Research team applies mathematical modeling and algorithms to learning process

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(PhysOrg.com) -- Most people inherently understand that they have a unique way of studying material for a test that suits their unique personality. Unfortunately, such differences between people tend to create problems for educators when trying to teach students how to study. Now, a team of applied mathematicians from Cornel have developed a model that they believe can be used by virtually any student to maximize the benefit they receive from studying. The model they've built, as the team describes in their paper published in the *Proceedings of the National Academy of Sciences*, is based on mathematical algorithms and information provided by the student.

The researchers started with the well worn proposition that in order for people to learn new material they need to have it presented to them more than once. Combined with that is the realization that the optimal time span between presentations of the same material is different for different people. There are also, of course, differences between individuals in the number of times material needs to be presented before it is sufficiently retained.

Then because each of these learning constraints can be theoretically measured, it should be possible to build a simple model describing how many times new material should be presented to a student and when, based on numbers obtained by the individual student. That's just what the team has done, but they've taken the whole thing a step further, because facts and concepts don't come one by one. During the learning process, students are bombarded with many different ideas and facts,

some of which aren't even related. Nonetheless, they are expected to make sense of it all and then in the end prove their understanding when taking a test.

This is where new models comes in. They use statistical analysis and mathematical algorithms to take into account all the various scenarios that are likely involved in the studying process and then provide best guesses for the student regarding how they should go about their study habits.

The team believes the models they've built will work for most students, though there will be exceptions of course. Some learn slower than average, some faster, and there are of course sometimes greater than average differences in intelligence which can obviously impact the learning process. Also there is the problem of differentiating between learning goals, such as studying to pass a test and learning as a means of supporting a lifelong career.

The results of the research done by the team is not purely academic, one of its members, Tim Novikoff owns a company that makes a computerized educational application that might just benefit from the models developed by the team.

More information: Education of a model student, *PNAS*, Published online before print January 23, 2012, doi: 10.1073/pnas.1109863109

Abstract
A dilemma faced by teachers, and increasingly by designers of educational software, is the trade-off between teaching new material and reviewing what has already been taught. Complicating matters, review is useful only if it is neither too soon nor too late. Moreover, different students need to review at different rates. We present a mathematical model that captures these issues in idealized form. The student's needs

are modeled as constraints on the schedule according to which educational material and review are spaced over time. Our results include algorithms to construct schedules that adhere to various spacing constraints, and bounds on the rate at which new material can be introduced under these schedules.