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I realize it may sound a bit audacious to claim that there's one key to all student success, but here it is:

Learning requires effort and study.

Having made this statement to many faculty audiences, I know that most of you are thinking, "Well, that's kind of obvious." After all, we all know that we have to work to learn anything, and learning complex ideas can require huge amounts of concentrated study time. I also know that a few of you may be preparing to argue the semantics, so I'll note that I'm using the term *study* in its broadest sense, which *Webster's Unabridged Dictionary* defines to be "application of the mind to the acquisition of knowledge." In that sense, "study" can apply to many different specific tasks, from intently listening to a teacher or reading a book to actively engaging in hands-on or group activities; it can even apply to a toddler learning to walk, since the mind must be applied to develop the necessary skills of coordination. So if we want students to succeed in our classes, we need to make sure they devote effort and study to the material we hope to teach them.

NOTE: WHAT COUNTS AS "STUDY" Be sure to pay attention to the first part of the definition of *study*: "application of the mind." It's quite possible to read a book or listen to a lecture without actually thinking about the material, in which case it's not truly study, but just an example of the old saying "in one ear and out the other." That is a major reason why science educators emphasize the importance of active engagement, such as hands-on activities. But even these are not foolproof, because it's also possible to be "in one hand and out the other" if the hands-on part can be done by rote or is formulaic, or if some members of a group can let others do the thinking for them. Time spent counts as "study time" only if students are really paying attention and reflecting on what they are doing.

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The State of U.S. Education: As obvious as it ought to be, the importance of studying is too often forgotten. Indeed, as explained below, it is being forgotten throughout the U.S. education system today, to the great detriment of our students and society.

▸ **K–12 Education**: One of the great laments about U.S. education today is the way our students tend to underperform relative to their peers in other developed nations. While there are undoubtedly many reasons for this underperformance, I believe that one clear contributor is the well-documented fact that our students spend less time in school and less time studying outside of school. By the time they graduate high school, kids in many European and Asian nations have had the equivalent of one to two additional years of study time compared to American kids. Of course, simply adding more school time and more homework will not be a panacea, and if overdone it can even backfire. For example, I've had teachers from China tell me that their students are overworked to the point of stifling their creativity, and that they feel their kids would benefit from more free time to just "be kids." Nevertheless, given that study is the most important key to student success, we can't expect our students to do better unless we enable them to devote enough time to study. So while we must be careful not to overdo it — and as teachers we must work hard to make sure that any extra class time or study time will be time well spent (as opposed to "busy work") — a key factor in improving K–12 education will be more study time, whether that time comes in school, at home, in enrichment programs, or elsewhere.

NOTE: STUDY EXPECTATIONS VARY GREATLY AMONG SCHOOLS Please note that I'm talking about averages here, and you can certainly find cases in which schools or school districts appear to have gone overboard in the amount of work they expect from students, or in which much of the work is more tedious than useful. Nevertheless, on a national average basis, our problem is *too little* time for studying, not too much.

NOTE: OPTIONS FOR INCREASING STUDY TIME There are two general ways to increase study time: We can have our kids spend more time in school or we can have them do more work outside of school (or some combination of both). In principle, either option would be fine, but here's a practical reality: Today, kids from well-off families with well-educated parents almost universally get substantial academic

help outside of school. At a minimum, they get help from their parents, and many get a variety of enrichment programs, great family trips, and other educationally beneficial experiences. In contrast, kids from poorer or less-educated families generally lack these opportunities; for example, research shows that for lower-income students, summer vacation is largely a time in which they forget what they've learned and fall even farther behind their peers. (For a great summary of the research on summer learning loss, see McCombs, J., et al., "Making Summer Count," RAND Education, 2011.)

Because of this reality, I believe the only equitable approach to education is to offer dramatically more school time — both more days per year and more hours per day. I realize that many well-off parents will object; perhaps there's a way to please everyone, such as by offering longer days and summer school as options rather than requirements. But one way or another, we must make sure that *all* kids have the time they need to study.

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▶ **College Education**: I don't think there can be any more severe indictment of the state of college education today than is found in these recently reported statistics (Babcock, P., and Marks, M., "Leisure College, USA: The Decline in Student Study Time," *American Enterprise Institute Education Outlook*, no. 7, Aug. 2010):

- In the 1960s, full-time students spent an average of approximately 24 hours per week studying outside class.
- Today, full-time students spend an average of only about 14 hours per week studying outside class.

Unless students of today are somehow studying much more efficiently than students of the past—and given the distractions that students now face from their electronic devices, it's far more likely that the opposite is true—then this dramatic reduction in study time can only mean that college students today are learning much less than their counterparts of the past. In other words, by allowing this decline in study time, colleges are delivering less value to both students and society. If we do not find a way to reverse this trend, then college will increasingly become a waste of time and money for everyone involved.

NOTE: VALIDITY OF THE DECLINE CLAIM In case you are wondering whether these data might simply reflect the fact that more students today are juggling families and jobs along with school, I'll quote from

the first page of the study by Babcock and Marks: "[T]he decline is not explained by changes over time in student work status, parental education, major choice, or the type of institution students attended." In other words, the authors claim that the comparison is between otherwise equivalent *full-time* students across the decades. The juggling acts of today's students may contribute to the pressures that have led to the decline in study time, but the conclusion that full-time students of today are studying less and therefore learning less than full-time students of the past still holds.

NOTE: THERE IS LESS DECLINE IN SCIENCE The news is not quite so bad for teachers of science: More detailed statistics (see Arum, R., and Roksa, J., *Academically Adrift*, University of Chicago Press, 2011) show that study time has declined less in science and other STEM (science, technology, engineering and mathematics) fields than in most other disciplines. Nevertheless, there is room for improvement, especially in classes at the introductory level. Although I have not found detailed data on this point, I believe that students *majoring* in science/STEM fields are generally studying as much or nearly as much as their peers did in the past; after all, the prerequisites for advanced science and engineering classes have not changed, and unless you understand the prerequisites you will not get far in subsequent classes. I therefore suspect that the decline in study time for science is coming from introductory-level classes, particularly those for nonscience majors, because these are the classes in which there is less pressure to ensure that students are prepared for higher-level coursework.

Indeed, the same idea likely explains the general college trend: Students majoring in STEM fields generally follow a course sequence in which each course builds upon previous courses; therefore, if a teacher of any one course fails to prepare students adequately, teachers in subsequent courses will quickly notice the deficiencies. In contrast, most non-STEM fields involve a series of courses that tend to be more individually distinct (that is, they don't rely so much on prerequisite knowledge), which means there is less pressure on teachers to ensure that their students learn a particular amount of material.

NOTE: REVERSING THE DECLINE TREND It's worth noting that while you as an individual teacher can help improve the situation in your own classes, the more general problem requires institutional reform. I

suspect that anyone teaching at the college level can list numerous examples of pressure from students, parents, and the institutional reward system, which all conspire to push college faculty toward lowering expectations. After all, as my colleague Nick Schneider says, "College is the only business in which customers (students) often demand *less* for their money." If you really want to make an impact in improving college education, join with other faculty in finding ways to change the dynamics of these pressures. I won't pretend to have answers as to how best to accomplish this change, but clearly it must involve ensuring that the system rewards teachers who set the highest expectations and achieve the greatest student learning, which in most cases is very different from the way the reward system works today.

Multitasking: The many distractions that today's students face with their electronic devices brings up the more general issue of multitasking. In decades past, it was common to see students filling every available desk in a school's library, engaged in deep, concentrated study. Today, it is far more common for students to study while playing music, exchanging texts with friends, or watching YouTube videos. Like much of the general public — including many scientists and science teachers — these students believe that they are able to multitask successfully. In many cases, they even believe that the multitasking enables them to study more efficiently. Unfortunately, research shows that they are mistaken.

Numerous studies (for example, Ophir, E., Nass, C., and Wagner, A., "Cognitive control in media multitaskers," *Proceedings of the National Academy of Sciences*, 106, no. 37, Sept. 15, 2009) show not only that multitaskers perform more poorly than those who focus their attention on one task at a time, but also that those who believe they are best at multitasking actually tend to be the worst! The research is so clear that we should provide students with a new definition of multitasking:

Multitasking: **Doing several things at once, all of them poorly**

It won't be easy to convince all your students, but there's little doubt that we all do better when we focus on the task at hand without distractions.

The difficulty with multitasking means that in addition to spending less time studying than they should, students are probably absorbing even less than their study time might otherwise suggest. If we hope to improve education, we need to make sure not only that our students put in more study time but that they drop the multitasking in favor of concentrated effort.

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NOTE: TECHNOLOGY *CAN* BE BENEFICIAL While multitasking usually revolves around technology (cell phones, computers, etc.), the technology itself is not the problem. There are plenty of ways in which we can put technology to use in improving education, but they will be successful only if we also ensure that students still make a concentrated effort to study when using these technologies.

NOTE: DISTRACTED DRIVERS It's worth noting that the same issues that make multitasking inefficient for study make it downright dangerous for driving. I won't go into detail here, but research shows that if you talk on a cell phone, text, program your GPS, or have any other similar distractions while driving, you may be as dangerous as a drunk driver — and this is true even if you use your devices "hands free." Tell your students about this; you may save someone's life.

Consequences to Education — The Pressure to "Dumb Down": As previously noted, the fact that students are studying less automatically means that they are learning less, which in turn means that students will be unable to meet the same expectations that we had in the past. As a result, teachers and schools at all levels are forced to make a difficult choice: We either accept that students will do more poorly in our classes than students of the past, or we "dumb down" our expectations so that students can still meet them with their reduced study time. Because students, parents, and administrators all get very upset if we give lower grades, the institutional pressure ends up being to dumb down.

The pressure to lower expectations is so constant that it's easy to lose sight of it, but it has tended to create a vicious cycle of ever-lower workloads. For example, the fact that students are studying less tends to make us assign less to them. This, in turn, means that we cannot cover as much material in our courses, leading us to reduce both breadth and depth. The fact that our courses become less comprehensive means that teachers put pressure on administrators to lower their standards for students and on publishers to reduce the content in textbooks. Then, just when we might think students would be able to meet these newly lowered standards of success, the natural human inclination to try to work a little less takes us back to the beginning of the cycle, and the expectations fall further. The only way to break the cycle is to restore standards and restore expectations for study.

NOTE: THE COMMON CORE STANDARDS At the K–12 level, the most important effort to restore standards in at least the past half-century has been

the development of the Common Core State Standards for mathematics and language arts, released in 2010, and the Next Generation Science Standards, released in 2013. The Common Core represents a bold effort to reverse the dumbing down of education and to raise the standards for learning. (For those who may not be familiar with its history, the Common Core effort was started by the National Governors Association in 2008, making it a bipartisan effort at curriculum reform driven from the state level.)

Unfortunately, the Common Core effort is now under attack, and several of the states that initially had committed to the Common Core have already removed themselves from the new standards. Part of the reason is political, as some groups see the Common Core effort as running contrary to the traditional "local control" of schools in the U.S. But another part simply has to do with pushback against higher expectations, as many parents and some teachers claim that the new standards are too much to ask of our students. For the sake of future generations, I encourage all of us to push for the acceptance of the Common Core, and then to work to meet its high expectations.

NOTE: DIGITAL TEXTBOOKS As a textbook author, I can't resist a note about the increasing use of digital resources in teaching, especially the move toward "digital textbooks." These digital resources can in principle offer great benefit to learning by, for example, providing video or animation to help explain complex concepts or by asking questions to check student understanding of key concepts before moving on to more advanced concepts. However, this promise can be realized only if two key principles are kept in mind:

1. Unless we want to encourage illiteracy in the next generation, digital resources such as video and interaction must be used as *enhancements* to reading, not as replacements for reading.

2. It is not yet clear that students can learn as effectively from e-books as from print books, and part of the reason is that e-books almost always mean attempting to study at the same time that you're getting texts, e-mails, Instagrams, etc.

So while we should certainly take advantage of the enhancements that digital resources can offer, I believe we should tread carefully in making a complete transition away from print books unless and until research demonstrates that students learn just as effectively from e-books. (For

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the programmers out there: How about creating an app that turns off all digital distractions except for access to the online resources being used for learning? I'd love to see a study that contrasts success at digital learning for students who use this app and those who don't.)

Consequences for Society: The immediate societal consequences of having students who don't study as much and learn as much are probably obvious: These students will be less able to compete in the global marketplace for jobs, which will hurt their own personal prospects while leaving the nation in a less competitive position. But I believe there is another major consequence that may be even more detrimental: Because so many of our citizens are able to get through school and get decent or good grades with so little work, they grow up to be adults who expect everything to come easily — which means they are not prepared to deal with the complexities of modern issues. Consider the national debt, tax policies, energy choices, global warming, or most any other major issue; all of these play a huge role in the way citizens vote today, yet they cannot be understood and thoughtfully addressed unless citizens put some reasonable amount of effort into studying them. When we have a population that expects things to come too easily, people end up making decisions based on sound bites or emotions, because they don't know how to put in the effort required to make decisions based on evidence and understanding.

Changing the National Conversation: In science, we know that it is easy to become overwhelmed if we focus solely on the vast body of facts and data that have been accumulated over time; that is why we instead focus on building an understanding of the underlying simplicity of nature, as expressed in comprehensive theories such as the theory of gravity, of the atom, or of evolution. I believe we should apply the same principle to education. For too long, we have allowed the national conversation about education to be fragmented into a series of small issues and Band-Aid reforms. This type of fragmented approach probably explains why educational improvement has been so difficult to achieve. After all, annual education spending exceeds $1 trillion per year in the United States alone, which means that even small changes are likely to harm someone's short-term financial interests and therefore to generate significant resistance. But there is an underlying simplicity to the idea that learning requires effort and study, and it provides a benchmark against which to judge any other proposed reforms:

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If a reform promotes more (and/or more efficient) study time, then it is likely to be successful; if it doesn't, then it is likely to fail.

If this book accomplishes just one thing, I hope it will be to shift the national conversation about education to one that focuses primarily on the importance of study and hard work to success.

NOTE: AN EQUATION FOR SUCCESS I'll end this section with a wonderful "equation for success" that came from a remarkable source: Ugandan high school student Daniel Omoko, whom I was introduced to through the Educate! foundation (experienceeducate.org), which works with youth and education programs in Africa:

Hard work + Determination − Laziness = Success

— Daniel Omoko, Uganda

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