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For Applied Learning to Work, a National Effort Is Required

By **Marc Tucker** on July 13, 2017 2:44 PM

"Why do I need to study Algebra I?"

"Because you will need it to study Algebra II."

"Why do I need to study Algebra II?"

"Because you will need it to study precalculus."

"And why do I need to study precalculus?"

"Because you will need it to study calculus."

"But I have no interest in doing anything with my life that would require a knowledge of calculus."

"Yes, I know, but if you do not study Algebra II, you will not be able to get into college, and if you study calculus, it will greatly improve your chances of getting into a good college."

"Oh. OK."

If you are the child of professionals in our society, parents who went to good colleges, got professional degrees and live the good life now, this conversation will make sense to you. You are willing to go through years of deferred gratification, doing what you are told is needed to enable you to live the same life your parents live, because you have good reason to believe that, if you do as you are told, if you take first this course and then that one, if you study quadratic equations you will never use again, you will attain the promised land. You know it is real, because you can see the anxiety in your parents' faces if you fail to take the right course or fail to get the grades they think you need to get, and you know you can do it because your teachers and your parents know you can do it.

Your education is structured this way because there is so much to learn to become a professional in virtually any field. What has to be learned is arranged in a very complex structure of knowledge that has been elaborated on over centuries. Somehow you must absorb and store in your memory and learn how to put to use in a few years what it took thousands, even millions, of people to learn over centuries or even millennia. And that knowledge is structured in layers. You have to learn this before you can learn that. To make all this possible, all that rich knowledge has been compressed into a numbing succession of abstractions, formulae, rules, conceptual schemes and procedures that capture the essence of what had been learned through all those centuries but, at the same time, drain it of the meaning that would give it life in our everyday world.

This is, I submit, a very unnatural way to learn anything. Humans are naturally curious for a reason. They want to understand how the world works. If they know how the world works, if they know how this is connected to that, they are more likely to survive in the primitive world and more likely to prosper in a more developed world. Knowing how this is connected to that, why this happens and that does not, is what has enabled humans to gain ascendancy over all the other animals and the environment as well.

But we are built for putting our knowledge to work, not for putting it into cold storage for later use. Our brains contain the capacity to make literally billions of connections and it is those connections that enable us to think and do. Synapses connect neurons together to make these connections. Patterns of connections that are made repeatedly and often are strengthened; those that are not used wither. When we practice a bowing technique on the violin or use quadratic equations to accomplish something that is important to us, those connections are strengthened and we get better and better at it. But stop practicing the bowing or use of quadratic equations and the knowledge recedes. This makes perfect sense of course, from the standpoint of evolution. The brain's capacity is enormous, but it is not unlimited. Why use up that capacity for the storage of knowledge you will not use? Better to have a use-it-or-lose-it policy that reserves our brain capacity for things that we really need. The brain is in this sense plastic, constantly growing its capacity to store and use knowledge we actually need and use, constantly shrinking its capacity to deal with knowledge we don't use.

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Because a great deal of our brain's capacity is devoted to things like motor operations and visual image processing, only a relatively small part is available for what we call thinking, so how that part of our brain's capacity is used is very important. A lot depends on making the most efficient use of that capacity. The process of evolution has been hard at work for a very long time on increasing that efficiency. The result is a brain that puts a very high priority not just on acquiring new knowledge, but on using that knowledge, and on using that knowledge for things that are important to us.

And that is what I meant when I said that the standard operating model for formal education is unnatural. That is why telling students that the reason they are studying X is in order to study Y runs against the human grain. If we wish to apply the old dictum "to thine own self be true" in this arena, we should be thinking about education not as years and years of accumulating knowledge only to use it years later, but, instead, as the constant interplay of theory and practice, of study and application, from start to finish.

For the most part, preparation for college and university is conceived as a process of stuffing the student with knowledge and theory, advancing through the grades in complexity and depth, until the student emerges from the chrysalis at the end clutching enough credits of the right sort and, with any luck and enough application, decent grades in at least a few courses said to be college level. Preparation for work right after high school is conceived as providing only the rudiments of literacy on which is built a program of training in how to do something in particular. In this way, for most students, we divorce academic training from practical training and do a grave injustice to both.

We tend to think that what we are doing is giving those who are "academically inclined" a chance to go to university and into the more prestigious and more highly compensated occupations, while we are giving those who are not good at academics a chance to at least earn a decent living by training them to do a job that does not require academic ability.

But I am convinced that both groups of students are robbed by this division. The students who do well enough on the academic side of this divide are, I submit, mainly those who come from families whose circumstances are likely to convince the students that delayed gratification will pay off. Much as they find little intrinsic reward in their classwork, they are willing to put up with learning things they will never use because they are convinced on the evidence that it will pay off for them eventually, mainly because they can see that it paid off for their parents. They are not doing well in these courses because the courses are taught in a way that is best suited for their learning. There is every reason to believe that they would do even better if they studied these subjects in a curriculum that was designed to embrace a constant interplay between theory and hands-on application. But they will put up with this unnatural form of instruction because they have no choice if they want to get a high-status job.

Similarly, the students who are shunted into vocational education are shortchanged because their life options are severely constrained by getting an education largely confined to basic literacy. This point is so obvious, I suspect, that it does not need elaboration. The fact that other countries are educating the bottom quartile of their students to far higher standards makes it no less obvious that we can and should be educating our vocational education students to a much higher academic standard than we are.

This line of reasoning clearly suggests that we should be thinking about curricula that integrate demanding academic studies with demanding application for all students.

This does not mean, in my mind, that we should just add a layer of project- and problem-based learning to the current academic curriculum. Nor does it mean simply cutting back on the academic curriculum to make room for more projects and problem-focused work. If anything, we need to make the academics more demanding than they are now for most students. I do not mean that we should be introducing more advanced topics earlier, but rather that the topics we ask students to study should be studied at a much deeper level.

Simply adding projects and problem-focused studies to a weak academic core will produce a curriculum that is weaker than most students now get. What is needed is not less academics and more projects for all, but rather a new curriculum—yet to be designed—that will combine a more demanding academic core with constant application, the two woven together in a tight braid.

That will require a significant investment of national treasure. The last time the United States did this in a significant way was in the 1950s and 60s, with the large investments made by the **National Science Foundation** in a whole generation of curriculum projects in school mathematics and science like the Elementary Science Study and PSSC Physics. In that case, too, the focus was on the development of courses on which deep exploration of fundamental principles and concepts was coupled with constant application of those principles and concepts to practical problems. Elementary school students, for example, learned principles of electricity by experimenting with various ways to connect batteries

and light bulbs and principles of biology by experimenting with real brine shrimp. The development work on these curricula was done by leading mathematicians and scientists working very closely with outstanding classroom teachers.

This is not work that can be done by classroom teachers in their spare time. It requires concentrated attention and sustained effort over months and years. It needs to be aligned with the Common Core State Standards and the Next Generation Science Standards and the assessments that are aligned with those standards. It needs to result in course designs that are robust enough to carry the intellectual weight of the standards and yet be flexible enough for good teachers to develop their own lesson plans to enable their students to reach the standards.

The national discussion of these issues now appears to assume that the curriculum needed to enable students to reach the standards many states have adopted will somehow emerge from the work that the regular classroom teachers will do and all that needs to be done is to curate the best of that material to produce the course designs and instructional materials teachers will need. This, in my view, is just nonsense. If you accept my view that a whole new kind of course and associated materials is needed to meet the challenge, incorporating both intellectually demanding academic study with a very practical, hands-on approach to learning, then it is time to confess that what is needed is not at all likely to simply emerge from the woodwork. States and the federal government and the nation's leading foundations will need to work together to develop what is needed.

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