

Technique #1: Pre- and Post-Content Assessments

Pre-assessments are used prior to instruction to assess students' prior knowledge and ensure that the course or lesson content is at an appropriate level for students. Post-assessments are used following instruction to assess if and how well students have learned content within a lesson or a course. Pre- and post-assessments may be implemented at the beginning and end of a course, a content module, or even a single lesson, depending on exactly what the instructor wishes to assess. They could be used as formative (while instruction is in progress) or summative (after instruction) assessments depending on when they are implemented and which concepts they target.

Regardless of the timing of implementation, both the pre- and post-assessment contain the same set of questions so that changes in students' understanding of specific concepts can be examined. Both assessments are generally not graded. This ensures that the assessments are low stakes and can better target understanding, rather than how well a student can study the material leading up to a formal examination.

One unique form of this type of assessment are knowledge assessments. These evaluate the ability of students to self-assess their knowledge by asking them to indicate how well they could answer a question if required to, rather than answering the question.

Examples:

- An instructor implements pre- and post-assessments on the first and last days of a course to evaluate the effectiveness of instruction throughout the term.
- An instructor implements pre- and post-knowledge assessments to evaluate how well learners think they have learned content. The instructor implements these knowledge assessments at various stages during the course so that self-assessment is completed shortly after instruction.
- An instructor implements a pre- and post-assessment at the beginning and end of an individual lesson to assess whether their students have learned a specific concept that the lesson was targeting. The results of this assessment may inform future teaching practices.
- An instructor of an online course implements pre- and post-assessment through their Learning Management System. They instruct students to complete each assessment during a short window (1-2 days) of time. Each assessment contains a validating question to ensure students are reading the questions thoroughly and students are given a limited amount of time to complete it.
- An instructor administers a pre-assessment and finds that their students are already proficient in some of the topics that they had intended to cover in their course. They revise future lessons to delve into more complex aspects of the topics and to include more advanced topics.
- An instructor administers a pre-assessment and finds that their students do not have the necessary background information to learn some of the topics they had intended to teach in the course. They use these results to create review material so that students are prepared for each lesson.

Technique #2: Classroom Observations

Classroom observations are a useful tool to provide an instructor with insight into what they and their students are doing during class time, and the impact that their teaching methods have on student behaviour. They are completed by one or more outside observers that attend one (or ideally multiple) of the instructor's classes and observes their teaching practices and student behaviour. There exist formal protocols for conducting classroom observations, but observations can also be more informal depending on the goal of the observation. The data generated from these observations can be used to provide instructors with feedback about their teaching and can be used to inform faculty professional development. There exist numerous formal protocols with which to complete classroom observations, but we will focus on two that are commonly-used and that can be easily learned and implemented.

Classroom Observation Protocol for Undergraduate STEM (COPUS):

COPUS provides a reliable characterization of instructor and student activity during a class. Every two minutes, the observer makes a general observation of what the instructor is doing, and what the students are doing. Each interval may include more than one action. They enter this information into a spreadsheet that creates a real-time visual representation of student and instructor activities in class.

Behavioural Engagement Related to Instruction (BERI):

The BERI protocol was specifically designed for large university classrooms in which students are more likely to experience anonymity and distraction, leading to decreased engagement. It generally requires multiple observers to complete the observation at the same time since each can only observe 10 students at once. Each observer notes the proportion of students that are engaged in at least two-minute intervals, or shorter intervals if there is a major change in activity or content. The protocol provides guidelines of what constitutes engaged and disengaged behaviour. The observers also note what the instructor is doing during that time interval. After the class, the data from all observers is compiled and the instructor is provided with a timeline of student engagement correlated with instructor actions.

Examples:

- An instructor has an observer complete multiple BERI observations in their classroom as they attempt to identify actions that are decreasing student engagement, and modify their teaching practices to increase overall engagement during class.
- A department head arranges for COPUS' to be completed in the classrooms of several department instructors to provide a common assessment of the general state of teaching within the department.
- An instructor is curious about a specific aspect of their teaching and asks a colleague to attend their class to conduct a general observation. Following the observation, the instructor and the observer discuss the class during which the instructor solicits specific feedback on the aspects of their teaching they were curious about.
- An instructor is creating their teaching portfolio and wants to gather evidence of their teaching practices and student behaviour in their classroom. They ask colleagues to complete COPUS and BERI evaluations and they include the results in their portfolio.

Technique #3: Interviews and Focus Groups

Interviews (with one participant) or focus groups (with two or more participants) are used to understand in more detail student content knowledge or perceptions. Whereas a content assessment or perception survey offers breadth, interviews/focus groups offer the opportunity to investigate a topic in more depth. In an interview/focus group, you can ask a student(s) *why* they responded in a certain way, or follow up unexpected responses by asking further probing questions. However, this richness of data comes at a cost. Interviews/focus groups are labour intensive to analyze, typically involving transcription of audio and then an iterative process of summarizing responses ('coding') and determining emergent themes.

Focus groups provide an opportunity to collect many responses in one setting and develop a group dynamic and shared experience. This creates the potential of eliciting responses that wouldn't be generated in a one-on-one interview. However, it is also possible that some voices will be dominated within a focus group setting, or that interviewees may act in a socially desirable way, rather than sharing their true feelings. Restricting the number of focus group participants to four will help limit the chances of this occurring, but in many cases a one-on-one interview is more appropriate.

Interview/focus group settings are personal. It is important to be aware of potential power differentials between interviewer and interviewee(s), and consider if it would be more appropriate to have a third party conduct interviews/focus groups.

Examples:

- Following a survey given in class, an instructor wants to understand student responses in more detail. They ask a colleague to interview students about specific questions of interest, using general survey findings as a starting point for the interview conversation.
- An instructor notices that students struggle with a particular concept on exams, but they are unsure why. The instructor asks a colleague to interview students by using a 'think aloud' technique. Students verbalize their thought processes as they work through the question and targeted follow up questions help uncover alternative perceptions of the concept.
- After they have finished teaching a new course, an instructor wants more detailed feedback than is given on formal teaching evaluations. The instructor invites students to participate in focus groups focusing on specific aspects of their teaching. These focus groups are facilitated by a colleague, who anonymizes and summarizes their findings before providing it to the instructor.
- An instructor develops a new teaching activity, but wishes to test it out before trying it with their new class. They invite previous students to participate in a focus group where they work through the new activity and provide feedback on its content and clarity.
- An instructor is curious about an aspect of the student experience in a particular course or topic. They ask a colleague to interview students, using a pre-planned series of questions.

Technique #4: Perception Surveys

Perception surveys are used to measure student attitudes, emotions or values, rather than content knowledge. Perception surveys may be used either as a pre- and post-assessment to measure the impact of a particular teaching innovation, or as a one-off to understand what perceptions students are bringing into the classroom or how they respond to a certain topic. Questions are often structured on a Likert scale (i.e., strongly disagree, disagree, neutral, agree, strongly agree), but may use different adjectives (e.g., helpful/not helpful, important/unimportant). Alternatively, they may be open-ended, so that students can explain their responses in more detail. Standard teaching evaluations would be considered perception surveys.

Some opt to use perception surveys that are published and reported on, offering comparisons of their students with populations outside of one's institution. These surveys have typically been validated, by ensuring that the questions are interpreted as intended and consistent with perceptions of experts. Some examples of commonly measured aspects of student perceptions are: motivation, the nature of their discipline, the nature of science, science communication and self-efficacy (confidence).

Examples:

- An instructor collects pre- and post-perception survey data to investigate student preparedness before and after a field trip. They conclude that students do not feel adequately prepared for the field trip, and adjust their pre-field trip labs accordingly.
- An instructor is interested in finding out what kind of motivation for learning their students have. In the first week of the course, students fill out a validated motivation survey. They find that their students are highly extrinsically motivated, and adjust their course content to have clearer links to career options.
- An instructor implements a new teaching module that is intended to teach students about the nature of science. They collect pre- and post-perception survey data to determine if students have become more expert-like in their perceptions of the nature of science after taking the course.
- After trying a new teaching activity, an instructor wants to know if the students found the activity engaging and helpful for their learning. The instructor asks a small number of feedback questions at the end of the new activity to gauge student perceptions. They use this feedback to make changes to the activity in future years.
- Halfway through a semester, an instructor wants feedback on how the course is going so far. They deploy a short evaluation survey through their learning management system. The instructor summarizes the results, communicates them to their students and makes changes as necessary.
- Six months after their earth system science course, an instructor is curious if students have maintained a pro-environmental mindset. The instructor asks permission of an instructor in a later course to give a survey on environmental attitudes.

