

# Creating a Differentiated Mastery Learning Course with Student Choices

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## UNIT: Measuring with Basic Laboratory Equipment

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### *Unit is structured to be Mastery Learning with Differentiation.*

*Students are required to show mastery of a concept before they are allowed to move on to the next concept.*

*Students are given opportunities to learn through a variety of instructional strategies and then assessed. If they do not achieve the mastery level for the assessment, they are given additional instruction/resources and then reassessed.*

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### **Decide what content must be mastered and identify the key essential concepts.**

Students must demonstrate that they can accurately measure Length, Mass, Volume, and Temperature.

Key Ideas:

#### **SI Units**

Terms: mass, volume, length, temperature, gram, meter, cubic centimeter, milliliter, centigrade/celsius, fahrenheit, kelvin,

Prefixes: milli, centi, kilo

Equipment: triple beam balance, Erlenmeyer flask, beaker, graduated cylinder, thermometer, pipette, meter stick

#### **Volume**

Skills: reading the meniscus (differences between glass and plastic), LxWxH for regular solids, displacement for irregular solids, estimating the last digit, using correct SI unit

#### **Mass**

Skills: zeroing the balance, setting largest masses first, estimating the last digit, using correct SI unit, measuring liquid mass, measuring mass of powders, measuring very small objects

#### **Length**

Skills: start measuring on a MARK on the ruler (not the end), estimating the last digit, using correct SI unit

#### **Temperature**

Skills: reading the TOP of the meniscus, boiling and freezing points of pure water (in °F, °C, °K), usefulness of each scale (°F, °C, °K), estimating the last digit, using correct SI unit

### **Decide what level of mastery to set as your minimum.**

- 80% is the minimal mastery for quizzes. Students scoring below 80% must improve their understanding with additional Learning Opportunities.
- The Mastery Test will have no minimal percent required. It is anticipated that a grade of 70% “C” will be the lowest scored if students achieved 80% “B” on their quizzes.

- The acceptable margin of error for measurements are:

Measurement	Margin of Error
Length	1 mm per length
Mass	0.05g
Volume	0.05 mL (10mL graduated cylinder) 0.5 mL (50-100mL graduated cylinder) cm <sup>3</sup> (depends on size of regular solid)
Temperature	0.5°

**Create a Unit Test that meets the mastery criteria.**

- Determine the mastery content and terminology that students should understand.
- Decide how you expect them to demonstrate their understanding.

**Create short quizzes that measure mastery in only one or two closely related concepts.**

Create multiple versions of each quiz.

- SI Units
- Volume
- Mass
- Length
- Temperature

**For each section create differentiated learning opportunities that offer students choices in how they learn.**

- Students may select learning opportunities that differ in the style of learning (auditory, visual, tactile).
- For each section (SI Units, Volume, Mass, Length, Temperature), students may chose to:
  - View animations/videos on a computer
  - Work at a hands-on skill station
  - Read informational resources
  - Complete practice worksheets
  - Observe teacher-led demonstrations and/or mini-lectures

**Estimate how much time is *realistically* needed for students to learn each aspect of the lesson sequence.**

It's better to schedule more tightly to keep people on track; you can always add time if it is truly needed.

**Daily routine:**

- Students enter the room and pull out their unit checklist to see where they are with their learning opportunities and assessments.
- Students decide their daily goals after consulting the classroom calender to check its suggested section/content to work on for that day to see if they're on track.

- Students consult the list of optional learning opportunities and any required activities, set their daily goals and start working.
- Students begin to work. They go to the designated filing cabinet to get any worksheets that they need, view a video/animation on a class computer, obtain lab materials to work at a skill station with a partner, etc.
- The teacher floats around as needed and checks on student progress.

### **Helping students get used to a Mastery Learning process.**

- Keep emphasizing the key points.
  - Self-paced learning isn't self-taught.
  - Every student is responsible for their own learning.
  - No student will move on until they have learned the material.
  - The teacher won't give up on a student until they have learned the material.
- Go over the different choices and requirements for the first few sections/topics. Students are used to being told what to do as a group and have little experience with being in charge of their learning, but they catch on quickly and love it!
- For the first few sections or topics, lead them through the process.
  - Get out the unit checklists and fill them out.
  - Students look at what options they have for learning opportunities.
  - For the first few sections lead the class through a different type of option so that they can learn how they all work. As you do this, introduce other management issues:
    - A. Where to get materials/worksheets and answer keys (student file cabinet).
    - B. How to look at the section goals to see if they're ready for a quiz.
    - C. How to ask for and take a quiz.
    - D. How to have a quiz graded.
    - E. How to complete a lab, etc.
- Set aside an area in the room for quizzes and either solo or group work.

### **Lectures**

- Lectures in a mastery class exist in a better, more flexible format than the traditional class.
  1. Three or four students approach and ask you to explain something.
  2. Ask if there are other students working on the same section and if they want to join in.
  3. This small, attentive, motivated group then gathers by a whiteboard for a mini-lecture or small group discussion.
  4. These small, mini-lectures can effectively include student input and may generate those precious "lightbulb" moment side discussions.
  5. The teacher may have to do the same lecture with other students later on when they are ready, but it is better than one single lecture where many students aren't prepared for it. Repeating a lecture to a fresh and interested audience is worth it!

## Laboratory Learning Opportunities

- Set up the back of the room for labs and hands-on practice areas with regular desks in the front.
- Have materials and directions for each lab and hands-on practice.
- When a student lets you know that they are ready for a lab, find them a partner. Talk them through how to use the equipment and impart any special information. Tell them that they can call you over at any time.
- Go back often to check on lab safety and see how the students are progressing.
- It may be necessary to conduct a group lab all at once for logistical reasons.  
---- *CAUTION*: don't do labs out of context or they aren't nearly as useful.

## Practice

- Use backward-faded worked examples that have progressively less information. Start with a completely laid-out problem and gradually remove information from each step. This allows the student to focus on the relationships one at a time until all of the supporting information is gone.
- Answer keys for learning opportunities *must* be kept at the front of the room (or wherever you designate) so that everyone can find them. Use 3-ring binders and put the keys in sequentially. Create a separate binder for worksheets, text questions, etc. Having different answer key notebooks means less waiting time for students. Putting them in binders keeps them from getting scattered, lost, or misplaced.
- The answer key should show the work for each step of a practice problem so that kids can check the process and find their mistake. If they can't find the error, they can consult with the teacher or another student.
- Encourage students to check their answers for worksheets or other practice every 2-3 problems. If they are on the wrong track, it is better to catch it quickly so they can develop and practice correct thinking processes. Continuing to the end before checking their work can result in solidifying a bad habit that is then harder to correct.
- Since practice sheets aren't graded, copying is pointless for students since it doesn't help them pass the quiz. Copying results in their not learning so they end up failing the quiz and have to redo the learning anyway. Copying is not beneficial behavior.
- For *computer tutorials* either create a list of recommended web pages or leave the search for information entirely up to the student.
- Consider adding additional hands-on practice opportunities to the lab stations as needed.

## Quizzes

- Treat quizzes as formative assessments. If students don't pass, talk with them to figure out why and which learning opportunities they may work on to learn the idea better. This takes the experience beyond

“What’s my grade?” to “What were my mistakes?” This style of formative assessment has a huge impact because it is timely, meaningful, and corrective.

- Keep five or more versions of the same quiz. Keep quizzes collated and stored in a filing cabinet or box that students do not have access to. When a student asks for a quiz, give them the first version in the front of the folder. Versions number two, three, etc. follow until version one appears again. Chances are slim that any retake is one they already tried, but you can check the failed copy they return (which was used as a study aid – *see below*) to make sure that this retake is different.
- Keep quizzes brief with one or two closely related concepts. This makes it easier to tell what students don’t get as you can identify specific misconceptions.
- Use colored paper for quizzes, which makes it easy to tell who is taking them. Quizzes could be coded by topic with all versions from one unit the same color.
- Grade a quiz immediately after the student is done and they are present while you grade it. This is a key component of effective, immediate feedback while it is fresh in their mind. Consider discussing the quiz as you grade it. If you think the student is ready, they could try another version or try some other learning opportunities before retaking the quiz.
- Use short answer quizzes or two-part questions where a multiple choice question is followed with a question that asks the student to “explain why you answered as you did”.
- If a student fails a quiz, return it to them as a study aid. They **MUST** give it back in order to get a retake so you can make sure that they get a version that was not previously tried and the various versions don’t accumulate amongst the students.
- Although you could record all quiz attempts, it is easier to just record the passing grade.
- Maintaining an ongoing grid of class quiz scores gives a quick view of where each student is working.
- You may record passing quiz scores on the class grid initially and enter them into the computer later on.
- Store passed quizzes in an individual file for each student. Allow them to have it when studying for a unit test. They *must return it* before leaving the room or asking for the test.
- At the start, you may allow rapid retakes to make the point about learning and help students recognize when they are ready. Consider limiting retakes to one or two before requiring that some learning opportunity be completed.
- For lower level/age courses you may require a minimum of three learning opportunities (that the student chooses) before students may request a quiz. Depending on the group, consider relaxing this requirement as the year progresses. Upper level courses may have no minimum requirement for learning opportunities.

## Grading Miscellanea

- Grade quizzes, labs, and tests; anything that you do where the student proves that they learned something. Everything else is a *learning opportunity* (not an assignment!). Students quickly learn that if

they don't do learning opportunities, they won't pass the quiz. The name change is important since the emphasis is not "I have to do it but I don't really see why other than to get points." to "The reason I'm doing this is to learn."

- The unit grade may be any combination of quiz and test scores you deem fair.
- If this is the only unit you do as Mastery Learning, you may schedule the unit test for a particular day so everyone takes it at once. Students are expected to be ready by successfully completing all quizzes. If some students have not passed all of the quizzes, their grade is appropriately affected. If your entire class is set up for Mastery Learning, consider giving the test ONLY when a student has completed all prerequisite work.

### **Fast and Slow Learners**

- High-aptitude students should be on task and engaged appropriately throughout the class period.
- If students have worked ahead, they could be encouraged to create a personal project to work on that connects somehow to the course. Or they may choose to use the time they've earned for alternative work, such as reading or drawing. As long as they don't disrupt class and make good use of their time (no naps), there is no real problem.

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- If students move too slowly, try to understand why. Is it due to absences or a lack of effort? If so, what is the underlying cause? Can you make the content more relevant, help them over a rough spot, or reduce the difficulty of the material so they can finally understand it?
- If a student is moving slower than expected, at least they are being allowed to understand the work as they progress. Moving slowly but with appropriate effort and work ethic is totally acceptable. Students at least succeed at what they are attempting.
- If students are slow in the beginning (probably due to inadequate background knowledge), they will often begin to catch up because: 1) they see you won't give up on them, which increases their self-confidence and self-efficacy, and 2) as they gain a better understanding of the basic background knowledge they move more quickly through the application of that knowledge later in the year.

### **Some Additional Thoughts.....**

- Keep all learning opportunities and lab worksheets in a student-accessible file cabinet. There is no need to copy enough for everyone since not everyone does the same thing. Anyway, you can always make more copies.
- Keep a classroom calendar on a whiteboard with the suggested course of action for the week. This time schedule should reasonably account for completing all of the unit work. If kids are close to this schedule, they could complete the curricular expectations. If they are behind (ex.: absences), they know that it is within their control to speed up and catch up.
- Plan ahead!! Know how things will run and have the infrastructure and resources in place ahead of time.