
Email: teachingandlearning@ucd.ie
Date: January 2010

Role of Assessment

Assessment plays a number of roles in the life of a student, some of which they may be more aware of than others.

It's widely accepted that students' learning patterns, educational focus, and allocation of time will be directly influenced by assessment.

> *...assessment methods and requirements probably have a greater influence on how and what students learn than any other factor. This influence may well be of greater importance than the impact of teaching materials*
>
> (Boud, 1988, p.39)

Assessment does more than allocate a grade or degree classification to students – it plays an important role in focusing their attention and, as Sainsbury & Walker (2007) observe, actually drives their learning. Gibbs (2003) states that assessment has 6 main functions:

1. Capturing student time and attention
2. Generating appropriate student learning activity
3. Providing timely feedback which students pay attention to
4. Helping students to internalise the discipline's standards and notions of equality
5. Generating marks or grades which distinguish between students or enable pass/fail decisions to be made
6. Providing evidence for other outside the course to enable them to judge the appropriateness of standards on the course.

He states that with the exception of the last two points these should occur as frequently as possible to support effective learning.

Other reasons given for conducting assessment include (Brown & Knight, 1994):

Fulfil student expectations

Motive students

Provide feedback

Provide opportunities to remedy mistakes

Help with module choice/selection

Indicate readiness for progression

Diagnostic tool

Enables grading and degree classification

Performance indicator for students

Performance indicator for staff

Performance indicator for institution

Tradition

Facilitates learning

Approaching assessment

When considering how to approach assessment Harris & Bell (1990) warn against getting too fixated with trying to apply as many new, innovate approaches as possible. Rather than simply replacing the end of term essay with an end of term report, the underlying philosophy of how we approach assessment has to be reconsidered. This means considering the course as a whole and the role of assessment within it. Biggs & Tang (2007) advocate an approach of asking why, what, how, who, and when?

Why?	What?	How?	Who?	When?
There are many reasons for assessing (see above). One important distinction is whether it's being conducted for formative or summative purposes.	Often focuses on a limited range of impractical skills or knowledge unrelated to the specified learning outcomes at expense of skills & abilities required to function in society.	Most assessment is undertaken by the traditional approaches of exam, essay, or report. A range of alternative methods are discussed in Assessment 5.	**Tutors** (for expertise); **self-assessment** (for reflection); **peer assessment** (for feedback); **employers** (outside HE); **clients** (professionalism & satisfaction)	Ideally assessment should be incremental to provide opportunities to learn from mistakes & feedback, not *en masse* at the end of term

Figure 1: *The Why, What, How, Who, & When of Assessment*

Measuring Student Learning

Adapted from Cornell Center for Teaching Innovation: Assessing Student Learning
https://www.cte.cornell.edu/teaching-ideas/assessing-student-learning/index.html

What is Assessment?

Assessment is the systematic collection of information about student learning, using the time, knowledge, expertise, and resources available, in order to inform decisions that affect student learning (Walvoord, 2010, p. 23).

How can you measure student learning?

- **Summative assessments** are tests, quizzes, and other *graded* course activities that are used to measure student performance.
  - They are *cumulative* and often reveal what students have learned at the end of a course or a chapter/unit.
  - Within a course, summative assessment includes the system for calculating individual student grades.

- **Formative assessment** is *any means by which students receive input and guiding feedback on their relative performance to help them improve, absent their grade*. Formative assessment can be provided face-to-face, during group work, in written comments, problem sets, and through emails.
    - Formative assessments can be used to measure student learning on a daily, *ongoing basis*. These assessments reveal how and what students are learning during the course and often *inform next steps in teaching and learning.*
    - Rather than relying on questions such as “Do you understand?”, or “Are there any questions?”, you can be more systematic and intentional asking students at the end of the class period to write the most important points or the most confusing aspect of the lecture on index cards. Collecting and reviewing the responses provides insight into what themes students have gleaned from your lecture and what your next teaching steps might be. Providing feedback on these themes to students gives them insight into their own learning.
    - Formative assessment can be observational. A lot of information of what students know or don’t know, and what students can or cannot do, can be obtained while observing students as they work collaboratively. Instructional decisions can be made based of these observations for both the current meeting and for future meetings. This type of formative assessment is less of a concrete strategy and more of a practice or habit of mind.

- **Self Assessment** allows students with a chance to report on their own learning. Surveying students about their learning is called **indirect assessment**.
    - Self assessment allows student to reflect on what they know, what they have learned, and what they still need to work on to be successful in their learning.
    - Self assessment is an important skill to develop for self-directed and lifelong learning, both within and outside of the classroom.
    - Students are provided with the opportunity to engage in metacognitive (thinking about thinking/learning about learning) processes that promote retention and overall academic growth.

Using Entrance and Exit Tickets to Conduct Formative Assessment

Adapted From: Brown University Center for Teaching and Learning Resource

Formative Assessments plays a major role in the teaching and learning cycle, both for students and for educators. Such assessments have several purposes, such as allowing educators to get a sense of student' prior knowledge on a given topic/concept, to measure learning over a given period of time, and to provide educators with evidence and reasoning that can guide their instructional decisions. These decisions are largely based on the skills and strengths their students currently have, but more importantly, on where their students need additional support and/or practice.

One such way to conduct formative assessment is through the use of *Entrance Tickets* and *Exit Tickets*. Entrance and exit tickets are short prompts and/or questions that provide educators with quick and focused student diagnostic. These exercises can be collected on 3x5 note cards, small pieces of paper, or through a course management system such as Canvas.

Entrance Tickets: Entry tickets focus student attention on the day's topic or ask students to recall background knowledge relevant to the day's topics. Entrance tickets can be handed into the educator or used as point of discussion at the beginning of the session.

Exit Tickets: Exit tickets collect feedback on students' understanding at the end of a class and provide the students with an opportunity to reflect on what they have learned. They can be helpful in prompting students to begin to synthesize and integrate the information gained during a class period. Usually, exit tickets are handed to the educator as the students leave. However, you might want to have some or all, in small classes, the students quickly share their responses.

Advantages of Entrance and Exit Tickets include…

- Encourages participation from all students.
- Prompts/Primes students to focus on key concepts and ideas that will be explored that day.
- High return of information for the amount of time invested by the educator.
- Important feedback for the instructor that can be useful to guide teaching decisions.
- Integration of content knowledge with reflection and metacognition.
- Act as a natural Warm-Up/Opener and Cool-Down/Closer to your section/session.

Below are some examples of Entrance and Exit tickets that you can use in your own teaching practices! However, the most effective tickets are those designed by you and are based around what information you want to know about your students and what you are hoping to measure! Also keep in mind that some of the examples could be used as either entrance or exit tickets.

Entrance tickets Examples of :

- What are 3 questions that you have from lecture or homework?
- Based on today's lecture, what is your understanding of _____?
- What are 3 key concepts that you learned in the last lecture?
- How many ways are there to solve *insert type of problem*? Can you describe them?
    - You could also provide a problem that has multiple ways of solving and see what method(s) students predominantly use and which they struggle with/are unaware of.

Source:
https://www.brown.edu/sheridan/teaching-learning-resources/teaching-resources/course-design/classroom-assessment/entrance-and-exit

Using Entrance and Exit Tickets to Conduct Formative Assessment

Adapted From: Brown University Center for Teaching and Learning Resource

- Which topic(s) on the upcoming exam do you feel most confident about? Which do you need more practice with?
- Use a KWL+ (**K**now, **W**ant to know, what you have **L**earned, **+** what you still want to know) chart to begin and end your section.
  - The K and W columns could be used as an entrance ticket, and the L and + columns could be used as an exit ticket.

Exit Tickets Examples:

- Give a 5 minute informal quiz that tests whether or not a fundamental skill or concept was understood/mastered.
- What was the "muddiest point" of today's section/session?
- 3:2:1
  - 3 things you did not know before today
  - 2 things that surprised you
  - 1 thing you want to do with what you learned
- 3-way summary:
  - Provide a 10-15 word summary of _____.
  - Provide a 30-50 word summary of _____.
  - Provide a 75-100 word summary of _____.
- Have students do a "One minute paper"
  - What were you most surprised by?
  - What questions do you still have?
  - What is a question that might appear on the next test or quiz?
- What do you think you accomplished during today's section/session?
- What did you find helpful about today? What could be improved?
- What can I do to create a better learning experience for you?
- Considering what was learned today, what do you need to do to solidify your understanding of the topics covered?

Useful Tips

- If using 3x5 note cards, have students respond to the entrance ticket on one side and the exit ticket on the other. If you choose to collect the tickets, you will have access to both responses from each student.
- Be intentional about *why* you are choosing a given entrance and exit ticket prompt. Ask yourself what you are trying to measure and/or gain insight on? Why is it important and how might it inform your future instruction and the support you provide to students?
- If using an exit ticket to measure something that has a direct/specific answer (e.g. a computational problem), predict the common pitfalls/misconceptions that students might encounter as they engage with the prompt. How can you address this during that day's section/session or in future meetings?

Source:
https://www.brown.edu/sheridan/teaching-learning-resources/teaching-resources/course-design/classroom-assessment/entrance-and-exit

Problem 1: Uninhibited Radioactive Decay follows the principle

$A(t) = A_0 e^{kt}, k < 0$, A_0 is the original amount of radioactive material and k is a negative number that represents the rate of decay.

A fossilized leaf contains 70% of it's original amount of carbon-14. The half-life for carbon-14 is 5730 years. (Hint: Half-life is the time required for half (50%) of a radioactive substance to decay.)

a) Determine the rate constant, k, for carbon-14.

b) Find the age of the fossil.

c) How long would it take for all of the carbon-14 to decay?

Problem 2: Analyzing the motion of a projectile: A projectile is fired from a cliff 200 feet above water at an inclination of 45^0 to the horizontal, with a muzzle velocity of 50 feet per second. The height h of the projectile above the water is modeled by

$$h(x) = \frac{-32x^2}{(50)^2} + x + 200$$

where x is the horizontal distance from the face of the projectile

from the face of the cliff. (Hint: *min/max formula* $x = \text{h} = -\frac{b}{2a}$)

a) At what horizontal distance from the face of the cliff is the height of the projectile a maximum?

b) Find the maximum height of the projectile.

c) At what horizontal distance from the face of the cliff will the projectile strike the water?

Case Scenario 1: Different Levels of Expertise

In a large Precalculus course, the first-year undergraduate students have various levels of expertise. Some students seem to have already learned much of the content and sometimes feel bored in class. For other students, much of the material is new and challenging.

When the students do group-based active problem-solving, you notice that the more prepared students excel at doing the work, figuring out the solutions quickly and sometimes commenting that the problem sets are easy. About half of the students, however, appear to not have a solid background in algebra and are not able to contribute as well to problem-solving sessions. You notice that this group of students often expresses feelings of inadequacy or frustration, or they simply do not engage in the group work because they feel lost and because other students find the solutions more quickly or dominate the conversations.

Questions for Discussion:

1. In this scenario, what are the dynamics affecting classroom climate and student learning?

2. What do you want to understand better or know more about in this situation?

3. How could you manage the climate of the learning environment in such a situation? Come up with two or three strategies you might use to promote an inclusive learning environment.

Case Scenario 2: Seeking Student Feedback

In order to help your students prepare for an upcoming exam, you decide to plan a mini-lesson on an important concept that was covered in class and that you anticipate will be on the test. At the end of your mini-lesson, you want to make sure the students understand the material, so you say, "I know this was just review from lecture, but do any of you have any questions about the material?" No one raises their hands, so you assume that everyone understands the material.

When the tests are graded, however, you notice that at least half of your students did not do well on the questions related to the concept that you took the time to review. You feel frustrated that the students were unwilling to ask for help or to admit that they didn't understand the material when you reviewed it.

Questions for Discussion:

1. In this scenario, what are the dynamics affecting classroom climate and student learning?

2. What do you want to understand better or know more about in this situation?

3. How would you move forward from this point to a) make sure that the students understand the concept for the next cumulative exam, and b) ensure that you are able to receive honest feedback from your students about their learning? Come up with two or three strategies that you could use.

Case Scenario 3: Gender Imbalance

The class that you're supporting has a noticeable gender imbalance, with only a few women-identifying students. You especially notice this in your section, where the women-identifying students are especially underrepresented and tend to be quiet. You've tried assigning group work to encourage more participation.

During the first few weeks of the class, the students have become accustomed to sitting in the same seats and so they keep working with the same people in their groups. You notice that the women are often hesitant to join groups and often remain quiet during group work, rarely contributing to the conversation. There are several groups in which there is only 1 woman-identifying person out of 4 or 5 people, and they seem particularly reserved in their group settings. You're concerned that these students are not getting the most out of the class or the collaborative problem-solving activities.

Questions for Discussion:

1. In this scenario, what are the dynamics affecting classroom climate and student learning?

2. What do you want to understand better or know more about in this situation?

3. How would you address the dynamics you observe in the student groups and create a positive learning environment for collaborative work? Come up with two or three strategies for increasing the engagement of the underrepresented students.

Case Scenario 4: Responding to Student Concerns about Academic Performance

Soon after a midterm exam, you notice that one of your students is quieter than usual, and seems withdrawn. They're not as engaged as they usually are, and they appear to be distracted. You feel concerned about this change in the student's behavior, so you stay after class to connect with the student. You learn during your conversation that the student is feeling disappointed about the grade they received on the recent exam.

"I'm really upset I got a C," the student says to you, "I even studied for a lot longer than my friend did, and he got an A-. I'm just not sure if I'm cut out for this class. Maybe I don't even belong in my major. I just don't seem to have what it takes and always do worse than other people."

Questions for Discussion:

1. In this scenario, what are the dynamics affecting classroom climate and student learning?

2. What do you want to understand better or know more about in this situation?

3. How would you respond to this student's concerns? Come up with two or three strategies to encourage the student to stay engaged in the course and motivate them to improve and reach their goals.

ACTIVITY 1: Brainstorming About Problem Solving Section Experiences

In this activity, we want to ask that you consider your own experience in sections or undergraduate courses that had an emphasis on problem solving. Using the prompts below, discuss positive and negative experiences that you had as an undergraduate. Use the white boards at the front of the room to write your group's collective experiences. Your group will be asked to share 1-2 common themes with the rest of the workshop at the end of the session.

PROMPTS

1) What words would best describe your undergraduate learning experience in sections or classes? If you have been a TA, you can also use this experience but put yourself in the shoes of a student.

2) What qualities did the BEST TA that you ever had exhibit? What did he or she say or do that made them stand out?

3) What qualities, actions, or behaviors did the WORST TA that you ever had exhibit? WHY do you think this person behaved in this way?

4) When specifically considering courses where you had to do a lot of problem solving, what did the sections with the TA look like? What activities did you do? Did you work with others or alone? How did the TA respond to students that were struggling?

5) How did you learn to do problem solving? What strategies or techniques do you currently use when asked to solve a math or physics problem? Be specific – what are the microsteps that you take do this and how did you learn these steps?

Differential Calculus (Math 19A) is one of the core courses required for our many STEM majors such as Mathematics, Physics, Chemistry, all Engineering etc. at UCSC. The course is organized around the major themes of Differentiation and requires students to understand concepts starting with limits and continuity and them moving to the definition of derivatives, various techniques of differentiations, derivatives of all different types of functions, and finally applications of derivatives and optimization. On the whole, students view/attend the lectures consistently and also receives help on their homework from instructor and TAs during discussion sections and office hours, and most of them appear to work really hard. Indeed, I often find them in LSS poring over their notes or quizzing each other to memorize and practice with all the individual rules and definitions. With a lot of work, they learn to recite the important abstract definitions and can recall the product rule, quotient rule, chain rule, implicit differentiation rule etc. one by one as procedures. However, in the exam when they were asked to solve a problem using optimization, where many of the concepts listed above cut across, students fail to show their understandings of the individual concept. For example, in the last exam I asked to solve the following problem:

Is it possible to design a cylinder of volume 900 cm^3 with the largest possible surface area?

To my surprise most students wanted to give a concrete number for its answer and not develop the argument after applying all their knowledge of Calculus that such a design of a cylinder is not possible under the given conditions.

I don't get it—they know all the parts (geometry of a cylinder, setting up the equations using the constraints, using appropriate rules of derivatives, then solving for the derivative equation to be equal to zero for optimizing). But when it comes to how these parts fit together so that you are maximizing the surface area to answer a real world problem, they have a really difficult time.

A-D Test Reflection

Reflect on the test by answering the following questions.

A. Describe how you studied for the exam.

1) How many hours did you spend?
2) What did you focus on? What influenced your decision to focus on this material?
3) How did you know you were understanding the material?
4) What did you do to self-check your comprehension of the material?
5) What material did you struggle with?
6) What did you do to improve your compression of the material you identified in question #5?

B. Describe your experience taking the exam.

1) How did you approach the test? Did you take the test in order presented, or did you skip to particular sections? Why did you approach the test this way?
2) Was the test easy?
3) What specific material did you struggle with?
4) How did you approach this difficult material? What strategies did you use?
5) Did you double check your work before you submitted the exam?

C. Assess your performance on the exam.

1) Do you believe that you performed well on the test?
2) What grade do you believe you earned?
3) Do you think this score represents your ability? If not, describe the discrepancy between your potential and your performance.

D. Describe how you will study for the exam.

Write a paragraph of at least seven sentences describing how you will prepare for the next test.

This activity is designed to give you a chance to reflect on your exam performance and, more importantly, on the effectiveness of your exam preparation. Please answer the questions sincerely. Your responses will be collected to inform the instructional team about students' experiences surrounding this exam and how we can best support your learning. They will have no impact on your grade.

1. Approximately how much time did you spend preparing for this exam? 12 hours

2. What percentage of your test-preparation time was spent in each of these activities?
   a. Reading the OLI section(s) for the first time _____
   b. Re-reading textbook section(s) _____
   c. Re-reading the OLI material 40%
   d. Reviewing your own notes 30%
   e. Working the practice exam questions 30%
   f. Reviewing materials from blackboard _____
      (What materials? _____)
   g. Other _____
      (Please specify: _____)

3. Now that you have looked over your graded exam, estimate the percentage of points you lost due to each of the following (make sure the percentages add up to 100):
   a. Trouble with applying definitions 10%
   b. Trouble remembering structures _____
   c. Lack of understanding of the concepts 20%
   d. Unclear expectations 30%
   e. Not knowing how to approach the problem _____
   f. Careless mistakes 40%
   g. Other _____
      (Please specify: _____)

4. Based on your responses to the questions above, name at least 3 things you will do differently in preparing for the next exam. For instance, will you just spend more time, change a specific study habit or try a new one (if so, name it), try to sharpen some other skill (if so, name it), use SI more, participate in more review opportunities, something else?

   1) For the next exam, I will begin studying a few days before the exam.
   2) I will participate in more review opportunities
   3) I will spend more time on the practice exam questions

5. What can we do to help support your learning and your preparation for the next exam?

   Provide answers to the My Responses in O.L.I.

PLEASE CONTINUE ON THE BACK ON ANY QUESTION WHERE YOU NEED MORE ROOM.

Chemistry Self-Assessment & Reflection: Exam #1 Name: _____

DUE: At the next class meeting, hand in this completed form at the beginning of lecture.

This form will help you to analyze your exam performance and find strategies that work best for you in learning the material for this course. Self-assessing your progress and adjusting your study strategies accordingly is what effective learners tend to do. Please answer the questions below sincerely. Your responses will have no impact on your grade, but they will inform the instructional team about how we can best support your learning. We will return your completed form before the second exam so that you can use your own responses to guide your approach to studying next time.

1. Approximately how much time did you spend preparing for this exam? _____

2. What percentage of your test-preparation time was spent in each of these activities?
   a. Skimming textbook chapters _____
   b. Reading textbook chapters thoroughly _____
   c. Reviewing your own notes _____
   d. Working on practice exam questions
   e. Reviewing materials from blackboard
   f. Other _____
      (Please specify: _____)

3. As you look over your graded exam, analyze where/how you lost points. Fill in the blanks below with the number of points you lost due to each of the following:
   a. Trouble applying definitions _____
   b. Trouble remembering structures _____
   c. Lack of understanding of a concept _____
   d. Not knowing how to begin a problem _____
   e. Careless mistakes _____
   f. Other _____
      (Please specify: _____)

4. Based on your responses to the questions above, name 3 things you plan to do differently in preparing for the next exam. For instance, will you just spend more time, change a specific study habit (if so, name it), try to sharpen some other skill (if so, name it), use other resources more, or something else?

5. What can we do to help support your learning and your preparation for the next exam?

PLEASE CONTINUE ON THE BACK ON ANY QUESTION WHERE YOU NEED MORE ROOM.

Name: _____

Department of Mathematical Sciences
Carnegie Mellon University

Test Reflection Sheet

Do you think that the problems on the exam fairly reflected the topics covered in class and recitation?

Yes ___ No ___

Did the grader's comments, together with the solutions, provide you with adequate feedback?

Yes ___ No ___

What percentage of your preparation for the test was done alone, and what percentage with one or more persons?

___ % Alone ___ % with other(s)

How much time did you spend reviewing with each of the following:

Reading class notes _____
Reworking old homework problems _____
Working additional problems _____
Reading the book _____

Now that you have looked over your exam, estimate the percentage of points you lost due to each of the following:

___ % from not understanding a concept
___ % from not being careful (i.e., careless mistakes)
___ % from not being able to formulate an approach to a problem
___ % from other reasons (please specify: _____)

Based on the estimates above, what will you do differently in preparing for the next test? For instance, will you change your study habits or try to sharpen particular skills? Please be specific. Also, what can we do to help?

33-111 Physics Post-Exam Reflection Name: _____

As with the first exam, this activity is designed to give you a chance to reflect on your exam performance and, more importantly, on the effectiveness of your exam preparation. Again, please answer the questions sincerely. Your responses will be collected to inform the instructional team; they will have no impact on your grade.

1. Approximately how much time did you spend preparing for this exam? _____

2. What percentage of your test-preparation time was spent in each of these activities?
   a. Reading textbook section(s) for the first time _____
   b. Re-reading textbook section(s) _____
   c. Reviewing homework solutions _____
   d. Solving problems for practice _____
   e. Reviewing your own notes _____
   f. Reviewing materials from blackboard _____
      (What materials? _____)
   g. Other _____
      (Please specify: _____)

3. What aspect(s) of your preparation for this exam seemed different from your exam 1 preparation? Did these changes have any effect?

4. Now that you have looked over your graded exam, estimate the percentage of points you lost due to each of the following (make sure the percentages add up to 100):
   a. Trouble with vectors and vector notation _____
   b. Algebra or arithmetic errors _____
   c. Problem with force-body diagram _____
   d. Lack of understanding of the concept _____
   e. Not knowing how to approach the problem _____
   f. Careless mistakes _____
   g. Other _____
      (Please specify: _____)

5. Students sometimes have difficulty drawing appropriate force-body diagrams and applying Newton's second law appropriately. Was either of these a difficulty for you (check question 2 on the exam)? If so, try to self-assess your understanding: Identify what aspect of these skills are causing you difficulty and what you can do to improve your ability to solve problems using these skills.

PLEASE CONTINUE ON THE BACK ON ANY QUESTION WHERE YOU NEED MORE ROOM.

Reflecting on Your Mid-Quarter Progress

Student:_____ Class:_____ Date:_____

What aspects of your effort and preparation were most effective?

What aspects of your effort and preparation were least effective?

What specific action or actions will improve your performance?

What will you do differently starting this week?

What can I do to help you achieve your goal?

On Your Mark Grading Workshop

Self-Reflection Prompts for Educators

Self-Reflection is an extremely powerful tool that is conducive to growth, whether is is academic growth, pedagogical growth, or fostering a growth mindset. Reflecting is just as important for educators as it is for students, and should be done regularly (at least once per week). Reflection allows you to compare and contrast what you had planned vs. what actually happened, where your strengths are, and where there is still room for growth. Self-reflective practices have been known to strengthen emotional intelligence, increase integrity, and foster confidence (Kovary - 2015), all of which influence quality teaching practices and interpersonal skills. Below are a few sets of prompts that you can use for self-reflection.

__Note__: These prompts can be modified and given to students for self reflection

- **Simple Reflection Prompts**
  1. What went excellently today/this week and why?
  2. What could have been better and how?
  3. What do I want to change in my teaching?

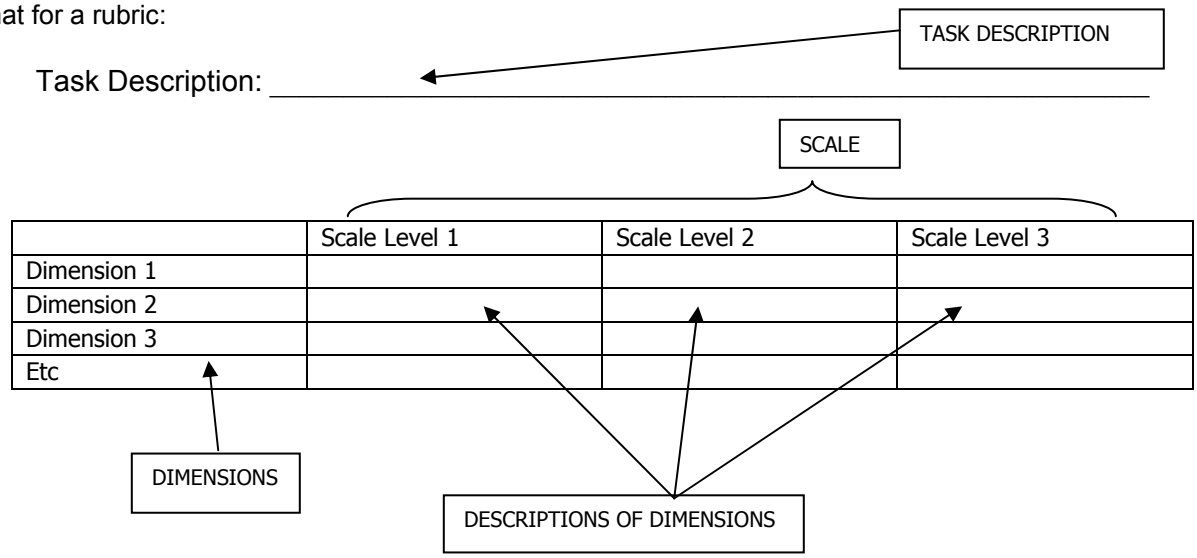
- **Through Reflection Prompts**
  1. Pick a subject to reflect on – career, personal life, finances, health.
  2. Carve out time when you can be alone, quiet and not interrupted.
  3. List out all the questions you would like to explore.
  4. Jot down your answers to each question.
  5. Be honest – this is for your own growth and does not need to be shared with anyone.
  6. Identify action steps you will take to start, stop or continue doing something. These can include how to be more grateful, more open, more supportive, more collaborative etc. or they can be very tactical things like sending fewer emails and having more one-on-one conversations.
  7. Celebrate your successes – congratulate yourself on all the great things you accomplished this year and what you are most proud of.

- **Create your Own Reflection Prompts!**

How to Create Rubrics

(Based on Introduction to Rubrics: An Assessment Tool to Save Grading Time, Convey Effective Feedback, and Promote Student Learning by Stevens and Levi 2005; Assessing Academic Programs in Higher Education by Allen 2004; and Learner-Centered Assessment on College Campuses: shifting the focus from teaching to learning by Huba and Freed 2000)

Format for a rubric:



A rubric involves four components:

Part 1: *Task Description*

- Involves a "performance" of some sort by the student
- The task can take the form of a specific assignment; e.g., a paper, a poster, a presentation
- The task can take the form of overall behavior; e.g., participation, use of proper lab protocols, behavioral expectations in the classroom

Part 2: *Scale*

- Describes how well or poorly any given task has been performed
- Positive terms which may be used: "Mastery", "Partial Mastery", "Progressing", "Emerging"
- Nonjudgmental or noncompetitive language: "High level", "Middle level", "Beginning level"
- Commonly used labels:
    - Sophisticated, competent, partly competent, not yet competent
    - Exemplary, proficient, marginal, unacceptable
    - Advanced, intermediate high, intermediate, novice
    - Distinguished, proficient, intermediate, novice
    - Accomplished, average, developing. Beginning
- 3-5 levels are typically used
    - the more levels there are, the more difficult it becomes to differentiate between them and to articulate precisely why one student's work falls into the scale level it does
    - but, more specific levels make the task clearer for the student and they reduce the professor's time needed to furnish detailed grading notes

Part 3: *Dimensions*

- Lay out the parts of the task simply and completely
- Should actually represent the type of component skills students must combine in a successful scholarly work
- Breaking up the assignment into its distinct dimensions leads to a kind of task analysis with the components of the task clearly identified

Name: _____

Math 3: Precalculus

Time: 20 Minutes

Quiz and Rubric Example

You may not use a calculator on this quiz. You must show your work and/or provide logic on each questions to receive a score.

1. Let $f(x) = \frac{1}{x}$ and $g(x) = \sqrt{x^2 - 4}$

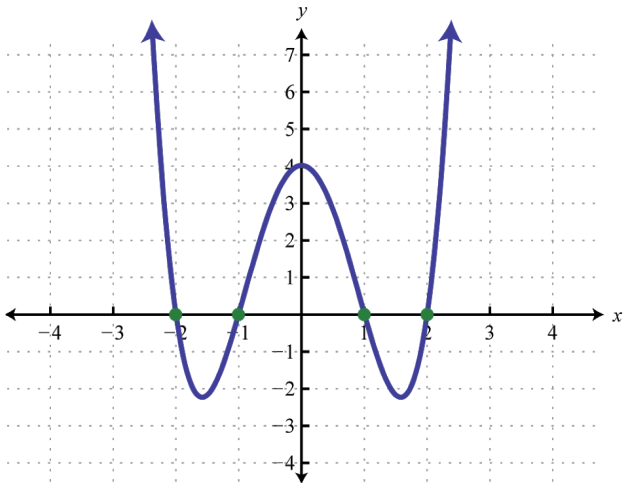
   a. Determine the domain of f(x). Write your answer in set -**OR**- union notiona **AND** using a complete sentence.

   b. Determine the domain of g(x). Write your answer in set -**OR**- union notiona **AND** using a complete sentence.

   c. Determine $(f(x) \cdot g(x)(3)$

2. Determine if $f(x) = x^2 - 3$ is an even function, odd function, or neither. Demonstrate your logic in words and/or using a picture.

3. Locate and label the following on the graph...
   a. Absolute Maximum
   b. Absolute Minimum
   c. Local Maxima
   d. Local Minima



Name: _____

Math 3: Precalculus

Time: 20 Minutes

Quiz and Rubric Example

	0 - Needs Improvement	2- Developing	4 - Developed	5- Advanced
Problem 1	Most/All answers have error or are incomplete/ unanswered. There is no logic to demonstrate thought process.	1 or more answers have errors. However, there is partially complete work for most/all components and logic is present.	All answers are correct but 1 or both complete sentences are not provided for parts a and b.	All answers are correct and complete sentences are provided for parts a and b each.
Problem 2	The answer is wrong, incomplete, or absent. There is no logic to back up the claim.	The question is answered incorrectly, but there is some logic to back up the claim, whether correct or not.	The question is answered correctly, but there is no logic to back up the claim -or- the logic is incorrect.	The question is answered correctly and there is correct logic (words or pics) to back up the claim.
Problem 3	Work on the question is wrong, incomplete or absent. There is no logic to back up the claim.	There are several errors, a few points are correctly labeled and identified.	Most points are correctly identified and labeled.	All points are correctly identified and labeled.

Additional Comments/Feedback (Optional)

Score: _____ / 15

Goals for Productive Discussions and Nine Talk Moves

Goal: Individual students share, expand and clarify their own thinking

1. **Time to Think:**

   Partner Talk

   Writing as Think Time

   Wait Time

2. **Say More:**

   "Can you say more about that?" "What do you mean by that?" "Can you give an example?"

3. **So, Are You Saying...?:**

   "So, let me see if I've got what you're saying. Are you saying...?" (always leaving space for the original student to agree or disagree and say more)

Goal: Students listen carefully to one another

4. **Who Can Rephrase or Repeat?**

   "Who can repeat what Javon just said or put it into their own words?" (After a partner talk) "What did your partner say?"

Goal: Students deepen their reasoning

5. **Asking for Evidence or Reasoning:**

   "Why do you think that?" "What's your evidence?" "How did you arrive at that conclusion?"
   "Is there anything in the text that made you think that?"

6. **Challenge or Counterexample:**

   "Does it always work that way?" "How does that idea square with Sonia's example?"
   "What if it had been a copper cube instead?"

Goal: Students think with others

7. **Agree/Disagree and Why?:**

   "Do you agree/disagree? (And why?)" "Are you saying the same thing as Jelya or something different, and if it's different, how is it different?" "What do people think about what Vannia said?"
   "Does anyone want to respond to that idea?"

8. **Add On:**

   "Who can add onto the idea that Jamal is building?"
   "Can anyone take that suggestion and push it a little further?"

9. **Explaining What Someone Else Means:**

   "Who can explain what Aisha means when she says that?" "Who thinks they could explain in their words why Simon came up with that answer?" "Why do you think he said that?"

Attendee prompt: Please discuss whether each statement is positive, neutral, or negative when thinking about current best practices in inclusive and evidence-based pedagogy

NOTE: These scenarios should be printed and cut into strips so that trainees can discuss them one at a time (maybe put them in the center of the table and have people grab them and work in pairs?)

- "My goal is to find the students who have the ability to succeed and help them push themselves forward"
- "I know that math can be really hard, don't worry"
- "If I said it, they learned it"
- "I believe that everyone can develop the ability through practice and struggle to succeed"
- "Look to the left….look to the right….half of you will not pass this class"
- "We are not here to hold your hands"
- "Not everybody is meant to be a mathematician"
- "I learn everybody's name in my discussion section so that I can address them individually when I cold call"
- "I know that you didn't do as well as you wanted to on this exam. Let's make a study plan for the next test and look at where you can improve."
- "Nice work on that problem set. You have a real talent for this."
- "You haven't been doing very well in your math classes. Have you thought about a different major that's less math-heavy?"
- "It's really important that you master this concept in this class, because it will be very important later on in your major."
- "This is a really hard test."
- "I always give my quizzes at the start of my 8am class. If people are late they need to figure out how to be on time or they lose points."
- "When I was in college, I failed my first math class."

- “Most students find this topic to be easy compared to other topics in the course.”

- “I am not going to go too into depth on this. You should have learned this in another course or in high school.”

- “All you need is more practice and you’ll do better on the next test!”

- “This topic is challenging, but it will show up over and over again in the rest of the course. If you do not understand this topic, it will be hard to be successful in my course.”

- “I’m not going to answer that question because I addressed that during the last lecture. Refer to your notes or to the textbook.”

Discussion Map

- **Ask a question that invites learners to share what they think.**
  - Prepare your questions ahead of time so that they aren't too leading, but really draw out student thinking. In other words, be sure the answer you are driving for isn't embedded in your tone or the wording of your query. For example, you could ask "What did you notice?" or observe? or note down/underline or highlight and why?
- **Listen to their responses and thinking.**
- **Remember to stay neutral in your reaction.**
  - You or a student might keep notes (graphical or text) on the board while the conversation unfolds.
- **Encourage and challenge learners to provide explanations, evidence, or clarifications to elaborate on their thinking.**
  - Ask if others have questions for the responders as you go along -- it doesn't always have to be from you -- in fact, what you want is to inspire a culture of conversation among participants with you simply listening and supporting deepened thinking when needed. Suggested probing questions are provided - perhaps write the probing questions on the board and encourage peers to further question one another using the following prompts:
    - What makes you think that?
    - Please give an example from your experience.
    - Was there anything in the reading/problems/tasks assigned that you can cite for supporting evidence?
    - What do you mean?
- **Encourage learners to provide alternative opinions or ideas, and react & respond to the ideas shared. Suggested probing questions:**
  - Can anyone add something to that comment?
  - Who would like to share an alternative opinion?
  - What do others think about that idea? [Here is a good place for low-tech clickers to get everyone's take quickly and cue you where to take the conversation, rather than having to pose the "does anyone disagree".]
  - Does anyone disagree with that comment?
- **Connect back to the main topic.**
  - Would anyone like to connect where we are back with the main topic?
  - What are the key linkages?
  - Is there any other aspect we could explore as a group?
- **Help to organize and summarize ideas.**
  - Or ask someone to come forward to write on the board or stand up and summarize the ideas. The first person called on can get help from others too. Can someone start us off building a summary of the ideas that have surfaced in this conversation?

Prior knowledge and Conceptual change

A key principle to keep in mind from research in cognitive science, educational psychology, and science education on students' understanding of science: Humans are viewed as goal-directed agents who actively seek information. They come to formal education with a range of prior knowledge, skills, beliefs, and concepts that significantly influence what they notice about the environment and how they organize and interpret it. This, in turn, affects their abilities to remember, reason, solve problems, and acquire new knowledge (Bransford, Brown, & Cocking, 2000, p. 10).

Having errors in your understanding is an inescapable part of learning. So is learning simply a matter of replacing those inaccuracies with the correct "answers?" We know that just telling students that their ideas, beliefs, and understandings are wrong does not work. Why not?

In regards to learners' **prior knowledge, skills, beliefs, & concepts**, consider three conditions (Chi, 2008):

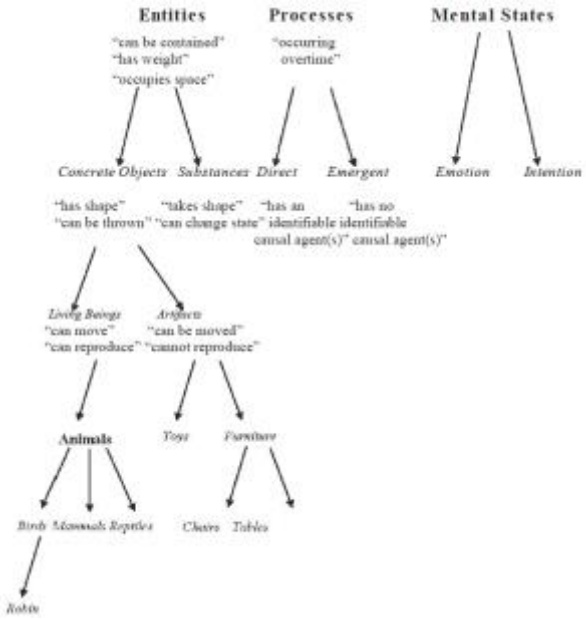
1. *Missing*. A learner may have no prior knowledge of the to-be-learned concepts, although they may have some related knowledge. So the prior knowledge is missing, and learning consists of adding new knowledge.
2. *Incomplete*. A learner may have some correct prior knowledge about the to-be-learned concepts, but that knowledge is incomplete. In this case, learning can be conceived as filling in the gaps.
3. *Misconceived*. A learner may have acquired ideas, e.g., from school or everyday experiences, which are in conflict with the to-be-learned concepts. Here, learning is changing prior misconceived knowledge to correct knowledge.

For prior knowledge that is misconceived, think about **knowledge in three grain sizes** (Chi, 2008):

1. *Belief* refers to a single idea or piece of information.
    a. A learner believes that all blood vessels have valves or that the heart is responsible for re-oxygenating blood. These beliefs are misconceived; they are considered false beliefs.
    b. Sometimes, explicitly or implicitly confronting the false belief with correct information that contradicts and refutes the false belief can achieve conceptual change. The false belief can be *revised*.
2. A *mental model* is formed from an organized collection of individual beliefs. It is an internal representation of a concept, or an interrelated system of concepts that corresponds in some ways to the external structure that it represents (Clement & Vosniadou, 2008; Nersessian, 2008).
    a. Learners can have missing, incomplete, or misconceived mental models; their interrelated system of concepts can comprise of false and correct beliefs, forming a coherent but flawed mental model. A learner builds a mental model of the circulatory system as a single loop system, where the heart is the source of oxygenating blood. The learner's model is in conflict with the normative scientific view, but coherent in the sense that learners can use their mental model to offer similar and consistently incorrect explanations and predictions in response to a variety of questions.
    b. Flawed mental models can be *transformed* into the correct model when false beliefs within a flawed model are refuted by instruction and recognized by learners as contradictions, so that the learners can self-repair their flawed mental models (Chi, 2008, p. 69). Knowing and learning many correct beliefs, or revising many false beliefs, does not guarantee successful transformation of a flawed mental model to the correct one. Some critical false beliefs serve to discriminate a flawed model from a correct model.
    c. For example, in understanding what causes the phases of the moon, we have learned a critical false belief that learners have is the Earth's shadow causes the phases of the moon. Thus, in our moon phases activity, we deliberately explore shadows at the very start of the activity.

d.

3. *Categorizing* is a process of identifying or assigning a concept to a category to which it belongs. This process is an important learning mechanism (Bransford et al., 2000) because in assigning a concept into a category, a learner can use knowledge of the category to make many inferences and attributions about the novel concept or phenomenon.
    a. Categories can be entities (e.g., can be contained, has weight, occupies space), processes (e.g., occur, take time), or mental states (e.g., emotion, intention). They can be organized hierarchically and laterally (p. 64).
    b. Learners often categorize heat as an entity. They think of heat as physical objects, such as "hot molecules" or a material substance such as "hot stuff" or "hotness" (Wiser, 2001). But heat is the speed at which molecules jostle; motion is a process not an entity.
    c. If the misconception is due to categorizing mistakes, then instruction needs to focus at the categorical level.



Categorize Earth as a physical object, so believe Earth is flat.

Categorize Earth as a solar object, so believe Earth is spherical.

image from p. 131 in Siegal, M., Nobes, G., & Panagiotaki, G. (2011). Children's knowledge of the Earth. *Nature Geoscience*, *4*(3), 130-132.

Instructional approaches to build learners' conceptual understanding, which include addressing their misconceptions, need to consider how the misconception is occurring for the learners. Learners sometimes let go of their incorrect ideas readily. Other times the misconceived understandings are robust and highly resistant to change, despite instructional interventions. Researchers and educators are still challenged with understanding why conceptual change can be so difficult. Studies in cognitive neuroscience offers some interesting insights (Dunbar, Fugelsang, & Stein, 2007; Fugelsang & Dunbar, 2005). fMRI scans of students engaged in causal reasoning tasks found that when students were given data that were consistent with their preferred theory, areas in the brain thought to be involved in learning were activated. When presented with data that were inconsistent with their preferred theory, areas of the brain associated with error detection and conflict monitoring were activated. Basically, when people receive information inconsistent with their preferred theory, learning does not easily occur. So, what are the origins of their erroneous thinking?

Learners' **inaccuracies arise in many different ways**:

- Personal experience. From their experiences, a heavy rock falls off the table faster than a light piece of paper, or that it's hotter as they move closer to the fire. These observations support and strengthen their beliefs that heavy things fall faster than light things (vs physicist's view that all objects fall at the same rate) and that the Earth is closer to the Sun during summer and farther away during winter (vs astronomer's explanation that seasons are due to the tilt of Earth's axis). So while their everyday observations are sensible and useable for explaining many experiences, they can also be problematic.
- Instruction. Students may overgeneralize instructional analogies, particularly if they are unfamiliar with a topic or don't understand the source example (Jee et al., 2010). The teaching materials may be inaccurate or misleading. Science content in textbooks have been found to give erroneous explanations and incomplete information (Hubisz, 2001; King, 2010), or the diagrams are depicted in such a way that can be confusing and misleading (e.g., nucleus is draw large and electron very small, but there is no indication in the text to clarify the representation; students are then surprised to learn that the nuclei are very small, even the massive ones (Hubisz, 2001, p. 306)).
- Deliberate misinformation. Topics like climate change, evolution, smoking, and vaccines have social, political, and economic implications. For some, like climate change, the scientific concepts are complex and sometimes counterintuitive to personal experiences. The concepts might not be taught in schools, and/or what is taught competes with other sources of information that are contradictory (Oreskes, Conway, & Shindell, 2008).

Conceptual change does happen. It takes time and is a slow process. **Conditions that facilitate conceptual change include**:

- *Awareness of contradiction.* In order for learners to revise their false beliefs, transform their mental models, or even re-categorize concepts, they need to be cognizant of the contradiction between what they think and the normative scientific view (Chi, 2008; Inagaki & Hatano, 2008). Without this awareness, learners may simply assimilate the new information. Due to their advanced metacognitive abilities from years of training, scientists carefully monitor coherence among pieces of knowledge constituting a theory and can be sensitive to and respond to a small amount of disconfirmation and dis-coordination in their knowledge system.
- *Availability of alternative concept.* Belief revision is possible when a learner can think of (or are given) an alternative belief. If learners do not think of an alternative theory, model, or interpretation, they may stick to the old belief even when predictions from it are not supported (Inagaki & Hatano, 2008).

Instructional practices that have been found to be effective, especially in addressing learners' misconceptions, include (Chapters 4 & 6 (Singer, Nielsen, & Schweingruber, 2012)):

- Student participation, active engagement, discourse
- Opportunities for reflection, metacognition (Zhao, Wardeska, McGuire, & Cook, 2014)
- Interactive lecture, lecture tutorial (Kortz, Smay, & Murray, 2008; Sokoloff & Thornton, 1997; Zimrot & Ashkenazi, 2007)
- Bridging analogies (Brown & Clement, 1989; Jee et al., 2010)

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