8

Science: Data Practices

Qi Guo, Whitney Keaton, & Cecil R. Short

Review foundational knowledge about [Data Practices](#) in K-12 Blended Teaching (Volume 1).

8.1 Collecting Data in Science Courses

Data can inform all parts of your teaching. It can help students see their own progress and areas that need improvement. It can help you understand what specific students need. It provides information that students can use in setting and evaluating goals. Technology has greatly expanded the way to record, collect, organize, and use data in a timely and efficient way. Because of technology, teachers can easily and quickly collect and use data to change and enhance their pedagogy, group students, plan remedial and extended activities for students who need it, and target specific needs of individuals, groups, and the whole class.

> ### Teachers Talk: Using Data from Different Sources to Assess Learning (2:53)
>
> Reflection Question: Dr. Ritson uses tools in Google Classroom and other external tools to collect data about student learning. What tools do you have available in your LMS and externally that you can use to collect data on your own students' mastery of the learning objectives?

In order for data to be helpful, you have to organize it in a meaningful way. You may want to use qualitative and quantitative data, observations, performance criteria, and areas of a rubric aligned with a certain learning objective. Here are a few examples:

Table 1

Collecting Data—Some Ideas

Desired Data	Ways to Gather the Data Using Technology
Students' personal characteristics	These data often come from teacher-made resources and surveys that help you get to know your students. You might use a Google Form to have students answer questions about their learning preferences (such as working alone, in groups, by reading, by watching, or by writing), their best times of day for studying, their hobbies, their interests, their perceptions of their strengths and weakness in science, what they want from your class, what they are nervous about in the class, the types of

Desired Data	Ways to Gather the Data Using Technology
	assessments and activities they prefer, etc. This data can also consist of socio-emotional data such as a student's mood, how much sleep they typically get at night, or when they last ate a full meal. Notice and take notes of students' participation, interest in various topics, friends, attention, outside interests, interaction with others, clues about home life, etc.
Mastery data	This data may be in your learning management system (LMS) or an outside mastery tracker that you create. It often includes data from activities and assessments. This data can usually be collected from the results and analytics of students' quizzes, assignments, or tests which reflect their understanding of certain concepts, definitions, formulas, their understanding of theories, their lab skills, or their ability to apply the theories they learned to solve real-world problems. This data can also come from state-mandated tests. Collecting and then analyzing mastery data can help teachers know where most students mastered, in which parts most students need remediation, and where the teaching approach needs some improvement. Teachers can then work on the specific parts guided by the data they collected and analyzed.

Training/resources needed to obtain/access data: Training in using the grade book, quiz statics, or other grade tracker. |
Activity data	You can obtain activity data from your LMS by running analytic reports. The reports may include students' time spent reviewing LMS pages or modules, participating in activities or assignments, who submitted assignments on time, who was late or absent, who missed assignments, etc. This data can also be obtained from observations of students' learning habits and behaviors, like staying on-task or not appearing challenged and engaged. Collecting and analyzing activity data can complement mastery data. Looking at activity data and mastery data together can help you understand the academic stories of individual students. For example, you may notice from mastery data that a student's academic performance has dropped abnormally, and upon checking his/her activity data, see if the decrease is due to less time spent on reviewing learning materials or not submitting assignments.
Goals and progress towards goals	You can keep track of goals and the progress students are making in a spreadsheet or goal sheet you create. You may choose to create SMART goal trackers that students keep in a data binder where they set and track their goals, growth, and challenges.
21st-century skills	You can collect data on how well students are developing the ability to collaborate through students' self-reflections on the process of collaboration and their contributions, participation in a discussion board, ability to work with students on a shared document, and reports from the students' peers. You can also track this data through class observations.
Help-seeking strategies	Observe how your students seek help and record what you see: Do individual students seek help online, from other students, or from you? Are they afraid to ask for help? Do they seek help when they might figure it out on their own?

✎ Blended Teaching Workbook

In your blended teaching workbook, you have a blank table like the one above. Decide what sources of data you would like to use in your classroom. Fill out the chart based on what data you want to collect. You may have to ask others for ideas on types of technology and what you need to learn to use the technology.

Teachers Talk: Canvas Provides Good Data for Teachers to Reflect Their Teaching Approach

Meredith Brady

Canvas has pretty good data for the quizzes and stuff that we use. We use a lot of formative checks to see how students are doing. If we need to, we spend more time on the topic or do another activity in the next day. Most often the changes we choose to make based on data affect next year as opposed to the current year. And we're always trying to reflect back and do better.

Teachers Talk: What Kind of Mastery Data Do Teachers Usually Look For?

Dr. Darren Ritson

Sometimes we use anecdotal evidence based on our formative assessments that we're doing in the classroom. We may look to see a specific assignment in Google Classroom. What was the average score for the kids; did they learn it for the most part?

Alan Schwalb

Google Classroom has a To-Do Button which was life-changing. When I figured out this brings up all the assignments such as the number of students who turned it in, the number of students that need to be graded and so forth. I look at that data to see who completed assignments, so I can grade them and put them in the gradebook and then see who's not completing work and maybe talk to them if they're not doing anything.

8.2 Utilizing Data in Science Courses

Tracking data can help science teachers improve student learning and their own teaching. Because data can help you know your students' skill levels in a large number of science objectives, it can help you in creating curriculum, differentiating and personalizing activities and assessments, helping students set goals, and tracking progress. It can also help you see strengths and weaknesses in your curriculum and approach to teaching, allowing you to improve your teaching. As you look at the examples below, notice how these teachers are using data. Think of ways you could improve your class by collecting and analyzing data.

Teachers Talk: Advice to New Teachers on Using Data
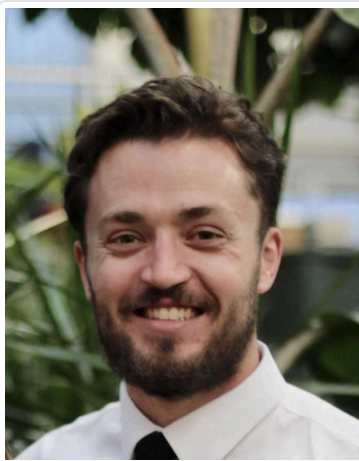
Matthew Harris

Find a way to efficiently gather student data that automatically informs you how they're doing. So, any platforms or programs you can find where you can spend less time gathering the data and more time using the data would be a huge benefit. Summit is a platform that does that pretty effectively. But there are ways to use things like Canvas and Google Classroom to give you that same data. Don't spend all of your time gathering the data. Because then you spend less time with your students, and I think some teachers over-focus on gathering data instead of using data.

In analyzing data, it is important to look for trends that may occur at the individual, group, or class level. Each of these different scopes may provide a different understanding of the data. For example, if you teach chemistry at three different times during the day and the second and third classes did well on an assignment but the first class did not, then you know there was likely some misunderstanding in the way the first class processed the information. Likewise, you may look at activity data for student progress in group labs and find that some groups are moving slower than other groups. This may allow you to provide slower groups with more time or support so they don't lag too far behind your other classes, or recognize which groups do not work well together due to getting distracted. At an individual level, you may recognize that some students seem to understand the class content really well when discussing it with you, but less well when they take a test. This pattern could be evidence of test anxiety or that the student was having an "off day."

Triangulating the kinds of data you track for students (such as performance data, activity data, and learner profile data) and the scope of that data (individual, group, or class data) can reveal different patterns and trends that help shape your instruction.

8.2.1 Mastery levels in a science class

Because the Science curriculum requires students to think critically and problem solve, it can sometimes be difficult to measure mastery. How do you decide when a student's understanding of a lab experiment meets the requirements for mastery of critical thinking and analysis skills?

This is where both data practices and personalization can help. A close analysis of such things as student papers, written and verbal explanations of scientific concepts, ability to argue their side of an issue, etc. can help you find strengths and weaknesses in your students' thinking, writing, speaking, and listening skills. For example, one person may be strong at explaining a scientific theory in concept but weak at providing evidence from an experiment done in class. Another may be strong at determining products of a chemical reaction but poor at the mathematical reasoning needed to balance that reaction. Maybe the student needs to improve in walking through the steps of a scientific problem step-by-step or making connections between theories and real-life situations. Maybe they need help using scientific language properly or using inquiry to solve a problem. Using this type of information to help students set measurable goals and create mastery paths can help both you and the student decide what mastery looks like and how to best measure mastery for each individual student.

It may be that some students have similar problems and can be grouped together to learn from each other and offer each other support. Students who excel can become mentors for those who need help and in turn can have students who are strong in areas in which they are weak become mentors for them. Determining what students have mastered and what needs additional reinforcement is an important place to start. In the video below, you can see some ways to determine the needs of your students.

> ### Teachers Talk: Using Data to Target Difficult Concepts and Redesign Teaching Approach (2:20)
>
> Reflection Questions: What types of formative assessments do you use in your classroom to determine how well your students are mastering the material and what you need to re-teach? Consider assessments you already use and how you could collect data from those in addition to new assessments you could incorporate.

8.2.2 Using data to help improve pedagogy

Because data often come from student performance and student activity, if you pay careful attention to student data, you can learn a lot about how to best teach your students and what pedagogy to use. What activities lead to the best results for what kinds of learning outcomes? What confuses your students? When are they most engaged? Does their engagement also lead to understanding and mastering learning outcomes? Reflecting on questions like these can help you evaluate yourself as a teacher and your students as learners. They can lead to insights that can strengthen your pedagogy and help students achieve mastery as well as their goals.

Quizzes (and other assessments) are a common source of data. Here are some ideas for using quiz data to improve your teaching and student learning:

1. Check to see if your LMS lets you align questions to specific learning outcomes. If it does, you can determine which outcomes students need more help with.
2. If many students miss the question, check to see if there is a problem with the question (miskeyed, difficult wording, unclear answers or expectations). If there are no problems with the question, check the standard to which the question is aligned. Pinpoint specific areas of confusion, analyze your instruction, and modify where needed.
3. If most students answer correctly, check to see if the question is too easy. If it isn't, review your teaching strategies for strengths that you might be able to use for similar learning objectives.
4. If just a few students miss the question, you may want to pull those students out in a small group and reteach specific principles, offer resources for remediation, or provide them with extra practice.

Teachers use data in all sorts of ways. Here are some examples of ways teachers have used data in a science classroom. What ideas do their experiences give you?

Example 1: Using Data to Help Students Get Services

Consider two students with opposite needs in a biology course. Through the use of data collection from tests and formative assessments done with programs like EdPuzzle and Nearpod during class, the teacher can assess their needs and determine how to best help them.

- With one student, the data showed overwhelmingly that the student was not understanding the basic concepts or terminology regarding plant cells. The teacher could provide remediation in this area using tools and programs geared toward struggling students.
- Another student was getting bored in the class. He was finishing all assessments quickly and earning high scores on all of them. The student could be given extension activities to allow him to do more inquiry activities that would hold his interest and allow him to stay engaged in the course.

Teachers Talk: Using Data to Provide Students with Targeted Tutoring and Feedback (2:42)

Reflection Questions: How can students in your classroom benefit from targeted feedback? Is there a time during your class session or your school day for targetted tutoring like Meredith Brady discusses?

Example 2: Using Data to Determine How to Make Questions Better

Sometimes what we intend to measure on an assessment is not what we are, in fact, measuring. It is important for you to analyze data from assessments not only to determine what your students know but to ascertain how well your assessments are actually measuring the intended learning objectives. For example, if a multiple-choice question on a test has a misleading choice as one of the wrong answers, it is possible that students are getting that question incorrect because of the way it is written rather than because of their own misconceptions in the science content. In order to best measure our students learning, teachers have to make sure they are actually asking the right questions. Analyzing assessment data frequently not only allows teachers to determine more about their students' learning, but also evaluate the quality of their teaching and assessing.

Teachers Talk: Test Data Informing Future Teaching

Dr. Darren Ritson

We would use data from the tests, the unit tests that we would give students, and we would use that data to look and see how the students were performing for the entire department. And that data wasn't going to change instruction for the students that we were teaching, it was going to change for the students we were going to teach in the future. It would allow us to look at test questions that we were asking, and we could look and see if somebody was scoring better on a specific question, and then we could find out what they were using in their classroom and see how we could adjust it to teach in our own classes.

Example 3: Using Data to Answer Questions

Using data teachers have been able to ask and find answers to a lot of different questions, for example:

- Q: Why did every single student miss this question?
- A: The question included a drop-down menu. The students didn't know how to use it.

- Q: Why did this class understand a certain concept and another class did not?
- A: We didn't have time for the online activity in one class. When I went back and did it with that class, their scores improved.

- Q: The data shows that my morning class struggles to understand concepts. Why?
- A: I had to experiment to find the answer to this one. Finally, I realized that these students needed to have some physical movement that early in the morning, even if it wasn't education-related. My afternoon classes, however, were tired from the day and just wanted to listen and work quietly. I had to adapt my approach for both classes.

Teachers Talk: Collect Data on Remediation Techniques

Alan Schwalb

Last year, a lot of the students had trouble with the concept of a density current, where essentially cold water sinks and warm freshwater floats and it creates a circular flow from the poles to the equator. And so we designed a digital source to address that concept. And then we basically tracked whether or not on that particular test question they did better after using the digital source.

Teachers Talk: Using the Flipped Model for Data-driven Instructions (8:38)

Reflection Questions: How is the flipped model that Patrick Hemmingsen uses helpful for him to collect data during class time? How does he use data to address misconceptions in science?

Example 4: Using Data to Group Students

Most Learning Management Systems will allow you to sort students by their scores on assessments. This data could be used to group students. For example, sometimes you may want to group a high-scoring student and a low-scoring student to allow for some peer tutoring. Other times, you may want to group a handful of students from the bottom together to work on some targeted remediation with you while the rest of the class moves on to something else. This data can also be used to group students for projects and inquiry-based experiments.

Meredith Brady

We have a time called "flex." It's like a 30-minute training version of second period where we help students who are falling behind, and I will often use data to teach groups during that time. I'll pull in certain students and we'll go through questions and quizzes that they've got wrong and kind of talk about that to reteach those topics.

Teachers Talk: Grouping Students According to Data (3:06)

Grouping Students According to Data

Matthew Harris
~ **Science Teacher**

Data Practices

EdTech Books   https://edtechbooks.org/k12blended2

Licensed under CC BY

[Watch on YouTube](https://...)

Reflection Questions: What are some ways that you could group students in your own classroom? Do you have data available to you that could help you to do this more efficiently? What do you see as the advantages of grouping your students for targeted instruction?

✎ **Blended Teaching Workbook**

Think of one source of data that you are not using but that you could use in your classroom. In your workbook, outline a way to collect that data and ways you can use it.

If you haven't already opened and saved your workbook, you can access it here.

Collecting and using data may feel uncomfortable. You may think you can't do it. But if you think about it, you are collecting data all the time. You are already regularly questioning your students, reading their lab reports and grading their work, and giving them activities to practice and check their understanding. You are ready to take the next step and find more formal ways to include data in your understanding of your students, their learning patterns and needs, and your strengths and weaknesses as a teacher.

Previous Citation(s)

Guo, Q., Keaton, W., & Short, C. R. (2022). Science: Data Practices. In C. R. Graham, J. Borup, M. A. Jensen, K. T. Arnesen, & C. R. Short (Eds.), *K-12 Blended Teaching (Vol 2): A Guide to Practice Within the Disciplines* , Vol. 2. EdTech Books. https://edtechbooks.org/-vPxh