2022 UA LITTLE ROCK MIST



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2022 UA Little Rock MIST

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TABLE OF CONTENTS

Licensing

1: MIST - Who and What

- 1.1: About MIST
- 1.2: People
- 1.3: MIST LibreText Walk-Through

2: Interactive Workshops

- 2.1: Welcome Session
- 2.2: Inclusivity Session
- 2.3: Backward Design I
- 2.4: Backward Design II
- 2.5: Scientific Teaching in Action
- 2.6: Peer Feedback and Reflection
- 2.7: Scholarly Teaching
  - 2.7.1: Evaluation Guide
  - 2.7.2: Evaluative Assessment Resources
- 2.8: Strategic Planning

3: Group Work

- 3.1: Group Work Sessions
  - 3.1.1: 5 Stages of Group Development
  - 3.1.2: Constructive and Destructive Group Behaviors
- 3.2: Group Presentations

4: Treasure Chest

- 4.1: Literature
- 4.2: Resources

5: Discussion Forum

- 5.1: Before the workshop begins
- 5.2: During the workshop
- 5.3: After the workshop

Index

Glossary

Detailed Licensing

Licensing

*A detailed breakdown of this resource's licensing can be found in **Back Matter/Detailed Licensing**.*

CHAPTER OVERVIEW

1: MIST - Who and What

Here you can find information about the MoSI workshops and your fellow workshop participants.

1.1: About MIST

1.2: People

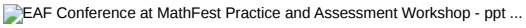
1.3: MIST LibreText Walk-Through

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1.1: About MIST

What is the MIST?

The Mobile Institute (formerly MoSI) is a place-based iteration of the renowned National Institute on Scientific Teaching. This format uses the Four Categories of Change Strategies to expand the focus from the individual to the institutional in order to better address institutional challenges to education reform. In addition to the proven training paradigm provided by the pedagogy workshop, the MIST provides training in peer evaluation to drive long-term reflective teaching, facilitated strategic planning to leverage newly gained expertise toward educational reform and an administrator's workshop to foster buy-in and support of local policy makers.



Goal

The goal of the Mobile Institute is to improve undergraduate education. This will be achieved by a) training faculty in effective, evidence-based teaching strategies; b) facilitating reflective practices through peer mentoring and evaluation and c) facilitating strategic planning to reform educational practices at the host institution. This institute is modeled after the National Institute and is meant to extend the impact of that successful, nationally renowned professional development workshop and promote broader adoption of reformed pedagogy and promote institutional reform in education.

Learning Outcomes

By the end of the institute, you will have:

- practiced a variety of evidence-based teaching strategies through workshops, presentations, and group work
- worked as a team to create teaching materials that implement evidence-based teaching strategies
- begun to shift your focus from content and teaching to outcomes and learning
- practiced peer evaluation to promote reflective teaching practices

The MIST Format

The MIST is a **project-based training program combining interactive workshops** on the tenets of scientific teaching **with group work sessions** where participants develop inclusive, student-centered teaching materials that they present to colleagues for peer-review at the end of the week.

The **interactive workshops** are designed to introduce participants to innovations and research on undergraduate education, and to model how to implement their underlying principles in a learning space.

Group work carefully designed to model scientific teaching has been found to be one of the most important processes at the Institute. Each is led by a trained facilitator to model teaching practices that will help the group establish and meet common goals. Each group presents their teaching module for review during a dress rehearsal with another

group and a final presentation. This allows groups to practice providing feedback on the effectiveness of learning activities and to incorporate peer feedback into their teaching modules before using them in their own classes.

References

- Borrego, M., and Henderson, C (2014) Increasing the use of evidence-based teaching in STEM Higher Education: A comparison of eight change strategies. *J Engineering Educ.*, 103(2), 220-252.
- Henderson, C., Beach, A., and Finkelstein, N. (2011) Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *J Res in Sci Teaching*, 48(8), 952-984.
- Henderson, C., Finkelstein, N., and Beach, A. (2010) Beyond Dissemination in College Science Teaching: An introduction to four core change strategies. *J Coll Sci Teach* 39(5), 18-25.

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1.2: People

MIST participants, local leaders, and training team

Thank you for joining the 2022 online MIST workshop! We hope that you enjoy yourself and take away something that will enhance your teaching capabilities.

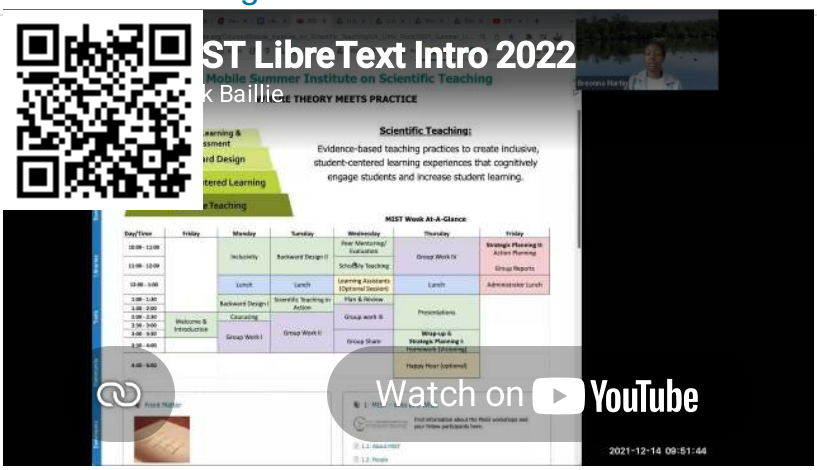
UA Little Rock People List MoSI 2022 : People

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People

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CHAPTER OVERVIEW

2: Interactive Workshops

Overview

The MIST is a project-based training program combining interactive workshops on the tenets of scientific teaching with group work sessions where participants develop inclusive, student-centered teaching materials that they present to colleagues for peer-review at the end of the week.

The **interactive workshops** are designed to introduce participants to innovations and research on undergraduate education, and to model principles about which they teach.

The workshop links below are in order of occurrence during the week and will take you to a page for each workshop.

2.1: Welcome Session
2.2: Inclusivity Session
2.3: Backward Design I
2.4: Backward Design II
2.5: Scientific Teaching in Action
2.6: Peer Feedback and Reflection
2.7: Scholarly Teaching
2.7.1: Evaluation Guide
2.7.2: Evaluative Assessment Resources
2.8: Strategic Planning

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2.1: Welcome Session

Workshop Overview

The Welcome and Introduction workshop introduces participants to the MIST approach and rationale, promotes community building, models scientific teaching in action and orients participants to the Libretext platform that will be used for asynchronous content delivery.

Learning Outcomes

Participants will be able to:

- Describe the rationale and approach of the Mobile Institute on Scientific Teaching (MIST)
- Implement relationship and community-building approaches on the first day of class
- Identify current teaching challenges
- Compare and contrast, at a broad level, in-person and remote teaching approaches
- Navigate the MIST asynchronous content-delivery platform, Libretext

Key Terms

- Scientific teaching
- Evidence-based teaching
- Inclusive teaching
- Student-centered learning
- Backward design
- Active learning
- Formative assessment
- Synchronous/asynchronous delivery

Active Learning/Formative Assessment Strategies

- Small group discussion/breakout rooms
- Polling questions
- Think-pair-share

Pre-Workshop

Background

Since its inception in 2014, the Mobile Summer Institute has trained nearly 1000 faculty at 35 institutions across 6 countries in scientific teaching. This program is a place-based iteration of the successful National Academies Summer Institute (SI) on Undergraduate Education (founders: Drs. Jo Handelsman (UWisconsin), Bill Wood (CU Boulder), Sarah Miller (UWisconsin) and Chris Pfund (UWisconsin)). The original SI was developed in response to a National Research Council report, *Bio2010*, that called for an intensive training program to promote adoption of active learning strategies to improve student learning and success. While the original summer institute was focused on life sciences, the current regional and mobile

iterations have expanded to other STEM and many non-STEM disciplines over the past decade.

Like the original model, the MIST is an intensive 5-day pedagogical workshop focused on evidence-based teaching practices and curricular design strategies intended to improve learning for all students and reduce the disproportionate loss of underrepresented students from higher education. Research shows that use of active learning increases performance and decreases failure (Freeman et al., 2014) and reduces the performance gap for underrepresented students (Theobold et al., 2020).

Scientific teaching is a condensation of effective, evidence-based teaching strategies targeted at faculty who understand the importance of evidence-based approaches but may not have any formal pedagogical training. It is a student-centered learning approach embedded in Backward Design, a curricular approach that places the focus on what students learn rather than what teachers cover.

Tasks

Please complete the following tasks prior to the workshop:

1. Getting to know you: Visit the Introduction/Welcome Session Google Folder then go to the folder for your institutions
   - Fill out the Getting to know you Google Doc according to the instructions in the document.
2. Watch this 3-minute video overview of Scientific Teaching, the organizing principle of the MoSI, created by Dr. Jessamina Blum (UMinnesota).



3. Watch the first 2 minutes and 40 seconds of A Private Universe - a documentary on the persistence of misconceptions.
4. Optional - watch Father Guido Sarducci's 5-minute University for a humorous look at the failings of passive, lecture-based education. Father Guido was a recurring fictional character developed by comedian Don Novello for Saturday Night Live in the 1970s.



During Workshop

Activity

1. Hopes - What do you hope to get out of this week? Visit the Introduction/Welcome Session Google Folder then go to the Google folder for your institution.
    - Record your answers in the Hopes & Gains Google Doc.

References

- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS*, 111(23), 8410-8415.
- Theobald, E., Hill, M. Tran, E., Agrawal, S., Arroyo, E., Behling, S., Chambwe, N., Cintrón, D., Cooper, J., Dunster, G., Grummer, J., Hennessey, K., Hsiao, J., Iranon, N., Jones, L., Jordt, H., Keller, M., Lacey, M., Littlefield, C., Lowe, A. Newman, A., Okolo, V. Olroyd, S., Peecook, B., Pickett, S., Slager, D., Caviedes-Solis, I., Stanchak, K., Sundaravardan, V., Valdebenito, D., Williams, C., Zinsli, K., Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *PNAS* 117(12) 6476-6483.
- Smith, M.K., Wood, W.B., Adams. W.K., Wieman, C., Knight, J.K., Guild, N., Su, T.T. (2009). Why Peer Discussion Improves Student Performance on In-Class Concept Questions. *Science*, 323, 122-124.
- Smith, M.K., Wood, W.B., Krauter, K., Knight, J.K. (2011). Combining peer discussion with instructor explanation increases student learning from in-class concept questions. *CBE – Life Sci Educ.* Spring; 10(1), 55-63.

Session Slides

Introduction/Welcome session slides

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2.2: Inclusivity Session

Workshop Overview

The Inclusivity workshop uses facilitated discussion and reflection to increase awareness of the most common invisible factors that serve as barriers to success for students from underserved groups. Awareness is only useful when paired with action, so participants will use their awareness to develop and share teaching strategies to offset the impact of structural barriers. Therefore participants will walk away with concrete examples of strategies they can use in their courses to reduce barriers and increase success for all students.

Learning Outcomes

Participants will be able to:

- Articulate factors that contribute to systemic inequities in education;
- Self-reflect on beliefs and behaviors to better understand how we can change to remove barriers to our students success;
- Incorporate strategies to remove, mitigate or offset barriers that contribute to system inequities.

Key Terms

- Inclusive teaching
- Social justice
- Equity
- Implicit/explicit diversity
- Implicit assumptions/unconscious biases
- Privilege
- Microaggression
- Cultural competency
- Stereotype threat

Active Learning/Formative Assessment Strategies

- Brainstorming
- Directed- and random-call report out
- Life walk
- Think-pair-share
- Small group discussion/breakout rooms
- Reflection

Pre-Workshop

Background

The goal of the following pre-workshop homework is to introduce all participants to five factors that make our classrooms exclusive: a) unconscious bias, b) stereotype threat, c) microaggressions, d) lack of cultural competency and exclusive language and policies in our syllabi. During the workshop, each participant will choose one of these areas and as part of a

group will do a deeper dive into that topic and then share resources and strategies with their cohort peers for offsetting that factor in the classroom.

Tasks

Please complete the following tasks prior to the workshop for an introduction to four barriers to inclusive classrooms:

1. Unconscious bias:
   - Read this 2-page NYTimes Op-Ed "What? Me Biased? What? Me Biased?.pdf
   - Visit Harvard Project Implicit and take at least two Implicit Assumption tests of your choice.
     (*Note: It can be uncomfortable to find out that you have unconscious biases. It's important to know that unconscious biases are a result of YOUR ENVIRONMENT and not what you consciously believe. The goal is to use awareness to make conscious efforts to offset unconscious biases. Knowledge is power.)
2. Stereotype threat: Watch the following the 8-minute video of Dr. Claude Steele (Stanford) discussing stereotype threat, the focus of his book, *Whistling Vivaldi*.



3. Microaggression: Watch this 4.5 minutes video on Microaggressions by Dr. Derald Wing Sue (Columbia).



4. Cultural competency: Visit the National Education Association website and read through the information on cultural competency on the first page. This can also serve as a resource later as there are links to resources for educators here as well.
5. An inclusive syllabus: A Google doc with Six Principles of an Inclusive Design syllabus

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During Workshop

Activities

1. Cultivating Brave Spaces: visit the Inclusivity Workshop Google Folder and go to the folder for your institution.
    1. Activity 1: Setting community guidelines for engagement. In the Cultivating Brave Spaces Google doc, read the opening information add your groups list of brainstormed guidelines to the first table. We will adopt these as the guidelines for engagement during this workshop.
    2. Activity 2: In the same Google doc, record your group's answers to the prompts at the top of the second Table.
2. Equity - Visit the Inclusivity Workshop Google Folder and go to the folder for your institution.
    1. Record your group's answers in the Equity activity Google Doc.
3. Deeper Dive on Invisible Barriers to Inclusion:
    - Visit the Inclusivity Workshop Google Folder and go to the folder for your institution to report your findings in the Deeper Dive on Invisible Barriers Google Doc.
    - Use the materials linked at the bottom of the Google document (for your convenience) or below for your topic to develop and share classroom strategies to offset one of the four invisible factors that contribute to classroom inequities.
        - Unconscious Bias materials:
            - Visit the Aperian Global Website to learn about three steps to address unconscious bias.
            - Take-home findings of students on unconscious bias - Intervention Studies for offsetting unconscious bias.pdf
            - Bibliography links for "Intervention Studies for offsetting unconscious bias.pdf" can be searched for on this site
        - Stereotype Threat materials:
            - A set of empirically validated interventions to offset stereotype threat: Interventions to help reduce stereotype threat.pdf
        - Microaggression materials:
            - A 4-page document from Equity Solutions with definitions, examples, exercises/tools and links to further resources - Introduction to microaggressions.pdf
            - A 2-page tool for Recognizing Microaggressions and the Messages They Send adapted from Dr. Derald Wing Sue, Microaggressions in Everyday Life: Race, Gender and Sexual Orientation, Wiley & Sons, 2010: Microaggressions_Examples_Arial_2014_11_12.pdf
        - Cultural competence materials:
            - A resource for Creating a Culture of Inclusion for Students based on a presentation by Lea Webb and Jahtayshia Davis of the Office of Diversity, Equity and Inclusion at Binghamton University, 2020. Cultural competence.pdf
            - Cultural competency: Visit the National Education Association website
        - Inclusive syllabus materials:
            - Matthew Cheney's Cruelty-free syllabus
            - Podcast: Toward Cruelty-Free Syllabi (recommended by Dr. Susannah McGowan from Georgetown University)
            - Podcast: Annotating the Marginal Syllabus
            - Article: Cameras Be Damned by Karen Costa (recommended by Geneva Lopez)
            - Article: One Way to Show Students You Care — and Why You Might Want to Try It
            - Google Document: Six Principles of an Inclusive Design Syllabus (UMass Amherst)
            - Google Folder: Resources for Six Principles of an Inclusive Design Syllabus (UMass Amherst)
            - Google doc: Radical Open Syllabus
            - First Day Toolkit by the Student Experience Project to create a more inclusive syllabus and more inclusive first-day messaging.

Post-Workshop

Selected Resources

- First Day Toolkit by the Student Experience Project to create a more inclusive syllabus and more inclusive first-day messaging.
- Want to reach all your students? Here's how to make your teaching more inclusive. An advice guide by Drs. Viji Sathy and Kelly A Hogan.
- CBE-LSE Inclusive Teaching Strategies
- Table of evidence-based classroom activities that address specific inclusivity issues by E. Pietri: evidence-based inclusivity interventions.pdf
- How to include a care note for people of color in your syllabus:
- TEDxUGA Talk by Dr. Ansley Booker, Unhidden Figures: Uncovering our cultural biases in STEM.
- TEDtalk The Danger of a Single Story
- New classroom tool being developed at Harvard for inclusive teaching practices in large courses: http://teachly.me/
- Cultural competency website from Georgetown: https://nccc.georgetown.edu/curricula/culturalcompetence.html
- Preparing teachers for diverse classrooms from Edutopia: https://www.edutopia.org/blog/preparing-cultural-diversity-resources-teachers
- MCOD - Multicultural Organization Development, website with guidance/resources for organizational change around this issue.
- ASPIRE - The National Alliance for Inclusive and Diverse STEM Faculty - webpage with resources from APLU.
- Video on Cultural Humility:



References

- Theobald, E., Hill, M. Tran, E., Agrawal, S., Arroyo, E., Behling, S., Chambwe, N., Cintrón, D., Cooper, J., Dunster, G., Grummer, J., Hennessey, K., Hsiao, J., Iranon, N., Jones, L., Jordt, H., Keller, M., Lacey, M., Littlefield, C., Lowe, A. Newman, A., Okolo, V. Olroyd, S., Peecook, B., Pickett, S., Slager, D., Caviedes-Solis, I., Stanchak, K., Sundaravardan, V., Valdebenito, D., Williams, C., Zinsli, K., Freeman, S. (2020) Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *PNAS* 117(12) 6476-6483.
- Inclusive Teaching, Bryan Dewsbury and Cynthia J Brame (2019) CBE - Life Sciences Education, 18:2.
- Does STEM Stand Out? Examining Racial/Ethnic Gaps in Persistence Across Postsecondary Fields by Catherine Riegle-Crumb, Barbara King, and Yasmiyn Irizarry. Does STEM Stand Out_.pdf
- Structure Matters: Twenty-one teaching strategies to promote student engagement and cultivate classroom equity, K Tanner CBE-LSE: Structure Matters 21 strategies inclusivity.pdf

- A special report from Magna Publications, You Belong Here: Making: Making Diversity, Equity and Inclusion a Mission in the Classroom - You-Belong-Here-Making-Diversity-Equity-and-Inclusion-a-Mission-in-the-Classroom.pdf

Session Slides

Inclusivity Session Slides

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2.3: Backward Design I

Workshop Overview

The Backward Design workshop sessions provide an introduction to this learner-focused course design approach. During the workshop, participants first will engage with the different steps of the process. Then, participants will apply the approach to a topic from a course with which students struggle. This workshop is split into two sessions. The first session will introduce the overall method. In the second session, the participants will practice what they learned about backward design - stating learning goals (broad, vague, not easily assessed, e.g. know, learn, understand...) and outcomes (specific, concrete, easily measurable, e.g. predict, explain, contrast, defend...) - by applying it to a specific topic.

Learning Outcomes

Participants will be able to:

- Argue the merits of a learner-centered course design approach
- Identify and align learning goals and outcomes for a specified topic/concept.

Key Terms

- Backward Design
- Deliberate practice
- Learning goals
- Learning outcomes
- Learning objectives
- Alignment
- Bloom's Taxonomy
- 3-Dimensional Learning Assessment Protocol (3-D LAP)

Active Learning/Formative Assessment Strategies

- Matching/categorizing
- Small group discussion
- Alignment table development
- Reflection

Pre-Workshop

Background

In order for our students to develop mastery, they need to spend time and effort engaged with the specific concept or skill. This idea is called Deliberate Practice (Ericsson et al., 1993). Essentially, the one doing is the one learning. The two essential components of this learning theory are effort expended on activities (practice) that are specifically designed to result in mastery of a desired skill or concept (deliberate). Backward Design is a course design approach that helps us focus on the deliberation aspect of Deliberate Practice. Backward Design guides us to be specific and intentional about what we want students to know, understand, and be able to do by the end of our course. With Backward Design, we then use that knowledge to guide our development of assessments that will provide evidence about whether or not students achieve our desired goal. Lastly, with Backward Design, we develop learning activities that will maximize the likelihood of students' success.

Tasks

Please complete the following tasks prior to the workshop:

1. Identify a topic from your class that you would like to transform during this workshop.

During Workshop

Activities

1. Developing learning goals and outcomes - Visit the Backward Design Session Google Folder then go into the folder for your institution.
    - Open the Backward Design in Action Google doc and follow along with the sequential activities to develop your alignment table for your topic during these sessions. Resources to help are linked to the bottom of the Google doc and linked below as well for your convenience.
        - Use the examples of alignment tables for different topics/disciplines also found in your institutions folder.
        - Below are embedded versions of Bloom's Taxonomy and the 3-D Learning Assessment Protocol - cognitive taxonomies. These and other related resources can be found in this Cognitive Taxonomy Google Folder.
            - Modified Version of Bloom's Taxonomy



https://lifelonglearning.wisc.edu/resources/

- 3-D LAP: The 3-Dimensional Learning Assessment Protocol (we are only using one of the dimensions that cuts across all disciplines). Use this as a guide to help you decide which disciplinary skills/habits of mind that you want students to practice in your class. (*PLOS One Article on 3D LAP by Cooper et. al.*: **Characterizing College Science Assessments: The Three-Dimensional Learning Assessment Protocol**)
    - Asking questions
    - Developing & using models
    - Planning & carrying out investigations
    - Analyzing & interpreting data
    - Using mathematics & computational thinking
    - Constructing explanations
    - Engaging in argument from evidence
    - Obtaining, evaluating, & communicating information

Post-Workshop

Task

1. Complete the Learning Goals and Outcomes columns in your row of the Alignment table in the Backward Design in Action Google doc in your institution's folder inside the Backward Design Session Google Folder. Use the examples of alignment tables (a document in your institution's folder) as a guide.

Resources

- More in-depth video on Backward Design by Jay McTighe, one of the authors of *Understanding by Design (1998)*.

References

- Ericsson, K, Krampe, R., Tesch-Römer, C. (1993)The role of deliberate practice in the acquisition of expert performance. *Psychological Review* 100: 363-406.
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS*, *111*(23), 8410-8415.
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- Wiggins, G & McTighe, J. (1998). Understanding by design, Alexandria, VA: ACSD

Session Slides

Backward Design session slides

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2.4: Backward Design II

Workshop Overview

The Backward Design (BD) workshop sessions provide an introduction to this learner-focused course design approach. During the workshop, participants first will be engaged in the different steps of the process and then will apply the approach to a topic from a course with which students struggle. This workshop is split into to session. The second session will take participants through steps 2 & 3 of BD - developing assessments and learning activities that align with participants learning goals and outcomes developed in the first session. The term "engaugement" was coined by the authors of Scientific Teaching - Handelsman, Miller and Pfund, to indicate the nearly inextricable link between active learning and formative assessment, i.e. when you ask a student to do something, they are simultaneously *engaged* in learning and can *gauge* their progress by whether or how well they can perform.

Using Backward Design allows us to re-envision our classes, so that in-class or synchronous time is spent on collaborative learning activities and formative assessments that foster critical thinking, problem-solving, and understanding of cognitively demanding material, while out-of-class or asynchronous time focuses on lower cognitive demand material in preparation for class or on further practice with higher cognitive demand concepts and skills after class.

Learning Outcomes

Participants will be able to:

- Use the principles of backward design to align learning outcomes with both learning activities/formative assessments and summative assessments
- Develop/modify learning materials to engage students in deliberate practice
- Use Bloom's Taxonomy & 3-D LAP to evaluate assessments

Key Terms

- Backward Design
- Deliberate practice
- Formative assessment
- Summative assessment
- Alignment
- Bloom's Taxonomy
- 3-Dimensional Learning Assessment Protocol (3-D LAP)

Active Learning/Formative Assessment Strategies

- Gallery walk
- Small group discussion
- Alignment table development
- Reflection
- Model-based reasoning/problem-solving
- Scenario/statement correction

Pre-Workshop

Background

In order for our students to develop mastery, they need to spend time/effort engaged with the specific concept or skill. This concept is called Deliberate Practice (Ericsson et al., 1993). Essentially, the one doing is the one learning. The two essential components of this learning theory are effort expended on activities (practice) that are specifically design to result in mastery of a desired skill or concept (deliberate). Backward Design is a course design approach that helps us focus on the deliberation aspect of Deliberate Practice. Backward Design that guides us to be specific and intentional about what we want students to know, understand and be able to do by the end of our course and then use that knowledge to guide development of assessments that will provide evidence about whether or not students achieve our desired goal and learning activities that will maximize the likelihood that they will be successful.

Tasks

1. *See the post-task from Backward Design I Session

During Workshop

Activities

1. Gallery Walk: Visit the Backward Design Session Google Folder then go to the folder for your institution to return to the Backward Design in Action Google Doc with the alignment table from yesterday's session.
    - Review your peers Alignment table rows starting with the rows directly under yours and work down (if you are at/near the bottom, wrap around and review rows at the top of ht table) using the Comment function in Google
        - Instructions for giving comments in Google
            - Highlight the text you want to comment on and a small plus sign inside a comment bubble symbol will appear to the right.
            - Click the plus sign symbol and put in your comment.
            - Click the "comment" button at the bottom.

Post-Workshop

Selected Resources

- Physically distanced classrooms:
    - Suggestions for doing active learning while physical distancing initiated by Dr. Jennifer Gartner (LSU).
    - Derek Bruff, director of the Center for Teaching at Vanderbilt University, addressed this challenge in a recent post: Active Learning in Hybrid and Physically Distanced Classrooms.
- Magna Publications Free Report webpage with lots of reports on various aspects of effective course design, engagement and online teaching.
- Chronicle of Higher Education, How to Engage Students in Hybrid Classes, with tips for remote teaching classes that are hybrids of in-person and remote learning. I perused the *Further Resources* segment at the bottom of this article and there were some useful links there as well.
- Guide by Sarah Rose Cavanagh on How to make your teaching more engaging from the Chronicle of Higher Education, 2019.
- Active learning/formative assessment strategies:
    - http://sciencecases.lib.buffalo.edu/cs
    - https://www.coursesource.org
    - https://www.summerinstitutes.org/teaching-supports
    - https://teaching.berkeley.edu/active-learning-strategies

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References

- Ericsson, K, Krampe, R., Tesch-Römer, C. (1993) The role of deliberate practice in the acquisition of expert performance. *Psychological Review* 100: 363-406.
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS*, *111*(23), 8410-8415.
- Theobald, E., Hill, M. Tran, E., Agrawal, S., Arroyo, E., Behling, S., Chambwe, N., Cintrón, D., Cooper, J., Dunster, G., Grummer, J., Hennessey, K., Hsiao, J., Iranon, N., Jones, L., Jordt, H., Keller, M., Lacey, M., Littlefield, C., Lowe, A. Newman, A., Okolo, V. Olroyd, S., Peecook, B., Pickett, S., Slager, D., Caviedes-Solis, I., Stanchak, K., Sundaravardan, V., Valdebenito, D., Williams, C., Zinsli, K., Freeman, S. (2020) Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. PNAS 117(12) 6476-6483.
- Wiggins, G & McTighe, J. (1998). Understanding by design, Alexandria, VA: ACSD

Session Slides

Backward Design Session Slides

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2.5: Scientific Teaching in Action

Workshop Overview

The Scientific Teaching workshop has many flavors depending on the expertise of the trainer(s) running the workshop. The general goal is to provide a deeper dive into the use of a variety of active learning approaches like immediate polling questions, the formation and management of learning groups, and other examples of deliberate practice. For your MIST, this workshop will focus on the use of deliberate practice to improve graph reading and interpretation skills. This workshop also demonstrates how to integrate the teaching of subject content with the development of student skills.

Learning Outcomes

Participants will be able to:

- Use deliberate practice to foster the acquisition of graph reading and interpretation skills

Key Terms

- Deliberate practice
- Evidence-based teaching
- Backward design
- Alignment between formative and summative assessment

Active Learning/Formative Assessment Strategies

- Small group discussion/breakout rooms

Pre-Workshop

Background

Deliberate practice posits that to develop expertise or mastery over a subject or skill, for example, it is necessary to spend sufficient time engaged in intentional effort that specifically relates to achievement of that mastery. The perfectly complements Backward Design in that it calls for practice that aligns with intended outcomes. For example, if you intend for students to leave your class with proficiency in reading and interpreting graphs, then students have to spend sufficient time practicing that skill. While sitting in class watching the teacher explain how to read graphs is effort, the effort is not aligned with the desired outcome of having students be able to read and interpret graphs for themselves. This type of misalignment between desired learning outcomes and class activities is common in passive lecture classes.

Post-Workshop

Resources

- A digital article, The Making of an Expert, on Harvard Business Review by Ericsson, Prietula and Cokely.

References

- Ericsson, K., Krampe, R., Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review* 100: 363-406.

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2.6: Peer Feedback and Reflection

Workshop Overview

Scientific teaching is at its core an evidence-based pedagogical approach. Peer feedback based on class observation is another form of evidence that we can gather to give us an indication of the effectiveness of our teaching. During this workshop, participants will discuss the merits of feedback and reflection in helping inform course revision and improvement and practice giving feedback using two course observation rubrics - a peer mentoring rubric and a class observation protocol. Participants will also develop a 1-year mentoring plan with a colleague to provide feedback to one another on their classes.

Learning Outcomes

Participants will be able to:

- use a peer feedback rubric to provide guidance on how to make classes more active, inclusive and student-centered
- use an observation rubric to provide an objective snapshot of a peer's current use of engaged pedagogies for self-reflection
- develop a 1-year plan for visiting the classes of a peer using these rubrics to help one another develop reflective practices

Key Terms

- Peer observation
- Student-centered learning
- Active learning
- Peer Feedback
- Reflection

Active Learning/Formative Assessment Strategies

- Small group discussion/breakout rooms
- Whole class discussion
- Brainstorm
- Peer observation

Pre-Workshop

Background

Nationally, campuses are measuring the use of active learning (Stains et al., 2018). Lecturing still predominates in post-secondary STEM classes, but active, students-centered strategies are being adopted. Transitioning to active learning from lecture or Socratic methods can be uncomfortable. Peer feedback and mentoring provide support that can reduce feelings of isolation during the process and improve performance in the classroom. The peer observation protocol that we train participants with during this workshop (COPUS, Smith et al, 2014) is the same metric used in the Stains et al., (2018) nationwide project. We will use this rubric in the Generalized Observation and Reflection Protocol (GORP) platform, an online and smartphone compatible platform develop at UC Davis.

Tasks

1. IF YOU ARE USING Generalized Observation and Reflection Protocol (GORP), then sign up for an account ahead of time by doing the following:
    - Go to https://gorp.ucdavis.edu/
    - Click "Sign Up"

- Your site administrator will assign you the roles you need (observation-create, observation-destroy, course-create, course-view, course-destroy, course-update)
- Complete the sign up, and search for your university / college in the **Institution** box.

2. Watch this 9-minute Introduction video on GORP:
   -



During Workshop

Tasks

1. Download the Peer Mentoring Rubric to practice giving feedback on a video clip, found in the Google Drive Folder for Peer Mentoring. We will use this same rubric to give feedback during the final presentations.
2. Send yourself a reminder to schedule your peer observation visits using FutureMe.org.
   1. Go to the website and set up a future email to yourself dated close to the beginning of the school term as a reminder to plan your peer observation visits.
   2. Include information related to the following questions:
      1. which class[es] you want to have observed
      2. who will observe your class
      3. which rubric will they use to observed, i.e. the feedback rubric, timing analysis rubric, COPUS...
      4. when will they visit, e.g., near the beginning and end to get a comparison of your progress; on certain dates when you plan to try out specific modules or strategies...

Post-Workshop

Tasks

1. If you didn't send your FutureMe.org peer observation reminder email, do so now following the instructions directly above.

Selected Resources

- Peer Evaluation Feedback Guide adapted from Jenny Momsen/FIRST IV - Peer mentoring rubric.pdf
- A statement created by Dr. Peggy Brickman (UGA) that extols the virtues of taking part in peer mentoring and evaluation accompanied by a list of references. This statement can be added to yearly teaching evaluation portfolios for participants who

visit one another's classes and provide peer feedback and mentoring. Peer Mentoring and Evaluation blurb for yearly teaching evaluation.pdf

- A great new resource for an evidence-based, departmentally-defined approach to enhance teaching evaluation called TEval at CU Boulder, by Drs. Noah Finkelstein, Joel C. Corbo, Daniel L. Reinholz, Mark Gammon, and Jessica Keating.
- A tool for utilizing the noise level in your classroom to gage the % of times that students have an opportunity to be actively engaged in class: Decibel Analysis for Research in Teaching (DART): https://sepaldart.herokuapp.com/. Developed by Kimberly Tanner.

References

- Batzli, J et al., (2006) Bridging the Pathway from Instruction to Research
- Smith, M., Jones, F., Gilber, S., Wieman, C. (2013) The classroom observation Prototocol for Undergraduate STEM (COPUS): A new instrument to characterize university STEM classroom practices. Cell Biology Education – Life Sciences Education
- Stains, M., Harshman, J., Barker, M. K., Chasteen, S. V., Cole, R., DeChenne-Peters, S. E., ... & Levis-Fitzgerald, M. (2018) Anatomy of STEM teaching in North American universities *Science*, *359*(6383), 1468-1470.

Session Slides

Peer Reflection and Feedback slide deck

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SECTION OVERVIEW

2.7: Scholarly Teaching

Workshop Overview

Scientific teaching is at its core an evidence-based pedagogical approach. Consulting education literature to determine which teaching strategies to use and gathering evidence to determine how well those strategies work in your classroom are critical steps when developing effective learning environments. This workshop explores various types of data that instructors can gather to evaluate student learning in order to facilitate the development of course evaluation plans by participants.

Learning Outcomes

Participants will be able to:

- Determine aspects of your teaching or student learning that you would like to assess
- Identify metrics with which to gather evidence pertaining to the selected aspects of teaching/learning
- Develop an evaluation plan to deploy the metrics to evaluate the selected aspects of teaching/learning in one of your courses

Key Terms

- Scholarly teaching
- Evaluation
- Assessment
- Qualitative data
- Quantitative data
- Concept inventories
- Perception surveys
- Normalized learning gains

Active Learning/Formative Assessment Strategies

- Small group discussion/breakout rooms
- Whole class discussion
- Practice using peer observation metrics
- Development of a course evaluation plan

Pre-Workshop

Background

Are your students learning what you want them to learn? How do you know? In preparation for this workshop, think about these three questions:

1. What knowledge do you want your students to gain from your class?
2. What types of skills (e.g. life skills, learning skills, technical skills) would you like students to acquire? and
3. What affective or behavioral changes would you like to see your students exhibit (e.g. improved critical thinking, increased confidence or enthusiasm for your discipline, identifying as a professional in your area, becoming a more civically engaged citizen) at the end of your course?

We will explore different types of data that we can collect in all types of teaching environments to help us evaluate changes in pedagogy and to inform iterative rounds of course revisions.

During Workshop

Activities

1. Course Evaluation Plan development: Visit the Scholarly Teaching Google folder then go to the folder for your institution.
    - Open the Course Evaluation Plan Google doc and following instructions.
        - You will claim a row, name it and respond to the prompts to develop your course evaluation plan.
        - Use the resources and links embedded in the Google doc to help you develop your plan.
    - You can download a copy for easy access when you are ready to implement and also revisit your plan in the Google folder at any time.

Post-Workshop

Resources

- Course Evaluation Plan Template.docx
- Evaluation Guide.pdf
- Evaluative Assessment Resources.pdf
- Designing Research to investigate student learning Ebert-May et al.pdf

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Session Slides

Scholarly Teaching Slide Deck

2.7.1: Evaluation Guide

2.7.2: Evaluative Assessment Resources

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2.7.1: Evaluation Guide

What are concept inventories?

(Excerpted from presentation by J. Knight, UC Boulder).

- Multiple choice (usually) instruments that address fundamental concepts and contain known student misunderstandings
- Developed through an iterative process that includes gathering evidence of validity and reliability through student and faculty interviews
- Diagnostic: can identify specific misunderstandings and measure student learning over time
- Objective: not tied directly to a course, but rather to a set of concepts

Guidelines for using concept inventories

(*Dirks, Wenderoth, Withers Assessment in the College Science Classroom, 2013*).

- Protect the test!
  - Must be given in a proctored environment to keep questions from getting out to students.
- Use for evaluation only
  - Not a learning tool.
- When used for pre-/post-testing
  - Use the same testing context
  - Can use same or isomorphic questions (Resource: Research Methods Knowledge Base – W. Trochim, 2013)
  - Normalized learning gain
- <g> = (%post - %pre)/(100-%pre)

Content-independent metrics

- Typically assess skills or affective domain
  - Critical thinking, views of science, enthusiasm for the discipline…
  - Can be used as pre/post, but typically post only
- Resource: FLAG – Field-tested Learning Assessment Guide - http://www.flaguide.org/index.php
- Mental Measures Yearbook http://buros.org/mental-measurements-yearbook
- http://www.salgsite.org/
- https://www.tntech.edu/cat/
- http://www.criticalthinking.org/pages/critical-thinking-testing-and-assessment/594
- https://www2.viu.ca/studentsuccessse...sInventory.pdf

Other Resources

- Summer Institutes website: http://www.summerinstitutes.org/
- University of Colorado – SEI: http://www.colorado.edu/sei/
- SERC: https://serc.carleton.edu/index.html
  - https://serc.carleton.edu/NAGTWorkshops/departments/degree_programs/metrics.html
- UW BERG: http://uwberg.com/teaching-resources/

Table below from Dirk et al., (2014) *Assessment in the College Science Classroom*, Ch7 Appendix A; Freeman, NYC.

Concept Inventories in Astronomy	
Astronomy Diagnostic Test (ADT)	Hufnagel 2002
Lunar Phases	Lindell and Olsen 2002
Light and Spectroscopy	Bardar et al., 2007
Concept Inventories in Biology	
Genetics Concept Inventory (GCA)	Smith et al., 2008
Genetics Literacy Assessment Instrument 2 (GLAI-2)	Bowling et al., 2008
Conceptual Inventory of Natural Selection (CINS)	Anderson et al., 2002
Biology Literacty (http://bioliteracy.net/)	Klymkowsky et al., 2010
Diagnostic Question Clusters: Biology	Wilson et al., 2006; D'Avanzo 2008
Host Pathogen Interactions (HPI)	Marbach-Ad et al., 2009
Introductory Molecular and Cell Biology Assessment (IMCA)	Shi et al., 2010
Concept Inventories in Chemistry	
Chemistry Concept Inventory	Mulford and Rbonison 2002 Krause et al., 2003
Concept Inventories in Engineering	
Engineering Thermodynamics Concept Inventory	Midkiff et al., 2001
Heat Transfer	Jacobie et al., 2003
Materials Concept Inventory	Krause et al., 2003
Signals and Systems Concept Inventory	Wage et al., 2005
Static Concept Inventory	Steif et al., 2005
Thermal and Transport Science Concept Inventory (TTCI)	Streveler et al., 2011
Concept Inventories in Geoscience	
Geoscience Concept Inventory (GCI)	Libarkin and Anderson, 2005
Concept Inventories in Math and Statistics	
Statistics Concept Inventory (SCI)	Allen 2006
Calculus Concept Inventory (CCI)	Epstein 2005
Concept Inventories in Physics	
Force Concept Inventory (FCI)	Hestenes et al., 1992
The Force and Motion Conceptual Evaluation (FMCE)	Thornton and Sokiloff 1998
Thermal Concept Evaluation	Yeo and Zadnick 2001
Brief Electricity and Magnetism Assessment (BEMA)	Ding et al., 2006
Conceptual Survey in Electricity and Magnetism (CSEM)	Maloney et al., 2001
Measuring Students Science Process and Reasoning Skills	
Rubric for Science Writing	Timmerman et al., 2010

Student-Achievement and Process Skills Instrument	Bunce et al., 2010

Measuring Student Attitudes about Science, Research or Study Methods

Colorado Learning Attitudes about Science Survey (CLASS)	http://www.colorado.edu/sei/class
Revised Two-Factor Study Process Questionnaire	Biggs et al, 2001
Student Assessment of Their Learning Gains (SALG) Instrument	http://www.salgsite.org/
Survey of Undergraduate Research Experiences	Lopatto 2004
Views About Science Survey (VASS)	Halloun and Hestenes 1998

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2.7.2: Evaluative Assessment Resources

I. BIOLOGY

Initially compiled by Kathy S. Williams (San Diego State University) and Erilynn T. Heinrichsen (University of California, San Diego)

Updated 2019 by Jenny Knight

ANIMAL DEVELOPMENT

Flowering Plant Growth and Development (13 two-tiered MC items)

Lin SW. 2004. Development and application of a two-tier diagnostic test for high school students' understanding of flowering plant growth and development. *International Journal of Science and Mathematics Education* 2: 175–199.

BIOCHEMISTRY

Threshold concepts in Biochemistry: Loertscher, J. (2011). *Biochemistry and molecular biology education*, *39*(1), 56-57.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4152212/

BREATHING AND RESPIRATION

Breathing and Respiration (12 two-tiered MC items)

Mann M, Treagust DF. 1998. A pencil and paper instrument to diagnose students' conceptions of breathing, gas exchange and respiration. *Australian Science Teachers Journal* 44: 55–59.

DEVELOPMENTAL BIOLOGY

Developmental Biology Content Survey (15 MC items)

Knight JK, Wood WB. 2005. Teaching more by lecturing less. *Cell Biology Education* 4: 298-310. doi:10.1187/05-06-0082. https://www.lifescied.org/doi/abs/10.1187/05-06-0082

ENERGY AND MATTER

(total of 16 Diagnostic Question Clusters of 6-8 items each; some items appear in more than one DQC)

Diagnostic Question Clusters on Energy and Matter (DQCs)

Wilson CD, Anderson CW, Heidemann M, Merrill JE, Merritt BW, Richmond G, Silbey DF, Parker JM. 2006. Assessing students' ability to trace matter in dynamic systems in cell biology. *CBE Life Sciences Education* 5: 323–331. https://www.lifescied.org/doi/abs/10.1187/cbe.06-02-0142

Hartley LM, Wilke BJ, Schramm JW, D'Avanzo C, Anderson CW. 2011. College students' understanding of the carbon cycle: contrasting principle-based and informal reasoning. *BioScience* 61: 65-75.

Thinking like a biologist: Using diagnostic questions to help students to reason with biological principles (16 DQC sets of ~7 items each, MC, TF, open-ended)

D'Avanzo C, Anderson CW, Griffith A, Merrill J. 2011. Thinking like a biologist. Using diagnostic questions to help students reason with biological principles. [The site at http://www.biodqc.org/ has Diagnostic Question Clusters (DQC's) organized by three ecological topics (Carbon Cycling, Energy Flow in Ecosystems, Climate Change), and by three biological processes; (Photosynthesis, Biosynthesis, Cellular Respiration) - with two DQCs each; plus one each DQC under topics Gasoline, Biofuels, Carbon in Nature, and Carbon Balance. Some items appear in more than one DQC.

ECOLOGY & EVOLUTION

EcoEvo-MAPS: An Ecology and Evolution Assessment for Introductory through Advanced Undergraduates https://www.lifescied.org/doi/abs/10.1187/cbe.17-02-0037

EvoDevoCI (MC and open ended items for 3 Exploratory Surveys and 6 Interview Question sets)

Hiatt A, Davis GK, Trujillo C, Terry M, French DP, Price RM, Perez KE. 2013. Getting to Evo-Devo: Concepts and challenges for students learning evolutionary developmental biology. *CBE Life Sciences Education* 12: 494-508. doi:10.1187/cbe.12-11- 0203. https://www.lifescied.org/doi/abs/10.1187/cbe.12-11-0203

EvoDevoCI (11 MC items, 4 scenarios)

Perez KE et al 2013. The EvoDevoCI: A Concept inventory for gauging students' understanding of evolutionary developmental biology. *CBE Life Sciences Education* 12: 665-675. doi:10.1187/cbe.13-04-0079. https://www.lifescied.org/doi/abs/10.1187/cbe.13-04-0079

Basic Tree Thinking Assessment (two tests, 10 MC items each, diagrams): Baum DA, Smith SD, Donovan SSS. 2005. The tree-thinking challenge. *Science* 310: 979-980.

Conceptual Inventory of Natural Selection (CINS) (20 MC items, scenarios)

Anderson DL, Fisher KM, Norman JG. 2002. Development and validation of the conceptual inventory of natural selection. *Journal of Research in Science Teaching* 39: 952-978.

Kalinowski, S. T., Leonard, M. J., & Taper, M. L. (2016). Development and validation of the conceptual assessment of natural selection (CANS). *CBE-Life Sciences Education*, *15*(4), ar64. https://www.lifescied.org/doi/10.1187/cbe.15-06-0134

EXPERIMENTAL DESIGN

Dasgupta, A. P., Anderson, T. R., & Pelaez, N. J. (2016). Development of the neuron assessment for measuring biology students' use of experimental design concepts and representations. *CBE-Life Sciences Education*, *15*(2), ar10. https://www.lifescied.org/doi/10.1187/cbe.15-03-0077

Deane, T., Nomme, K., Jeffery, E., Pollock, C., & Birol, G. (2014). Development of the biological experimental design concept inventory (BEDCI). *CBE-Life Sciences Education*, *13*(3), 540-551.https://www.lifescied.org/doi/10.1187/cbe.13-11-0218

GENETICS

Genetics Literacy Assessment Instrument (GLAI) (31 MC items) FOUR in Bowling et al. Genetics 2008;

Bowling BV, Acra EE, Wang L, Myers MF, Dean GE, Markle GC, Moskalik CL, Huether CA. 2008. Development and evaluation of a genetics literacy assessment instrument for undergraduates. *Genetics* 178: 15-22. [download PDF] from nku.edu

Genetics Concept Assessment (GCA) (25 MC items, diagrams)

Smith MK, Wood WB, Knight JK. 2008. The genetics concept assessment: A new concept inventory for gauging student understanding of genetics *CBE Life Science Education* 7: 422-430. https://doi.org/10.1187/cbe.08-08-0045

Genetics Diagnostic (13 two-tiered MC items, diagrams)

Tsui CY, Treagust D. 2009. Evaluating secondary students' scientific reasoning in genetics using a two-tier diagnostic instrument. *International Journal of Science Education* 32: 1073-1098.

Genetic Drift Inventory (GeDI) (22 agree–disagree items)

Price RM, Andrews TC, McElhinny TL, Mead LS, Abraham JK, Thanukos A, Perez KE. 2014. The Genetic Drift Inventory: A tool for measuring what advanced undergraduates have mastered about genetic drift. *CBE Life Science Education* 13: 65-75. doi:

10.1187/cbe.13-08-0159. https://www.lifescied.org/doi/abs/10.1187/cbe.13-08-0159

Dominance Concept Inventory: Abraham, J. K., Perez, K. E., & Price, R. M. (2014). The Dominance Concept Inventory: a tool for assessing undergraduate student alternative conceptions about dominance in Mendelian and population genetics. *CBE-Life Sciences Education*, *13*(2), 349-358. https://www.lifescied.org/doi/10.1187/cbe.13-08-0160

GENERAL BIOLOGY

Gen-MAPS: Couch, BA, Wright CD, Freeman S, Knight JK, Semsar K, Smith MK, Summers MM, Zheng Y, Crowe AJ, Brownell SE (2019). GenBio-MAPS: A programmatic assessment to measure student understanding of Vision and Change core concepts across general biology programs. *CBE Life Sci. Educ. 18:arx 1–14, doi: 10.1187/cbe.18-07-0117*

HOST-PATHOGEN INTERACTIONS

Host-Pathogen Interactions (HPI) (17 [18 noted in Marbach-Ad et al. 2009] two-tiered MC items) ITEMS NOT PROVIDED

Marbach-Ad G, Briken V, El-Sayed NM, Frauwirth K, Fredericksen B, Hutcheson S, Gao L-Y, Joseph SW, Lee V, McIver KS, Mosser D, Quimby BB, Shields P, Song W, Stein DC, Yuan RT, Smith AC. 2009. Assessing student understanding of host pathogen interactions using a concept inventory. *Journal of Microbiology Education* 10: 43-50.

Marbach-Ad G, McAdams KC, Benson S, Briken V, Cathcart L, Chase M, El-Sayed NM, Frauwirth K, Fredericksen B, Joseph SW, Lee V, McIver KS, Mosser D, Quimby BB, Shields P, Song W, Stein DC, Stewart R, Thompson KV, Smith AC. 2010. A model for using a concept inventory as a tool for students' assessment and faculty professional development. *CBE Life Science Education* 9: 408-416. https://www.lifescied.org/doi/full/10.1187/cbe.10-05-0069

INTRODUCTORY BIOLOGY

Biology Concept Inventory (BCI) (30 MC items) ON-LINE at http://bioliteracy.colorado.edu/

Klymkowsky MW, Garvin-Doxas K, Zeilik M. 2003. Bioliteracy and teaching efficacy: What biologists can learn from physicists. *Cell Biology Education* 2: 155-161. doi: 10.1187/cbe.03-03-0014. https://www.lifescied.org/doi/abs/10.1187/cbe.03-03-0014

Garvin-Doxas K, Doxas I, Klymkowsky MW. 2008. Ed's Tools: A web-based software toolset for accelerated concept inventory construction. pp 130-140. In: Deeds, D & B Callen, editors; Proceedings of the National STEM Assessment Conference.

MACROEVOLUTION

Measure of Understanding of Macroevolution (MUM) (28 items: 27 MC items, plus one open-ended item, diagrams) PROVIDED

Nadelson LS, Southerland SA. 2010. Development and preliminary evaluation of the Measure of Understanding of Macroevolution: Introducing the MUM. *The Journal of Experimental Education* 78: 151–190. [download PDF] from researchgate.net

MICROBIOLOGY

Development, Validation, and Application of the Microbiology Concept Inventory.Timothy D. Paustian, Amy G. Briggs, Robert E. Brennan, Nancy Boury, John Buchner, Shannon Harris, Rachel E. A. Horak, Lee E. Hughes, D. Sue Katz-Amburn, Maria J. Massimelli, Ann H. McDonald, Todd P. Primm, Ann C. Smith, Ann M. Stevens, Sunny B. Yung. (2017) *J. Microbiol. Biol. Educ.* 18(3): doi:10.1128/jmbe.v18i3.1320

Development and Validation of the Microbiology for Health Sciences Concept Inventory. Heather M. Seitz, Rachel E. A. Horak, Megan W. Howard, Lucy W. Kluckhohn Jones, Theodore Muth, Christopher Parker, Andrea Pratt Rediske, Maureen M. Whitehurst. (2017) *J. Microbiol. Biol. Educ.* 18(3): doi:10.1128/jmbe.v18i3.1322

MOLECULAR BIOLOGY

Central Dogma: Newman, D. L., Snyder, C. W., Fisk, J. N., & Wright, L. K. (2016). Development of the central dogma concept inventory (CDCI) assessment tool. *CBE-Life Sciences Education*, *15*(2), ar9. https://www.lifescied.org/doi/10.1187/cbe.15-06-0124

Lac Operon: Stefanski, K. M., Gardner, G. E., & Seipelt-Thiemann, R. L. (2016). Development of a Lac Operon Concept Inventory (LOCI). *CBE-Life Sciences Education*, *15*(2), ar24.

https://www.lifescied.org/doi/10.1187/cbe.15-07-0162

Introductory Molecular Biology: Introductory Molecular and Cell Biology Assessment (IMCA) (24 MC items, diagrams) Shi J, Wood WB, Martin JM, Guild NA, Vicens Q, Knight JK. 2010. A diagnostic assessment for introductory molecular and cell biology. *CBE Life Sciences Education* 9: 453-461. doi: 10.1187/cbe.10-04-0055. https://www.lifescied.org/doi/abs/10.1187/cbe.10-04-0055

Molecular Biology Capstone Assessment: Couch, B. A., Wood, W. B., & Knight, J. K. (2015). The Molecular Biology Capstone Assessment: a concept assessment for upper-division molecular biology students. CBE-Life Sciences Education, 14(1), ar10. https://www.lifescied.org/doi/10.1187/cbe.14-04-0071

Molecular Life Sciences Concept Inventory (MLS) www.lifescinventory.edu.au

OSMOSIS AND DIFFUSION

Diffusion and Osmosis Diagnostic Test (DODT) (12 two-tiered MC items, diagrams)

Odom AL, Barrow LH. 1995. The development and application of a two-tiered diagnostic test measuring college biology students' understanding of diffusion and osmosis following a course of instruction. *Journal of Research in Science Teaching* 32: 45-61. [HTML] from wiley.com

Odom AL. 1995. Secondary and college biology students' misconceptions about diffusion and osmosis. *American Biology Teacher* 57: 409–415. [download PDF] from pbworks.com

Osmosis and diffusion conceptual assessment (ODCA) (8 two-tiered MC items, diagrams) Fisher KM, Williams KS, Lineback J. 2011. Osmosis and diffusion conceptual assessment. *CBE Life Sciences Education* 10:418-29. https://www.lifescied.org/doi/abs/10.1187/cbe.11-04-0038

PHOTOSYNTHESIS AND RESPIRATION

Photosynthesis and Respiration (13 two-tiered MC items, plus open ended)

Haslam F, Treagust DF. 1987. Diagnosing secondary students' misconceptions of photosynthesis and respiration in plants using a two-tier multiple choice instrument. *Journal of Biological Education* 21: 203–211.

Covalent Bonding and Photosynthesis test development ITEMS NOT PROVIDED

Treagust D. 1986. Evaluating students' misconceptions by means of diagnostic multiple choice items. *Journal of Research in Science Education* 16: 199-207.

PHYSIOLOGY

Homeostasis: Development and Validation of the Homeostasis Concept Inventory McFarland, JL, Price RM, Wenderoth MP, Marinkova P, Cliff W, Michael J, Modell J, Wright A CBE—Life Sciences Education Volume 16, Issue 201 Jun 2017

Phys-MAPS: Semsar K, Brownell SE, Couch BA, Crowe AJ, Smith MK, Summers MM, Wright CD, Knight JK (2018). Phys-MAPS: A programmatic physiology assessment for introductory and advanced undergraduates. Adv Physiol Educ 43: 15–27, 2019; doi:10.1152/advan.00128.2018.

QUANTITATIVE/STATISTICAL REASONING

Stanhope, L., Ziegler, L., Haque, T., Le, L., Vinces, M., Davis, G. K., ... & Umbanhowar, C. (2017). Development of a Biological Science Quantitative Reasoning Exam (BioSQuaRE). *CBE-Life Sciences Education*, *16*(4), ar66. https://www.lifescied.org/doi/full/10.1187/cbe.16-10-0301

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SCIENTIFIC LITERACY

Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE-Life Sciences Education*, *11*(4), 364-377.https://www.lifescied.org/doi/full/10.1187/cbe.12-03-0026

TRANSPORT IN PLANTS AND CIRCULATION IN HUMANS

Internal Transport in Plants and the Human Circulatory Systems (28 two-tiered MC items) Wang JR. 2004. Development and validation of a two-tier instrument to examine understanding of internal transport in plants and the human circulatory system. *International Journal of Science and Mathematics Education* 2: 131–157.

II. ASTRONOMY

Astronomy Diagnostic Test (ADT) Hufnagel 2002

Lunar Phases Lindell and Olsen 2002

Light and Spectroscopy, Bardar et al., 2007

III. COMPUTER SCIENCE

http://dbserc.pitt.edu/Assessment/As...mputer-Science

IV. CHEMISTRY

● INORGANIC CHEMISTRY (VIPER)

Virtual inorganic pedagogical electronic resource: a community for teachers and students of inorganic chemistry https://www.ionicviper.org//

● CHEMISTRY

Compiled in list of chemistry concept inventories: http://chemistry.miamioh.edu/bretzsl/cer/assessment.html

DBER Resources - curated by Marilyne Stains - https://sites.google.com/site/marilynestains/useful-links-for-the-group

others

http://dbserc.pitt.edu/Assessment/Assessments-Chemistry

http://www.rsc.org/learn-chemistry/r...id=CMP00004906

V. PHYSICS

The AAPT ComPADRE Digital Library is a network of free online resource collections supporting faculty, students, and teachers in Physics and Astronomy Education. https://www.compadre.org/

Other Resources:

The Living Physics Portal-Due for Beta release Fall 2018

The Living Physics Portal is an online environment for physics faculty to share and discuss free curricular resources for teaching introductory physics for life sciences (IPLS). The objective of the Portal is to improve the education of the next generation of medical professionals and biologists by making physics classes more relevant for life sciences students. http://livingphysicsportal.org/

ALPhA

> The Advanced Laboratory Physics Association (ALPhA) was formed in 2007 to provide communication and interaction among the faculty and staff who are involved in advanced laboratory physics instruction at colleges and universities in the United States and the rest of the world. https://www.advlab.org/

VI. STATISTICS

Statistics Concept Assessment

https://www.researchgate.net/publication/35439982_The_statistics_concept_inventory_development_and_analysis_of_a_cognitive_assessment_instrument_in_statistics

Research Methods and Statistics: http://journals.sagepub.com/doi/abs/10.1177/0098628317711287

VII. Inventories for Assessing Students' Perceptions About Biology (College-level)

ENGAGEMENT

Wiggins, B. L., Eddy, S. L., Wener-Fligner, L., Freisem, K., Grunspan, D. Z., Theobald, E. J., ... & Crowe, A. J. (2017). ASPECT: A survey to assess student perspective of engagement in an active-learning classroom. *CBE-Life Sciences Education*, *16*(2), ar32. https://www.lifescied.org/doi/10.1187/cbe.16-08-0244

Student Course Engagement Questionnaire

http://serc.carleton.edu/files/NAGTWorkshops/assess05/SCEQ.pdf

(Handelsman et al. 2005)

23 Likert items assessing perceived skills engagement, participation/interaction engagement, emotional engagement, and performance engagement

LEARNING GAINS

Classroom Activities and Outcomes Survey (Terenzini et al. 2001)

24 Likert items rating progress in learning skills related to engineering or general scientific inquiry.

Student Assessment of Learning Gains (SALG) http://salgsite.org/(Seymour et al. 2000)

Multiple Likert items within 10 major categories rating gains in learning, skills, and attitudes due to components of a class

Survey of Undergraduate Research Experiences (SURE) (Lopatto 2004)

http://www.grinnell.edu/academic/csla/assessment/sure 20 Likert items assessing perceived learning gains as a result of participation in undergraduate research.

Undergrad Research Student Self-Assessment

http://www.colorado.edu/eer/research...gradtools.html (Hunter et al. 2007)

Multiple Likert items assessing perceived gains in skills related to participation in research, yes/no questions categorizing specific experiences, and open response items.

MOTIVATION

Achievement Goal Questionnaire

(Elliot and Church 1997, Finney et al. 2004)

18 Likert items rating performance approach and avoidance goals, and mastery goals.

Motivated Strategies for Learning Questionnaire (MSLQ)

http://www.indiana.edu/~p540alex/MSLQ.pdf (Pintrich Paul R. 1991, Pintrich P. R. et al. 1993)

31 Likert items assessing students' goals and value beliefs. 31 assessing use of learning strategies and 19 items concerning student management of learning resources.

Science Motivation Questionnaire (SMQ)

http://www.coe.uga.edu/smq/ ← not working

NEW LINK: https://coe.uga.edu/assets/downloads/mse/smqii-glynn.pdf

(Glynn et al. 2011)

30 Likert items comprising 6 components of motivation: intrinsic, extrinsic, relevance, responsibility, confidence, and anxiety.

Self-Efficacy

College Biology Self Efficacy

(Baldwin et al. 1999)

VIEWS/ATTITUDES

Biology Attitude Scale (Russell and Hollander 1975)

22 items: 14 Likert-type and 8 semantic differential measuring students' perceptions of liking or disliking biology

Colorado Learning Attitudes about Science Survey (CLASS)- Biology https://www.lifescied.org/doi/abs/10.1187/cbe.10-10-0133

(Semsar et al. 2011) 31 Likert-type items for measuring novice-to-expert-like perceptions including enjoyment of the discipline, connections to the real world and underlying knowledge and problem-solving strategies.

Environmental Values Short Form (Zimmermann 1996)

31 Likert items assessing level of agreement with statements describing concern for different environmental issues

Survey of Teaching Beliefs and Practices for Undergraduates (STEP-U)

Marbach-Ad, G., Rietschel, C., & Thompson, K. V. (2016). Validation and Application of the Survey of Teaching Beliefs and Practices for Undergraduates (STEP-U): Identifying Factors Associated with Valuing Important Workplace Skills among Biology Students. CBE-Life Sciences Education, 15(4), ar59. https://www.lifescied.org/doi/10.1187/cbe.16-05-0164

Views About Sciences Survey (VASS)

http://modeling.asu.edu/R%26E/Research.html (Halloun and Hestenes 1996)

50 items: Students choose a value describing their position with regards to two alternate conclusions to a statement probing their views about knowing and learning science in three scientific and three cognitive dimensions.

Views on Science and Education (VOSE)

http://www.ied.edu.hk/apfslt/download/v7_issue2_files/chensf.pdf

(Chen 2006)

15 items for which several statements or claims are listed. Respondents choose their level of agreement to these series of predetermined statements/claims to provide reasoning behind their opinion.

Views on Science-Technology-Society (VOSTS) (Aikenhead and Ryan 1992)

http://www.usask.ca/education/people/aikenhead/

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2.8: Strategic Planning

Workshop Overview

The strategic planning workshop is a facilitated session that guides participants through: a) visioning of the ideal campus for student learning, b) needs assessment to gauge where the host campus is falling short of the ideal, c) identification of an issue or issues that the participants wish to address to move the campus closer to the ideal, d) strategic planning using Backward Design (Wiggins and McTighe, 1998) to develop a plan to successfully address the issue.

Learning Outcomes

Participants will:

- Develop a strategic plan to address a campus issue whose resolution will support participants' efforts to adopt evidence-based teaching and create an inclusive learning program for students.

Key Terms

- Backward design
- Visioning
- Needs assessment

Active Learning/Formative Assessment Strategies

- Brainstorming
- Whole group discussion
- Consensus-forming
- Strategic planning

Pre-Workshop

Background

Work by organizational change researchers has shown that pedagogical training focused on the individual, without concomitant changes to the individual's environment that support them as they transition from more passive to more active, student-centered teaching, is insufficient. For this reason, the MIST was adapted from the original National Academies Summer Institute using Charles Henderson's Four Categories of Change Strategies to add elements- the Strategic Planning and Administrator workshops - that address institutional barriers to broad adoption of evidence-based teaching approaches.

Task

1. Reflect on the following two questions:
    - If you were dropped into the middle of a campus that was ideal for student learning, what would attributes would you see? What would you see in terms of spaces, infrastructure, policies, attitudes, values, cultures, teaching behaviors, curricula, etc?
    - What would your campus need to do to move closer to this ideal?

During Workshop

Activities

1. Create your vision statement: Visit the Strategic Planning Google Folder then go to the folder for your institution.
    - Collect vision statements on the vision statement report out document.
2. Create your needs assessment: Visit the Strategic Planning Google Folder then go to the folder for your institution.
    - Collect needs assessment statements on the needs assessment report out document.

3. Develop your strategic plan: Visit the Strategic Planning Google Folder then go to the folder for your institution.
    - Make a copy of the Strategic Planning template and name it for your group's topic and fill it out with your goal, outcomes and action plan for achieving your outcomes.

References

- Borrego, M., and Henderson, C (2014) Increasing the use of evidence-based teaching in STEM Higher Education: A comparison of eight change strategies. *J Engineering Educ.*, 103(2), 220-252.
- Henderson, C., Beach, A., and Finkelstein, N. (2011) Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *J Res in Sci Teaching*, 48(8), 952-984.
- Henderson, C., Finkelstein, N., and Beach, A. (2010) Beyond Dissemination in College Science Teaching: An introduction to four core change strategies. *J Coll Sci Teach* 39(5), 18-25.

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CHAPTER OVERVIEW

3: Group Work

Overview

The MIST is a **project-based training program combining interactive workshops** on the tenets of scientific teaching **with group work sessions** where participants develop inclusive, student-centered teaching materials that they present to colleagues for peer-review at the end of the week.

Group work carefully designed to model scientific teaching has been found to be one of the most important processes at the Summer Institute. Each is led by a trained facilitator to model teaching practices that will help the group establish and meet common goals. Each group presents their teaching module for review during a dress rehearsal with another group and a final presentation. This allows groups to practice providing feedback on the effectiveness of learning activities and to incorporate peer feedback into their teaching modules before using them in their own classes.

Each group will create a folder in this Google Group Work folder where you will work collaboratively on your teaching module (tidibt) for the week.

In addition, all new MIST participants have access to a Master MIST Google folder, where you can access teaching modules from other institutions.

The pages below contain resources to support your group work.

3.1: Group Work Sessions

3.1.1: 5 Stages of Group Development

3.1.2: Constructive and Destructive Group Behaviors

3.2: Group Presentations

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SECTION OVERVIEW

3.1: Group Work Sessions

About Group Work Sessions

Throughout the week, you and your team will participate in groups of four during group work sessions. During those sessions, you will be moving at your pace through the stages described below.

Goals

The goal of the first session is to meet your group mates, pick the topics for your teachable tidbit, and begin to backward design your tidbit. Backward design will consist of writing learning goals and outcomes, identifying summative assessments that will provide data about student learning and finally developing the learning activities that will help students achieve the desired outcomes.

Teachable tidbits

During the institute, each group will develop teachable tidbits that address topics/concepts within the group's topic area. Teachable tidbits are instructional materials designed to engage students in learning. Generally, they consist of a single activity that can be integrated into a larger context, such as a course or a lecture. You will work through the following stages in your group:

1. **Group Dynamics.** Identify and discuss your own constructive and destructive group behaviors and the stages of group development.
2. **Identify a topic area for your teachable tidbit.** You want this to be narrow enough to address within the timeframe allotted. For example, if your topic is evolution, will you focus on some aspect of the concept of natural selection, like the role of mutation in genetic variation, or another concept altogether?
3. **Identify learning goals and intended outcomes for the teachable tidbit.** Start by stating broad learning goals such as "students will understand equilibrium" and then move on to more specific learning outcomes for each goal. If you stopped at this point, you might leave students wondering, "what do you mean by understand?" Think about how you will assess student understanding. When stating learning outcomes, use active verbs that suggest suitable assessments. For example, "Students will be able to predict how relative changes in concentrations of reactants or products will affect forward or reverse reaction rates" is a specific and assessable learning outcome that would indicate whether or not a student actually understood the concept of equilibrium.
4. **Determine appropriate assessments.**
5. **Construct an inclusive, active lesson plan.**

The goal of these sessions is to continue to develop your teachable tidbit(s) incorporating active learning/formative assessment strategies to create an inclusive learning experience that will help students achieve the intended learning outcomes. Learning activities should engage students' previous knowledge and help them construct new knowledge and engage in deliberate practice of important skills. Ultimately, your learning outcomes, learning assessments, and learning activities should all align with each other.

Upload your materials

Each group will create a folder in this Google Group Work folder where you will work collaboratively on your teaching module (tidibt) for the week.

Participants also have access to tidbits from other groups and other institutions by going to the MoSI Host Campus Folder that holds all of the folders associated with the workshops and group work.

Topic hierarchy

3.1.1: 5 Stages of Group Development

3.1.2: Constructive and Destructive Group Behaviors

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3.1.1: 5 Stages of Group Development

Stages of Team Development

This process of learning to work together effectively is known as team development. Research has shown that teams go through definitive stages during development. Bruce Tuckman, an educational psychologist, identified a five-stage development process that most teams follow to become high performing. He called the stages: forming, storming, norming, performing, and adjourning. Team progress through the stages is shown in the following diagram.



Most high-performing teams go through five stages of team development.

Forming stage

The forming stage involves a period of orientation and getting acquainted. Uncertainty is high during this stage, and people are looking for leadership and authority. A member who asserts authority or is knowledgeable may be looked to take control. Team members are asking such questions as “What does the team offer me?” “What is expected of me?” “Will I fit in?” Most interactions are social as members get to know each other.

Storming stage

The storming stage is the most difficult and critical stage to pass through. It is a period marked by conflict and competition as individual personalities emerge. Team performance may actually decrease in this stage because energy is put into unproductive activities. Members may disagree on team goals, and subgroups and cliques may form around strong personalities or areas of agreement. To get through this stage, members must work to overcome obstacles, to accept individual differences, and to work through conflicting ideas on team tasks and goals. Teams can get bogged down in this stage. Failure to address conflicts may result in long-term problems.

Norming stage

If teams get through the storming stage, conflict is resolved and some degree of unity emerges. In the norming stage, consensus develops around who the leader or leaders are, and individual member’s roles. Interpersonal differences begin to be resolved, and a sense of cohesion and unity emerges. Team performance increases during this stage as members learn to cooperate and begin to focus on team goals. However, the harmony is precarious, and if disagreements re-emerge the team can slide back into storming.

Performing stage

In the performing stage, consensus and cooperation have been well-established and the team is mature, organized, and well-functioning. There is a clear and stable structure, and members are committed to the team’s mission. Problems and conflicts still emerge, but they are dealt with constructively. (We will discuss the role of conflict and conflict resolution in the next section). The team is focused on problem solving and meeting team goals.

Adjourning stage

In the adjourning stage, most of the team’s goals have been accomplished. The emphasis is on wrapping up final tasks and documenting the effort and results. As the work load is diminished, individual members may be reassigned to other teams, and the team disbands. There may be regret as the team ends, so a ceremonial acknowledgement of the work and success of the team can

be helpful. If the team is a standing committee with ongoing responsibility, members may be replaced by new people and the team can go back to a forming or storming stage and repeat the development process.

Team Norms and Cohesiveness

When you have been on a team, how did you know how to act? How did you know what behaviors were acceptable or what level of performance was required? Teams usually develop **norms** that guide the activities of team members. Team norms set a standard for behavior, attitude, and performance that all team members are expected to follow. Norms are like rules but they are not written down. Instead, all the team members implicitly understand them. Norms are effective because team members want to support the team and preserve relationships in the team, and when norms are violated, there is peer pressure or sanctions to enforce compliance.

Norms result from the interaction of team members during the development process. Initially, during the forming and storming stages, norms focus on expectations for attendance and commitment. Later, during the norming and performing stages, norms focus on relationships and levels of performance. Performance norms are very important because they define the level of work effort and standards that determine the success of the team. As you might expect, leaders play an important part in establishing productive norms by acting as role models and by rewarding desired behaviors.

Norms are only effective in controlling behaviors when they are accepted by team members. The level of **cohesiveness** on the team primarily determines whether team members accept and conform to norms. Team cohesiveness is the extent that members are attracted to the team and are motivated to remain in the team. Members of highly cohesive teams value their membership, are committed to team activities, and gain satisfaction from team success. They try to conform to norms because they want to maintain their relationships in the team and they want to meet team expectations. Teams with strong performance norms and high cohesiveness are high performing.

For example, the seven-member executive team at Whole Foods spends time together outside of work. Its members frequently socialize and even take group vacations. According to co-CEO John Mackey, they have developed a high degree of trust that results in better communication and a willingness to work out problems and disagreements when they occur.[1]

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1. Jennifer Alsever, Jessi Hempel, Alex Taylor III, and Daniel Roberts, “6 Great Teams that Take Care of Business,” Fortune, April 10, 2014, **http://fortune.com/2014/04/10/6-great-teams-that-take-care-of-business/** ↵

LICENSES AND ATTRIBUTIONS

Content Reused from https://courses.lumenlearning.com/suny-principlesmanagement/chapter/reading-the-five-stages-of-team-development/

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3.1.2: Constructive and Destructive Group Behaviors

Constructive Group Behaviors

Cooperating: Is interested in the views and perspectives of the other group members and is willing to adapt for the good of the group.

Clarifying: Makes issues clear for the group by listening, summarizing and focusing discussions.

Inspiring: Enlivens the group, encourages participation and progress.

Harmonizing: Encourages group cohesion and collaboration. For example, uses humor as a relief after a particularly difficult discussion.

Risk Taking: Is willing to risk possible personal loss or embarrassment for the group or project success.

Process Checking: Questions the group on process issues such as agenda, time frames, discussion topics, decision methods, use of information, etc.

Destructive Group Behaviors

Dominating: Takes much of meeting time expressing self views and opinions. Tries to take control by use of power, time, etc.

Rushing: Encourages the group to move on before task is complete. Gets "tired" of listening to others and working as a group.

Withdrawing: Removes self from discussions or decision-making. Refuses to participate.

Discounting: Disregards or minimizes group or individual ideas or suggestions. Severe discounting behavior includes insults, which are often in the form of jokes.

Digressing: Rambles, tells stories, and takes group away from primary purpose.

Blocking: Impedes group progress by obstructing all ideas and suggestions. "That will never work because…"

Brunt (1993). Facilitation Skills for Quality Improvement. *Quality Enhancement Strategies*. 1008 Fish Hatchery Road. Madison. WI 53715

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3.2: Group Presentations

Final preparation for Presentations

During this session you will put finishing touches on the 30-minute presentation of your teachable tidbits.

Group Presentations

1. Teach one of your tidbits, including a brief overview of the context in which the tidbit will be taught. You will have 30 minutes for your presentation.

2. Provide feedback on your peers' tidbits. Use the rubric from the Peer Mentoring workshop to provide constructive feedback that will help the presenters become more active and student-centered.

Upload your materials

Upload teachable tidbit and related/supporting materials to your institutional folder inside the Group Work Google Folder for the workshop.

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CHAPTER OVERVIEW

4: Treasure Chest

Overview

The treasure chest is meant to serve as a site that you can visit during and revisit after the MIST to find literature and resources that may be beneficial to you as you continue to transform your courses in the future.

4.1: Literature

4.2: Resources

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4.1: Literature

*Note: if the link to the publisher's website does not provide free access to the article, you can still find freely available pdfs online.

Additional resources on scientific teaching:

- Cavanagh et al. (2016) Student Buy-In to Active Learning in a College Science Course. CBE-Life Sciences Education; 15:ar76.
- Couch et al. (2015) Scientific Teaching: Defining a Taxonomy of Observable Practices. CBE-Life Sciences Education; 14:ar9.
- Gross et al. (2015) Increased Preclass Preparation Underlies Student Outcome Improvement in the Flipped Classroom. CBE-Life Sciences Education; 14:ar36.
- Auchincloss et al. (2014) Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report. CBE-Life Sciences Education; 13(1), 29-40.
- Tanner (2013) Structure Matters: Twenty-One Teaching Strategies to Promote Student Engagement and Cultivate Classroom Equity. CBE-Life Sciences Education; 12(3), 322 – 331.
- Chen et al. (2013) Training TAs in Scientific Teaching for the Human Physiology and Anatomy Laboratory. Advances in Physiology Education; 37(4), 436-439.
- Pfund et al. (2009) Professional Development. Summer Institute to Improve University Science Teaching. Science; 324(5926), 470-471.
- Batzli, Ebert-May, Janet Hodder (2006) Bridging the pathway from instruction to research. Frontiers of Ecology and the Environment; 4(2), 105-107.
- Handelsman et al. (2004) Education. Scientific Teaching. Science; 304(5670), 521-522.
- Frederick (2016) Teach the Prof How to Teach. Scientific American.

Additional resources on equity, inclusion, and persistence:

- Asai, D., (2020) Race Matters. Cell 181:754-757.
- Pope, Price, Wolfers (2018) Awareness Reduces Racial Bias. Management Science; 64(11) 4988-4995.
- Aragón, Dovidio, Graham (2017) Colorblind and Multicultural Ideologies Are Associated With Faculty Adoption of Inclusive Teaching Practices. Journal of Diversity in Higher Education; 10(3), 201-215.
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CHAPTER OVERVIEW

5: Discussion Forum

5.1: Before the workshop begins

5.2: During the workshop

5.3: After the workshop

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5.1: Before the workshop begins

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Index

A

Alignment table development
- 2.3: Backward Design I

C

Categorizing
- 2.3: Backward Design I

M

Matching
- 2.3: Backward Design I

R

reflection
- 2.3: Backward Design I

S

Small group discussion
- 2.3: Backward Design I

Glossary

Sample Word 1 | Sample Definition 1

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    - 4.2: Resources - *CC BY-NC-SA 4.0*
  - 5: Discussion Forum - *Undeclared*
    - 5.1: Before the workshop begins - *Undeclared*
    - 5.2: During the workshop - *Undeclared*
    - 5.3: After the workshop - *Undeclared*
  - Back Matter - *Undeclared*
    - Index - *Undeclared*
    - Glossary - *Undeclared*
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