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See, Hear, Speak... Using Non-traditional Assessment Techniques in Undergraduate-level Biology Courses

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Summary
While teaching to multiple learning styles (visual, auditory, kinesthetic, and tactile learning) has become more common in Science classrooms, assessments are often unchanged and generally delivered in traditional written formats. Since not every student's strength lies in such assessment methods, it is important to recognize the variety of ways in which we can evaluate learning in order to be more inclusive of student abilities. Even though biology coursework may not seem to lend itself to non-traditional testing, there are many opportunities to do so. These types of assessments actively engage students and allow them to sharpen a broader range of strengths. This workshop, aimed at early-career undergraduate instructors (graduate students and postdoctoral fellows), will encourage participants to design non-traditional assessments for their biology courses.

Keywords
biology education, learning styles, non-traditional teaching and alternative assessments

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SUMMARY

While teaching to multiple learning styles (visual, auditory, kinesthetic, and tactile learning) has become more common in Science classrooms, assessments are often unchanged and generally delivered in traditional written formats. Since not every student's strength lies in such assessment methods, it is important to recognize the variety of ways in which we can evaluate learning in order to be more inclusive of student abilities. Even though biology coursework may not seem to lend itself to non-traditional testing, there are many opportunities to do so. These types of assessments actively engage students and allow them to sharpen a broader range of strengths. This workshop, aimed at early-career undergraduate instructors (graduate students and postdoctoral fellows), will encourage participants to design non-traditional assessments for their biology courses.

KEYWORDS: biology education, learning styles, non-traditional teaching and alternative assessments

LEARNING OUTCOMES

By the end of the workshop, participants will be able to:

- describe how traditional and alternative teaching methods suit different learning styles;
- identify effective examination alternatives;
- assess the benefits and challenges to using different approaches to course assessments; and
- design biology coursework assessments using non-traditional methods or techniques.

REFERENCE SUMMARIES

Van Mondfrans, A. P. & Travers, R. M. (1964). Learning of Redundant Material Presented through Two Sensory Modalities. *Perceptual and Motor Skills,* 19:743-751.

This early study presents evidence for the retention of previously unfamiliar material when presented in different modes. The researchers presented lists of common words and nonsense syllables to students in visual, auditory, and audio-visual modes to compare the effectiveness of each presentation mode on the students' recall abilities. Interestingly, there was a trend for stimuli presented in multiple synchronous modes (audio-visual) to increase the ability to remember the words. While the stimuli were presented in different modes to the students, all students were required to *write down* the answers - the assessment of

retention did not reflect the modes used to teach the information. Thus, this article is important because it demonstrates the issue I am attempting to address in the workshop: namely, that *assessments* should be delivered in multiple formats. While it seems as though many instructors are attempting to use multiple methods of teaching biological concepts in their classrooms (for instance using video or audio examples embedded in their lectures), these methods are not considered appropriate or ignored when creating assessments. It is my hope that the idea that using multiple formats to teach can extend beyond the presentation of information, skills or concepts, and also be applied to assessments (exams and assignments). This paper will be incoporated into the beginning of the workshop to introduce the idea that students can benefit from multiple formats of instruction and alternative forms of assessment.

Sankaranarayanan, G., Weghorst, S. Sanner, M. Gillet, A. & Olson, A. (2003). Role of Haptics in Teaching Structural Molecular Biology. *Proceedings of the 11th Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (HAPTICS'03).* Pp. 363-366.

This descriptive paper is a great example of how new techniques used in undergraduate biology classrooms to teach complicated concepts in a unique way. Sankaranarayanan and colleagues borrow a commonly used learning tactic from organic chemistry: the idea of building a physical model of a target molecule in order to increase understanding of its structure and relationships with other molecules. The complexity of biological molecules has, until recently, restricted the use of this method in the classroom; however, new software now allows students to create 3D models of biological molecular structures. Visualization and creation can be very effective teaching tools in any biological setting, especially for kinesthetic and visual learners. My hope is that this example might inspire instructors to use similar methods to effectively apply an interdisciplinary teaching technique in their own classroom. Additionally, in the context of the workshop, I hope that instructors can also extend this application to assessment techniques in their fields. This reference will introduce participants to thinking creatively about applying non-traditional methods in their teaching and assessments by giving them an example to consider during the workshop.

Ramsey, L. L., Walczyk, J., Deese, W. C. and Eddy, D. (2000). Using Demonstration Assessments to Improve Learning. *Journal of Chemical Education,* 77: 1511.

This paper tests the hypothesis that assessing students in laboratories through demonstration tests (skills/kinesthetic-based assessments) is more effective than assessing through written tests alone. All students were taught the same materials in the laboratories; however, some students were assessed on their knowledge and application of

concepts by performing a demonstration that used a combination of skills learned in previous lessons. A control group was tested on the same knowledge and concepts through simple short answer quizzes. Using a previously developed performance model ("Chemistry Conceptual Assessment"), investigators determined that students tested using demonstration techniques learned and integrated concepts more effectively than those tested through quizzes. They believe the effectiveness of the demonstration test is a result of integrated modes of learning. This study shows the potential for alternative assessment techniques to improving the undergraduate education experience. When participants encounter this study early in the workshop, they will be given the chance to reflect on how to apply similar techniques to biology laboratories in order to achieve a variety of learning objectives in the field.

Hofstein, A. (2004). The Laboratory in Chemistry Education: Thirty Years of Experience with Developments, Implementation and Research. *Chemistry Education: Research and Practice*, 5: 247-264.

This review of over thirty years of research in chemistry education focuses on advances in teaching, especially in the laboratory context. The report suggests that well-designed assessments examine students at all levels of experimentation (from hypothesis making to interpretation of results), involve continuous and sometimes long-term assessments plans, and include written assessments, practical (tactile), and verbal components. The advantages of using such techniques were apparent in students' abilities and in their attitudes towards university-level science more generally. This study will be used in the workshop with Ramsey *et al.* (2000) to emphasize the benefits of assessing students through multiple formats.

CONTENT AND ORGANIZATION

Duration [min]	Subject	Activity	Purpose
20	Introduction	As participants arrive, ask them to put a sticker or checkmark in one of three categories presented at the front of the room for the following two questions: • What type of learner are you? (Options: Visual, Auditory and Kinesthetic)	Identify and reflect on personal learning styles and demonstrate similarities and differences across the group. To make clear that people have preferences

		• What kind of exam do you prefer? (Options: Written Exam, Oral Exam, and Practical Exam) Facilitate an introduction drawing on the results of the above activity and the pre-workshop task involving the learning style assessment (see Presentation Strategies). Allow time for participants to meet one another and discuss similarities and differences in their learning style preferences. Introduce the main idea in the paper by van Mondfrans & Travers (1964) that suggests students learn better using multiple senses.	for different kinds of assessments which may be connected to personal learning styles, and that assessments can be designed to tap into multiple senses.
20	Small group Discussion: Assessment Methods	Create small groups of participants and prompt discussion on the following questions: What a) teaching and b) assessment methods do biology instructors tend to use and why? Ask groups to discuss the benefits and challenges of using dominant (traditional) assessment methods in their classrooms. Allow time for discussion, then create a summary list at the front of the room for people to review. Introduce Bloom's Taxonomy for Learning. Cite Bloom (1956) and Anderson & Krathwohl (2001). Ask small groups to connect traditional assessments in biology (e.g., written	Reflect on why traditional methods are used and/or favoured. Identify issues with traditional assessments and possible gaps that might be addressed using alternative examination types. Stimulate discussion and provide context for the following activities.

		exams) with the Bloom's cognitive levels of learning. Explore and discuss any identified gaps.	
15	Mini-lecture: Assessments in the Laboratory	Present the idea of testing laboratory components through skills-based assessments by introducing examples from Ramsey *et al.* (2000). Note that while this study was done in a chemistry context, biology labs may also benefit from short skill-quizzes (demonstration assessments). Use Hofstein (2004) as further evidence for best practices in laboratory assessment.	Demonstrate an alternative method for acquiring effective laboratory skills. Reflect on the application of chemistry examples to biology contexts.
20	Activity: Non-traditional teaching methods	Introduce the idea of teaching using non-traditional methods. Cite Sankaranarayanan et al.'s (2003) example of 3D haptic models in chemistry. Ask participants to offer ideas on how to apply a similar method to their own teaching. In small groups, ask participants to brainstorm non-traditional methods of teaching using an assigned course topic and learning outcome. The handout in Appendix A provides a series of scenarios so that each small group can work with a different context. Ask each group to report one teaching approach to the larger group. Explore concerns and challenges.	Practice creative thinking by identifying and pairing alternative teaching methods to specific situations. Evaluate the effectiveness of alternative teaching methods in given course contexts.
30	Activity: Non-traditional assessment methods	Ask participants to suggest ways of assessing students beyond written exams that they have seen in the past. Again, in small groups, ask participants to brainstorm non-	Assess workshop participants' level of experience with using non-traditional assessments.

		traditional methods of assessment using the assigned course topic and learning outcome from the previous activity (Appendix A). Have each small group report back their ideas to the larger group. Explore advantages and challenges involved with using non-traditional assessment techniques (e.g., *pros*: students respond well, opens up more exam question possibilities; *cons*: lack of equipment, too many students). Wrap up discussion by returning to Bloom's Taxonomy for Learning. Explore how alternative assessment formats may assess students at higher cognitive levels than traditional written exams.	Practice designing non-traditional assessment methods. Reflect on the benefits and potential challenges of implementing multiple forms of assessment in biology classrooms.
15	Conclusion	Summarize the advantages and challenges to testing using alternative methods. Provide resources list (e.g., articles cited in this workshop) that could be useful for instructors moving forward.	Recap key information and motivate participants to continue to reflect on their approaches to teaching and assessment.
Total Time: 120 minutes			

PRESENTATION STRATEGIES

Pre-workshop: Review and select an online learning style inventory. Send the link to participants prior to the workshop and let them know that they will be sharing and reflecting on their personal learning preferences during the workshop.

Examples of previously developed learning style inventories available online:

- Simon Fraser Universities VAK Learning Style Inventory
  - http://sfu.ewb.ca/documents/vaklearningstyles.pdf
- 20 Question Survey from educationplanner.org

    - http://www.educationplanner.org/students/self-assessments/learning-styles.shtml
- The VARK Questionnaire: How Do I Learn Best
    - http://vark-learn.com/the-vark-questionnaire/

Introduction: The pre-workshop task and introductory activity will start participants thinking about their personal learning preferences and about the ways in which course content is typically taught and assessed.

Small group Discussion on Assessment Methods: This activity examines the traditional assessment methods used in biology classrooms and the associated benefits and challenges. It is likely that written assignments and exams will be the dominant assessments identified by the group. This activity provides a basic assessment list which participants will then be able to modify and broaden over the course of the workshop.

By sharing an illustration of Bloom's Taxonomy of Learning during this section of the workshop, participants will be familiarized with the cognitive levels of learning and how these are related to student assessment. The goals of this activity are to demonstrate that traditional forms of assessment (e.g., written exams) regularly focus on memorization and recall and then motivate participants to design assessments that challenge students at higher cognitive levels.

Mini-lecture on Assessments in the Laboratory: Since laboratories are usually a large component of biology courses, emphasize that laboratory assessments should align with learning outcomes that focus on knowledge application and demonstration of skills. By introducing Hofstein (2004) and examples from Ramsey *et al.* (2000), participants will be able to reflect on how skills-based assessments are possible in laboratory contexts. They will gain an appreciation for the potential benefits of these assessment techniques to students.

Non-traditional Teaching Methods Activity: In this section of the workshop, introduce participants to non-traditional methods of delivering course content that target different learning preferences. Describe and provide specific examples of visual, auditory, and kinesthetic learning. For instance, introduce different types of visual learning by comparing video, photograph, and textual examples.

Using the "Teaching and Assessment Scenarios" in Appendix A, have participants develop non-traditional methods of teaching an assigned course topic (i.e., beyond the traditional lecture). This activity promotes group interaction and creative collaboration. The result

will be a list of teaching methods that each participant may be able to adopt in future classrooms.

Non-traditional Assessment Methods Activity: The final activity asks participants to formulate a list of student assessments that does not include written exams. Challenge participants to get creative. In their small groups, they will design non-traditional methods of assessment using the assigned course topic and learning outcome from the previous activity (Appendix A).

Be sure to discuss the advantages and challenges involved with using non-traditional assessment techniques. Bring Bloom's Taxonomy for Learning back into the discussion to demonstrate alternative assessment formats could be used to assess students at higher cognitive levels than memorization and recall. For instance, testing aurally (with sounds) can be used for knowledge (i.e. identifying a sound) but it may also be used for comprehension, application and/or analysis. If an unfamiliar animal call is played to students, they may be able to analyze its structure and function based on similarities of its characteristics to other, familiar calls, enabling students to hypothesize about its context. This activity allows participants to understand how the levels of learning might be assessed effectively using the methods previously discussed.

Conclusion: Provide references and resources to workshop participants moving forward in order to motivate their continued reflection on teaching and assessment strategies. Collect e-mail addresses in order to distribute copies of the Teaching and Assessment Scenarios, and the contributions of participants during the workshop. Consider gathering anonymous feedback at the end of the session or afterwards. If possible, maintain communication with participants and follow-up on any questions or comments.

ADDITIONAL REFERENCES

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Bloom, B. S. (1956). *Taxonomy of educational objectives, the classification of educational goals - Handbook I: Cognitive Domain*. New York: McKay.

Hart, D. (1994). *Authentic assessment: A handbook for educators*. Menlo Park, CA: Addison-Wesley Publishing Company.

Kolb, D. A. & Lewis, L. H. (1986). Facilitating experiential learning: Observations and reflections. *New Directions for Adult and Continuing Education,* 1986: 99-107.

APPENDIX A: Handout on "Teaching and Assessment Scenarios"

Instructions for Facilitators
Print the scenarios on the next page on separate sheets and consider adding your own examples to the list. Once session participants are in small groups, each group receives one (or more) scenario(s) to work on for both the teaching and assessment activities. Each scenario includes the course name, level, number of students, topic, and lesson learning outcome. Share the Example Scenario below as a guide to help participants get started. Think about laminating example scenarios if used over multiple sessions, and keep the best examples generated by participants (with their permission) to share during future sessions.

- *Teaching Activity*: Participants develop non-traditional methods of teaching the given topic (i.e., how would an instructor teach the content without lecturing?)

- *Assessment Activity*: Participants create ways of assessing the given learning outcome using an assessment method other than a written exam questions. Or, if the student will be asked to write down answers, participants must design alternative forms for delivering the test questions.

Example Scenario
Course: Animal Behaviour
Level: 3rd year
Number of students: 75
Topic: Alarm behaviours
Learning outcome: The student should be able to identify the function of an alarm signal in context, and provide a possible example of alarm behaviour.

Non-traditional Teaching Technique:
In class, have students listen to animal alarm calls with their eyes closed. Ask them to speculate on the origins and functions of each call. Then, take students on a virtual nature walk (using video clips) so that they can observe the various alarm behaviours in context. Facilitate a discussion where alarm calls are compared and contrasted.

Non-traditional Assessment Technique:
This would be ideal for a short answer question on an exam. During the exam, play an audio clip of an unfamiliar alarm call and pose the following questions: a) Identify the most likely function of this signal, and justify your answer using biological concepts; b) Provide another example of such a signal, and note at least two similarities between your example and the audio track.

Scenario 1
Course: Introductory Biology
Level: 1st year
Number of students: 800
Topic: Mendelian Genetics (the theory of inheritance).
Learning outcome: The student should be able to describe the Mendelian theory of inheritance, and identify a system in which it might occur.

Scenario 2
Course: Community Ecology
Level: 2nd year
Number of students: 150
Topic: Keystone species
Learning outcome: The student should be able to identify and/or describe a keystone species, and its role in a biological community

Scenario 3
Course: Plant physiology
Level: 3rd year
Number of students: 50
Topic: Plant respiration
Learning outcome: The student should be able to describe the essential processes and locations of the main steps of plant respiration.

Scenario 4
Course: Animal structure and function
Level: 2nd year
Number of students: 80
Topic: Exoskeletons
Learning outcome: To propose an hypothesis for the evolution of the exoskeleton

Scenario 5
Course: Advanced methods in research
Level: 4th year (Honours)
Number of students: 25
Topic: Statistical analysis
Learning outcome: To apply the correct statistical technique to analyze a specific data set.