Middle School Science Fairs to the Ivory Tower: Lessons from Harvard Professor David J. Malan

By Alan November

Sometimes, I "borrow" lessons from higher ed that can be adapted for a powerful return in k12. For example, past higher ed inventions such as clickers and flip learning (both developed by physics professor Dr. Eric Mazur) have shown enormous promise in K-12. I would like to introduce you to Harvard Professor David J. Malan and his special approach to creating a highly rigorous and successful learning environment.

There are at least three lessons from Malan's course that we can leverage across k12:

- Strengthen the social side of learning
- Teach students to self assess
- Provide public audience to inspire students to invent

Professor David Malan has managed to pull off a neat trick: His Computer Science 50 course is one of the most popular courses at both Harvard *and* Yale. Imagine teaching a course with 800+ students at Harvard and another 400+ students at Yale with an extremely high level of rigor and creativity. What is even more surprising for such huge enrollments is the sense of social community that is the cultural core of CS50.

CS50 assumes no prior knowledge or skill in computer programming. Yet it's rigorous, intense, and extremely demanding. The course is available for credit at either university, and anyone around the world can take a noncredit version at no cost through the open courseware platform edX. While some students aspire to become software engineers, some enroll just to experience the course.

My son, Dan, was among them. When he first signed up for CS50, it is fair to say he was not in the habit of choosing the most demanding courses on campus. But Dr. Malan's unique learning culture and sense of responsibility placed on the students, helped Dan to discover a passion for "learning how to learn" and thinking about design; skills he can apply to manage his learning in any situation; from other courses to his professional growth. Two years later he is still on fire and will graduate in May to pursue a career in computer science. I was so intrigued by the impact CS50 had on my son, I started to explore the opportunity to export various facets of CS50 to any k12 setting.

After many conversations with Professor David and Dan, I have identified at least three processes that we can apply across the curriculum and grade levels. (Of course, many k12 teachers already are.)

1. Learning is social, students are hardwired to work together to solve problems:

One of the aspects that makes his course unique is its culture. Malan pays as much attention to his students' *social* experience in the class as he does to their academic experience, so that his students feel like they are part of a learning community.

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For instance, he organizes several events throughout the semester that bring students together, such as “hackathons” and weekly lunches every Friday on the Harvard campus. His teaching assistants also host “office hours” every Monday through Thursday night from 9 p.m. to midnight, where students can gather (often over snacks) to discuss problem sets or ask questions—and these nightly events routinely draw upwards of 300 students.

“I went to office hours four nights a week,” Dan recalls. “That was the only way I could make it through the course.”

When Dan would arrive, the TAs would ask how far he had gotten in that week’s problem set and how confident he was in his work. Then, they would put him in a group with other students at his same comfort level. “There was never an issue finding a group that was at your pace,” he says.

By making the learning fun and social, while not sacrificing rigor, Malan has found that his students give their best effort.

“We hope that by creating these somewhat special and unusual experiences for students, we can expect more from them,” he explains. “If we are perceived as meeting them halfway, we hope they will meet us halfway as well and will get as much out of the course as they can.”

Making the learning a shared, social experience not only motivates students to do their best work; it also helps them learn from each other. And **when students learn from their peers, they’re apt to learn more effectively.**

There is a phenomenon known as the “curse of knowledge,” in which teachers who have thorough knowledge of a subject sometimes have trouble reaching students who are new to the material, because they’ve forgotten what it’s like to be in that position. Students, on the other hand, are more likely to empathize or relate to their peers who are struggling.

Dan can attest to the enormous value of the student community that Malan has crafted. Dan found the highly social office hours especially helpful, because they gave him a chance to discuss the problem sets with his peers in the same situation—and inevitably he would see the topic in a fresh new light.

How many opportunities are there in k12 to craft various social settings for students to come together outside of class to work with peers? Many schools are now converting libraries where students traditionally cannot raise their voice into learning commons where there are spirited debates among students as they study together.

2. Malan requires students how to self-assess their work.

As I watched my son, Dan, become increasingly focused, organized and passionate about his CS50 experience, I had to ask him, “Is there anything Professor Malan is doing for you that other teachers could have also done to help you become a much better student? His answer was almost too simple. “He taught me how to assess my own work.”

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Research clearly shows the high value of self-assessment for students, and yet Dan says he was never really asked to reflect on his own work until he took Malan's course. We do not need fancy technology to do this. What we need to do is empower our students to take more responsibility to reflect on the quality of their own work.

Researcher John Hattie and his team have pored over nearly 1,200 educational studies from around the world to identify the factors that most strongly correlate with student success. Of the 195 independent variables he has identified, self-assessment ranks third on his list in terms of importance—and it's the single most effective learning strategy that students can use for themselves. (The first two on the list are teacher behaviors.)

Teaching students how to self-assess their work can lead to interdependent learners, instead of being solely dependent upon the teacher for feedback. By thinking about the quality of their own work, students take more responsibility for quality and are more likely to try to improve.

Dan went on to explain. "Before submitting our homework, we had to answer questions about how we thought we did, how much time we spent on it, and so on," Dan says. "At the end of the semester, we were asked: What grade do you think you deserve, and why? What grade do you think you'll receive?"

Malan says he began this practice as a "sanity check": He wanted to see how closely students' expectations aligned with their actual performance in the class.

"We didn't want to create an environment where students left feeling like they underperformed or disappointed themselves," he says. "We'd much prefer that every student end up feeling significantly accomplished, regardless of their prior knowledge or background in the subject."

Malan has expanded this practice to include additional opportunities for students to reflect on their performance. For instance, he has introduced what he calls "postmortems" into the course. These are video breakdowns in which a teaching assistant walks students through a solution to the problem, so they can see how else they might have solved it—and how they might go about improving their own code.

"In an ideal world, I dream of a scenario where we have enough time for students to iterate on their work, see what they could be doing better, and actually resubmit the work and appreciate the delta between version one and version two," he says. While the compressed timeframe for his course doesn't allow for this practice, he has tried to provide resources for students to at least reflect on their work.

We have unlimited opportunities to help students reflect on their own work. One simple strategy is to ask students to highlight their own writing with various colors in order to reflect on strengths and weaknesses of their work.

3. Fairs replace finals: Students become problem designers.

My own experience as a teacher is that the norm for students is to want clear guidelines for "What do I need to do to get an A?" In some ways, the traditional assessment system that we have designed to motivate students to excel actually acts as a break or a ceiling and has the impact of preventing students from doing

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their best work.

David Malan highly values the imagination of his students to design their own problems. But how do you balance expectations of covering the curriculum without clear rubrics for assessment? So I asked him: "What evidence do you have your students are meeting expectations? And he gave a mind-bending answer: *When students go beyond what I've taught them in my class*.

He says his proudest moment came in his second year of teaching the course. Drawing inspiration from middle school science fairs, he arranged the first of what would become a regular event: a "CS50 Fair" at the end of the course, in which students came together to celebrate the work they had done—and much of this work was truly amazing. "It was so incredibly gratifying," he says.

As Dan explains: "You got to do whatever you wanted for your final project. And there were so many kinds of projects displayed at the fair that we had never talked about in class. I remember someone made a social media calendar for the sailing team, and someone else made a Nintendo simulator. We never talked about programming with hardware in the class. So you've got all these people doing things that we'd never talked about, and they went out of their way to learn something brand new—even though they could have earned full marks by doing something that had already been covered during the semester."

By the end of the course, Malan's students who might never have previously seen a line of code become problem designers. Not only that, many are *inspired* to go beyond the curriculum.

"Every week, he would say: If you get what we're doing here, you can easily translate it to other things," Dan says. "You can go out and learn anything else."

I think that should be the goal of every teacher. Getting students to regurgitate what the teacher says is easy. But teaching them how to think and construct new knowledge and design their own increasingly complex problems—that's what education *should* be.

Yes, David Malan borrowed this idea from his memories from middle school. Perhaps we have under utilized a very powerful idea that we have had for decades. Maybe we need more learning fairs across the curriculum. When students present their work to the public there is a different sense of excitement and motivation than sitting for a final exam.

Resources:

To learn more about Professor's Malan's ideas about pedagogy and process check out our podcast interview with David at: http://novemberlearning.com/blog/category/educational-transformation-podcasts/

Professor Malan's BLC CS50 presentation video: http://novemberlearning.com/educational-resources-for-educators/videos/this-is-cs50-ap-with-david-malan/

Links to the CS50 Videos: https://www.youtube.com/cs50

Link to David's website: https://cs50.harvard.edu/

Link to enrolling in the free AP version of CS50 for high school and middle school students and staff development resources for teachers: https://cs50.harvard.edu/ap

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