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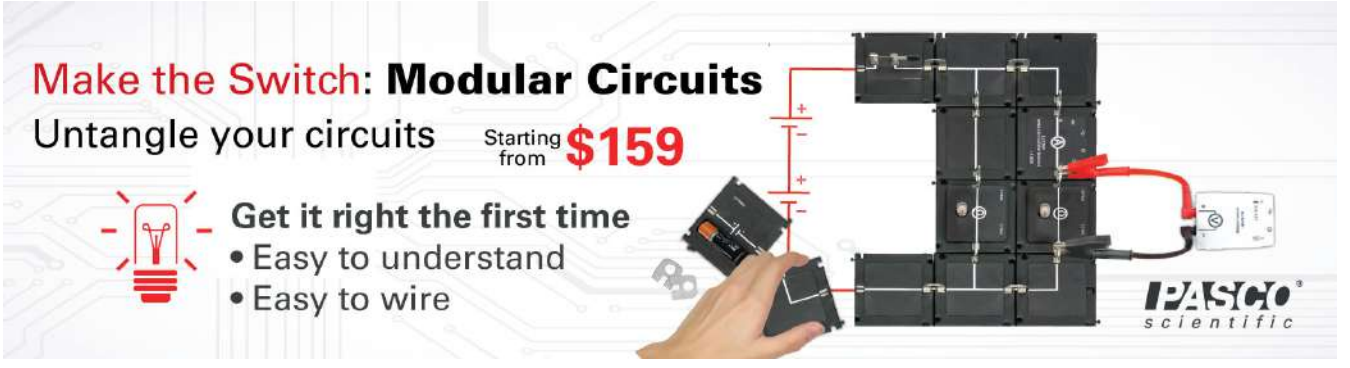

Grading for Understanding – Standards-Based Grading

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Standards-based grading (SBG), sometimes called learning objectives-based assessment (LOBA), is an assessment model that relies on students demonstrating mastery of learning objectives (sometimes referred to as standards).[1,2] The goal of this grading system is to focus students on mastering learning objectives rather than on accumulating points. I have used SBG in an introductory physics course for the past five years and worked with several physics faculty members to implement SBG in the first and second semester of algebra-based and calculus-based introductory physics courses at a primarily undergraduate comprehensive public university with class sizes of 48 students. In this article I will discuss methods for implementing SBG in a physics class.

Guiding principles

Our local implementation of SBG is referred to as LOBA in order to distinguish it from grading models based on national standards. Before diving into how to implement a new grading scheme, I will mention the guiding principles behind LOBA:

(1) Mistakes are an important part of the learning process and students should be encouraged to make mistakes and learn from those mistakes. Students should not be penalized for making mistakes, but rather rewarded for success.

(2) Students should be focused on mastering the material and not earning points.

(3) Student grades should depend only on how proficient a student is at the important skills and concepts from the class. If points are used to motivate students to show up to class and turn homework in on time, grades are no longer an accurate reflection of how well students understand the material.

(4) Students should be allowed to reassess on a particular concept or skill until they have mastered it.

What does it look like?

During one class period each week, students take an assessment for the chapter just finished. Each problem on the assessment is tied to one or more learning objectives and, when grading the problems, I give the students a mark of "Advanced," "Proficient," "Developing," or "Beginning" for each learning objective associated with a particular problem. Students have to earn an "Advanced" or "Proficient" rating on two different assessments to have completed a learning objective. A second assessment is typically given during the discussion section the following week. Once students have received their graded assessments, they can sign up to reassess on a particular chapter outside of class. Each time a student reassesses, they get a different set of problems. Students are free to continue reassessing on each chapter as many times as they need in order to demonstrate their proficiency on most of the learning objectives. Their final course grade is determined by the number of learning objectives they have completed by the end of the semester.

Steps to implementing LOBA

The most daunting aspect of starting LOBA is knowing where to start. I relied on excellent blog postings by other people that have implemented a standards-based grading system as a guide.[3-6] Based on my experience helping other faculty start using LOBA, I have compiled a list of useful tips for instructors wishing to jump into LOBA.

• *Step 1: Write learning objectives*

The best way to write learning objectives is to start thinking about them the semester before you implement LOBA. As you grade homework and exams, keep a list of all the things you feel students should be doing to demonstrate an understanding of the course material. For example, I had trouble with students assuming that the normal force on an object was equal to the mass times g, so I added the learning objective "I can show that the normal force is not always equal to mg." I ran into students confusing vector and scalar quantities, so I had a learning objective that stated "I can distinguish a vector from a scalar by drawing an arrow over vector variables." By the end of the semester you should have a list of skills and concepts that students need to know. You can pare these down to a manageable number of learning objectives.

The total number of learning objectives for your course depends on the amount of assessment time available to your students. A good rule of thumb for the number of learning objectives (LO) is

$$\text{Number of LO} = \frac{(\text{assessments per week})(\text{weeks per semester})(\text{LO per assessment})}{(\text{Number of proficient marks to complete LO})}. \quad (1)$$

In my introductory physics course, with one assessment per week, 15 weeks in the semester, 12 learning objectives per assessment, and two proficiencies required to complete a learning objective, I should have fewer than 90 learning objectives per semester. If learning objectives are fine grained enough that a single problem has multiple learning objectives, then it is reasonable to expect students to complete a larger number of learning objectives. If your learning objectives are much broader and focus on larger concepts rather than distinct skills, you will need far fewer learning objectives.

You will also want to divide up your learning objectives into a hierarchy of importance, so that basic skills are given more weight than the more advanced skills. A question I ask myself is, what things would I want a student who got a C in the course to know? These learning objectives make up my C-level learning objectives. The more advanced skills and concepts are classified as A-level learning objectives.

Make sure that you write the learning objectives from the student perspective using active language such as "I can show that…." Avoid vague phrases like "I understand…" or "I can appreciate…." The goal is to give the students something concrete so that when you hand back a graded assessment, the students have no difficulty seeing whether they demonstrated proficiency or not. A typical C-level learning objective would be "I can relate all of the forces experienced by an object to the net force exerted on the object" or "I can calculate the work done by a constant force." An example of an A-level learning objective is "I can calculate the work done by a non-constant force using integration." With explicit learning objectives you can also make use of backward design in determining how to teach your course.

• *Step 2: Determine how to assign grades*

I found this to be the hardest part of starting up. One issue is how to weigh A-level and C-level learning objectives in determining letter grades. Since I view C-level learning objectives as more important, I ended up using a grading scheme that gave greater weight to those objectives.

If you don't distinguish between different levels of learning objectives, the simplest way to determine letter grades is to associate the percentage of completed objectives with a letter grade, similar to the way letter grades are assigned based on total points. For instance, a student who completes 90% of the learning objectives would earn an A. This may be the easiest scheme for students to understand.

Another possible method is to assign a base letter grade determined by the fraction of total C-level learning objectives completed (see Table I) to determine a base grade number. The fraction of completed A-level learning objectives applies a shift to the base grade, resulting in a final grade number that yields a final letter grade. The scale is nonlinear to give greater weight to the C-level learning objectives.

• *Step 3: Keep track of learning objectives*

Keeping track of this information can be challenging. I use Excel to count up the number of proficient C-level and A-level learning objectives and convert the total number of completed learning objectives into a letter grade. Blogs on LOBA or SBG are great resources to see how other people keep track of these things.[8]

Make sure you give the students a way of tracking their learning objectives themselves. A checklist or spreadsheet will ease student anxiety and give them a way to double-check your tally of learning objectives. Students appreciate it if you provide a spreadsheet to calculate the grade for the student.

Table I. Chart for determining final letter grades.

Base letter grade	C-level learning objectives completed	Base grade number
C	80% or less	12
C-	70% or less	8
D	60% or less	3
F	Less than 50%	0

A-level learning objectives completed	Grade number shift
80% or less	+6
70% or less	+5
60% or less	+4
50% or less	+3
40% or less	+2
20% or less	+1

Final letter grade	Final grade number
A	18
A-	17
B+	16
B	15
B-	14
C+	13
C	12
C-	8-11
D	3-7
F	0-2

• *Step 4: Determine the format of assessments*

Assessing each learning objective can take many forms, but the most common method is a traditional quiz. Each question corresponds to at least one learning objective and usually several learning objectives. The questions on each assessment and reassessment are different, which does lead to needing several versions of assessments. Although some instructors do personalize reassessments based on what learning objectives each student needs, I found it is less time consuming to group each chapter of learning objectives into a single assessment. Other assessment opportunities include oral presentations,[9] lab reports, written papers, projects, or even on-the-spot answers to challenging questions.

The first time you teach a course, focus on having two or three versions of each assessment ready. While you may be concerned that reusing assessments may lead to student cheating, it is my belief that if students want to sit down and memorize several versions of an assessment, they will have learned the material fairly well despite themselves. Research has shown that more frequent assessing can result in increased performance on standard numerical problems and reduced cheating.[10]

Here is an example of an assessment question used to evaluate multiple learning objectives:

A small book sits at rest on a ramp that slopes down and to the left. On top of the small book is a large book, also at rest.

a) Draw a free-body diagram for both books and indicate all third-law pairs.
b) Compare the magnitude of the normal force on the large book by the small book to the magnitude of the gravitational force on the large book by Earth. Specify which, if either, is larger.
c) Compare the magnitude of the friction force on the large book by the small book to the magnitude of the friction force on the small book by the large book. Specify which, if either, is larger.

The learning objectives for this question are listed, along with the criteria for a student to obtain a proficient score for each question.

1. I can draw a free-body diagram with all forces labeled with a variable that indicates the type of force, the target of the force, and the agent of the force.
   a. Proficient if all forces shown and almost all forces are correctly labeled.
2. I can identify third-law pairs on a free-body diagram.
   a. Proficient if all third-law pairs are identified and correctly matched up.
3. I can show that the normal force is not always equal to *mg*.
   a. Proficient if student explains the normal force on the large book by the small book is smaller than the gravitational force on the large book by the Earth.
4. I can use Newton's third law to determine that the magnitudes of third-law pairs are equal and opposite.
   a. Proficient if student explains the two friction forces have the same magnitude.
5. I can distinguish a vector variable from a scalar by drawing arrows over vector variables.
   a. Proficient if almost all force variables on the free-body diagram have arrows over them.

Advanced scores are given for these learning objectives if students provide a more detailed answer supporting their reasoning. A developing score is given to students whose answer falls short of the proficient mark but shows they have some idea of what the question is asking. For instance, if they identify at least one correct set of third-law pairs but include incorrect pairings, they would earn a developing score. Beginning scores are for students who attempt the question but don't have a clear idea of what they are doing.

• Step 5: Determine logistics of reassessment

One of the biggest concerns new instructors have is how they will manage all of the reassessments. I started off by only offering reassessments during my office hours. When other instructors started using LOBA, we would offer reassessment opportunities for each other. Eventually enough instructors were using LOBA that the department hired student proctors to administer reassessments for 10-15 hours each week.

I recommend placing limits on the number of chapters they can reassess in any given day and the times they can reassess. I limit students to one chapter reassessment per day and request 24 hour notice to give me time to prepare the reassessment. Other instructors only allow reassessment for a certain number of weeks after the initial assessment or limit students to only two or three attempts per chapter. It is also helpful to require students to prove they have spent time preparing for reassessment. In my case, I require that they turn in corrections for the previous assessment as well as show they have completed a number of online homework problems. Placing limitations on reassessing is crucial to maintaining a manageable workload for the instructor.

• Step 6: Take a deep breath and jump

Making a major change in your grading system can be very daunting, especially since you have spent your entire academic career thriving in a points-based world. One key is to make the leap and have faith that you have enough experience as an instructor to make things work.

While it is possible to try LOBA out on a small scale, perhaps with a single unit, in my experience it is not as successful because students don't have enough time to understand the grading system or adapt their studying to the grading system.

• Step 7: Explain things to students early and often

This will be an unsettling experience for students at the start because they have developed a skill set for succeeding in a points-based course. You will need to explain why you are doing this and what they need to do to be successful in your course. You will need to explain things frequently at the start of the course. You will also want to reassure students about their grades because they tend to be very nervous if they don't understand how their final grade will be calculated.

Class size limitations of LOBA

The primary consideration of implementing LOBA is the time constraints, both on the instructor and the student. The implementation of LOBA I've laid out does not scale well with larger class sizes, resulting in a significant increase in grading workload. The largest class size using LOBA was over 80 students, which proved to be burdensome. To scale up to larger sizes, reassessment opportunities would need to be limited, the number of learning objectives made smaller, or more proctors and graders would be needed. My colleagues and I currently run classes of 48 students with few problems.

Conclusion

As instructors we try to encourage our students to take risks when it comes to solving problems, but often they will not even attempt a solution unless they have a clear idea on how to find the right answer. But while we are encouraging students to learn from their mistakes, we frequently take points away when they get homework questions wrong. The alternative is to give points for attempting the problems, but this leads students to believe that mastering the material isn't important and that a little effort is all that is needed to do well in the course. Under LOBA, students do not receive credit for homework and they aren't penalized for getting questions wrong on assessments. The only reward for students is when they answer assessment questions correctly they get proficiency at related learning objectives. Since students are allowed to reassess on each learning objective as many times as they need, students now have an incentive to learn from their mistakes on previous assessments. Although it can be unsettling making such major changes to a course, I hope this paper gives you the tools to give it a try.

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