Are You Failing Your Students Without Realizing It?

Are you grading your math tests and assignments exclusively by hand? If so, your students may be missing out!

This wasn't always the case. Until recently, automated grading systems have been very limited in the questions they could ask, which made them of dubious value in STEM courses (science, technology, mathematics, and engineering). A multiple choice question just couldn’t tell you if the student understood how to solve the problem. Maybe they did. Or maybe they understood how to apply a test to each choice in order to identify the correct answer. Maybe they knew enough to eliminate some obviously incorrect responses to improve their odds of guessing correctly. Or maybe they were just lucky. And that’s assuming the system could handle the mathematical notation and the plots needed to ask that multiple choice question properly in the first place. These systems simply could not provide you with a reliable view into your students’ comprehension, and as a result, it was a bad idea to rely on them. And so STEM instructors avoided these systems, or if forced to use them, grumbled and did their best to keep the grading system’s limitations from hurting their students.

But today’s grading technology has advanced to the point where you are arguably doing your students a disservice if you don’t include a good automated testing and assessment tool in your grading mix. In this article, we’ll examine some of those arguments, consider what characteristics would go into an effective assessment tool for STEM, and then take a brief look at how one such tool, Maple T.A.’™, from Maplesoft™, meets those requirements.

Why Use Automated Assessment?

If you have access to an effective automated assessment system as part of your grading mix, and aren’t using it, here are some questions to ask yourself.

If grading time was not a factor, would you give your students more assignments?

You know that students learn best by doing, and that one of the most effective ways to get them to “do” is to give them assignments that will count towards their final grade. This motivates them to do the work and gives them (and you) feedback on their understanding throughout the course. But you can only give as many assignments as you can handle, as there are only so many hours in a day, and teaching assistant hours are limited. Automated systems let you give more assignments to help your students stay on track.
If the time and effort involved were not factors, would you provide your students with more practice questions? Without an automated system, good practice questions are hard to come by. Even if students find appropriate questions to try, they often don’t know if they are answering them correctly or continuing to reinforce bad habits. But automated systems can generate virtually unlimited practice questions, and give the students instant feedback. Students find out what they know, and what they need to work on, easily. They can try as many questions as they want or need until they have mastered the techniques and are confident in their abilities. **Automated systems can provide your students with virtually unlimited opportunities to practice and develop their skills, and increase their confidence.**

Have time constraints or problems with teaching assistants ever meant that assignments were returned after the students could have used the feedback they provided?
When you have to rely on busy human graders with many demands on their time, feedback may come days, or even weeks, after the students hand in the assignment. In the meantime, the course marches on, and the course material builds on the foundation of the previous units. If you could provide students with feedback instantly, while the assignment was still fresh in their minds, it would let them know more precisely what they did and did not understand in this unit, so they could take corrective action before the problem gets even worse in the next. And if a large number of students experienced problems with the same topic, you could address the issue in class the very next day. **With automated systems, assignment feedback is available instantly, when it can do the most good.**

Do you ever wish you could give different versions of an assignment to force students to do their own work?
When you are using paper assignments, it usually takes far too much effort to create and manage more than one version of the assignment. So students, being somewhat short-term-goal-oriented, sometimes copy answers. On the other hand, if you could give every student a different assignment, students might collaborate productively to help each other learn how to solve the problems, and then they would complete their assignments independently. **With automated systems, students share methods, not answers, so assignments help more students learn the material.**
If you weren’t spending hours and hours grading, what could you do with that time instead?

Manual grading, whether you are doing it yourself or managing your teaching assistants, simply takes up a lot of time. If you could get some of those hours back, you could use that time for other tasks that help your students, such as offering more office hours for individual assistance, course planning, developing enrichment or remedial materials, or providing more drop-in tutorial sessions. With automated systems, you spend less time grading, so you can spend more time helping your students in other ways.

What Would Make a Good Automated Assessment Tool for STEM?

It's clear that there could be a lot of benefits to automated testing if the system was reliable, flexible, and comprehensive enough. But if the system won’t let you ask good questions and cover the topics you need, then the results won’t actually assess student understanding accurately enough to achieve the benefits. So what would a good system need to do? Here are some requirements of a good automated system for STEM assessment:

1. **Free response.** It must support “free response” math questions. That is, there must be a free-form response area, similar to a blank space on the page. That way, students actually have to solve the problem, with no hints as to what the answer might look like.

2. **Mathematical equivalence.** Once you have free-response, one of the biggest stumbling blocks comes from the issue of “mathematical equivalence”. There is usually more than one way to write down the same expression, and much of the time, you would consider all variations to be correct. For example, \( x + \frac{y}{2} = \frac{(2x + y)}{2} \). and there are also more complicated equivalences, such as \(-\frac{1}{2} + \frac{1}{3} \sin^2(x) = -\frac{\cos(x)^2}{3} - \frac{1}{6}\), that must be taken into account. Our ideal system would need to be able to recognize equivalent mathematical expressions, just like a human grader would.

3. **Multiple correct answers.** Sometimes the issue is not that there are different forms of the correct answer. The issue is that there is more than one correct answer. In fact, there may be infinitely many correct answers. Think about questions that start with “Give an example of...” A human grader would know how to apply tests to check that the response is correct, and an ideal system needs to be able to do that, too.

4. **Algorithmic questions.** An ideal system should be really good at generating algorithmic questions. It should not limit itself to “fill-in-the-random-integer” templates, but allow you to ask for things like matrices with certain properties, prime numbers, or polynomials with specific degrees. It should also allow you to specify relationships between the variables, such as “pick \(a\) and \(b\) such that \(a < 0, b > 0, \) and \(|a \cdot b| < 20\).

5. **Plotting.** Because visualization is an important part of many STEM courses, you need to be able to include plots in your questions, from simple 2-D curves to 3-D surfaces, polar plots, statistical plots, contour plots, animations, and many more. You should be able to generate plots algorithmically, so that when you are using templates to generate questions, each question also includes a plot generated specifically to go with that version of the question. And if you are authoring the question yourself, you should not have to create the plots in a separate tool and then bring them in to your grading system; everything you need should be part of the grading system itself.

6. **Lots of question types.** Free response questions are extremely useful, but they aren’t enough. Our ideal system should also provide other STEM-focused question types, like graph sketching, questions that can handle units and margins of errors, and free-body diagrams. Of course, it should also include multiple choice, fill-in-the-blank questions, and other non-STEM specific question types, too.

That’s a good start. But does a system like this exist?

The short answer is “yes".
Maple T.A.

Maple T.A., the powerful online testing and assessment system from Maplesoft, is designed especially for courses involving mathematics. Maple T.A. is built on the Maple math engine, which gives it a lot of mathematical power to draw on. That’s why it can meet all the requirements identified in the previous section: support free-response math questions, handle mathematical equivalence, deal with open-ended questions with infinitely many correct answers, provide math-aware algorithms for generating questions, offer a rich set of customizable visualizations, and offer a large number of question types for both technical and non-technical content.

In addition, here are just a few more things it can do:

7. **Technology integration.** If your school is using a learning management system, you can integrate Maple T.A. into your existing system so you can provide a seamless experience for your students. Maple T.A. can be integrated with Blackboard®, Canvas, Moodle™, Brightspace™, and much more.

8. **Mobile-accessible.** Students can access Maple T.A. from any web-enabled device.

9. **Adaptive testing.** Maple T.A. supports both adaptive questions and adaptive assignments.

10. **Control over content.** Maple T.A. puts you in control of your testing content. You can choose from the tens of thousands of freely available questions. You can easily modify these questions to better suit your specific needs. And you can create your own questions. Maple T.A. provides the most comprehensive, easiest-to-use authoring tools available for STEM-based content.

The goal of this article is not to provide a comprehensive product overview; for more information about Maple T.A., visit [www.maplesoft.com/mapleta](http://www.maplesoft.com/mapleta).

Conclusion

Integrating automated grading into your courses has the potential to provide your students with advantages that can be very difficult to achieve when using manual grading exclusively, such as increased practice opportunities, very timely feedback, increased confidence, and extremely rapid identification of problem areas. Until recently, the benefits of automated grading have been largely unobtainable for instructors and students in STEM courses, because the automated systems simply couldn’t meet the requirements of a good STEM assessment tool. However, the technology has advanced, and today Maple T.A. can meet these requirements, putting effective automated assessment within reach for STEM courses. As a result, it’s time to ask yourself the question: Have you been failing your students without realizing it?