The Open Organization Guide for Educators

The Open Organization Guide for Educators

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with an introduction by Ben Owens

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Gina Likins' "Performing the collaborative dilemma" originally appeared in *The Open Organization Workbook*.

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Colophon

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2 https://dejavu-fonts.github.io/

3 https://github.com/RedHatOfficial/RedHatFont

4 https://www.libreoffice.org/

Additional reading

From Jim Whitehurst

The Open Organization: Igniting Passion and Performance (Harvard Business Review Press)

Organize for Innovation: Rethinking How We Work (Opensource.com)

From the open organization community

The Open Organization Leaders Manual: A handbook for building innovative and engaged teams (Opensource.com)

The Open Organization Guide to IT Culture Change: Open Principles and Practices for a More Innovative IT Department (Opensource.com)

The Open Organization Workbook: How to build a culture of innovation in your organization (Opensource.com)

Every week, Opensource.com publishes new stories about the ways open principles help innovative leaders rethink organizational culture and design. Visit opensource.com/open-organization to read more.

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Introduction

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About the cover

Artists Names

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Visions

Economics, openness, and the education system

Rahul Razdan

Openness has been a powerful driver in fields such as software development. This book examines open principles' potential to drive innovation in the area of education. However, before prescribing future remedies, we should understand some of the fundamental historical, social, and economic forces driving the *current* education system in the United States. Only with that understanding can we outline future pathways for reform.

Built deeply into the current education system is the idea of two scarce resources, both of which must be optimized. These are *the instructor* (the knowledge bearer) and *the classroom* (the place where knowledge is transferred). Historically, if one wanted to teach a subject such as chemistry, one had to both locate a chemistry instructor and move this instructor within physical proximity of students. The cost of the teacher was such that the delivery of instruction had to be one-to-many, so the construct of the classroom was invented. In order to manage delivery costs, the class must move in lock-step, and students must begin at a similar level of skill. These levels of similar skills forced creation of the concept of grade levels. Over time, the scarcity of these two resources led to the creation of all the institutional structures familiar to us today, and the vast majority of educational institutions build delivery structures to optimize for this scarcity. Further, as one proceeds up the academic ladder (from high school, to undergraduate education, to graduate studies), scarcity increases because the number of instructors with knowledge of advanced topics decreases. This

increase in scarcity creates a real need for filtering—thus the invention of other familiar systems, like grades and admissions. One could easily view this system in a negative light. But two points are important to emphasize:

1. Until recently, *this scarcity was reality*.
2. This model has been a *massive success* in raising the general education level of millions (if not billions) of people.

The system works, but it has its challenges from the perspective of the individual student. These challenges include flexibility, differentiation, and a fairly contrived use of grading. Let's examine each of these and explore how we might combine open principles and open technologies to address these challenges.

Flexibility

In the current system, because the student is the widget in a series of grades and tracks, the student *must* consume information at a *rate* and in a *timeframe* driven by the education machine. This lack of flexibility causes enormous issues for students, including:

- **Banked learning.** Since students are banked into cohorts in the construction of the classroom, students who can move at a faster pace are underutilized and generally bored. And students who need more time to absorb concepts are penalized in a recurring fashion in a race to catch up or fail.
- **Imprisoned in time/space.** Students who function badly in early mornings (medically documented for teenagers) or mid-afternoons are forced to endure lessons at times of low attentiveness.
- **Multiple shallow distributed classes.** In order to ease planning for workforce and educational facilities, which currently expect influxes of students at predictable intervals, schools ask students to carry five or six classes over a semester or year. As a result, immersive learning is minimized while scheduling and program management skills are over-emphasised. In fact, schools (typically unknow-

ingly) transfer the complexity of load management to students.

- **Limitations on learning time.** Most schools still only operate from 8 a.m. to 3 p.m. in non-summer months.

Since the education system's primary objective is to promote learning, the only good that comes from this lack of flexibility is an economically viable delivery system. As we've seen, this is entirely justifiable as long as the core tenets of scarcity do, in fact, hold true—but this system is not without significant costs for the students.

Differentiation and societal segregation

Read any luminary in the area of career development (such as Reed Hoffman, the founder of LinkedIn), and you'll notice a focus on the necessity of differentiation (e.g., developing a personal brand) in an area that can be economically valuable to society. Without explicitly intending to do so, the current K–12 educational system actively *discourages* building differentiation. Classes and curricula are largely banked based on the realities of the delivery system. Given the financial commitments to the teachers and physical limitations of bringing the teachers into the classroom, schools can't consider classes outside the realm of the conventional.

All of this creates a comic situation in which students are pushed through a largely uniform K–12 education system only to have colleges ultimately ask them "So how are you different?". It's a good subject for a Far Side cartoon. Moreover, the current education system physically isolates students from their communities and segregates them from society, making career discovery a challenge.

As historians say, judging historical figures by today's norms is not fair. So we can only judge the current educational system on how well it solves historically specific problems for which it was designed. However, solving the problems of differentiation and career discovery *earlier* would have enormous positive consequences for students as well as for society.

Grading systems

Assessment is a key part of learning, especially when it occurs in close proximity to the learning process. Similarly, certification of competence is also important. However, the current grading and transcript paradigm was actually built for an entirely different purpose: *filtering*. That is, scarcity and capacity constraints creates an economic need to use some method (even if somewhat arbitrary) to reduce the population of people entering the next level of education. This is why those systems often reward speed of learning or measure irrelevant intermediate assessment points—as opposed to competence at the end of a course.

This, too, leads to some nonsensical situations. For example, parents pay taxes (or tuition) to schools claiming to teach their children, and if students and teachers do *not* succeed in reaching the required capabilities, students earn a "bad grade" designed to filter them out of the system. *One would have to think hard to find other situations in which the buyer pays for a service that filters them out of their own future options.* Also, in some circumstances, the judgement involved with grades have clinically recorded effects such as "bad grade phobia." This is the situation where students literally shut down psychologically over years of receiving bad grades. One wonders, what is the point ? Would a simpler, capability-based model be better for all involved?

Openness, technology, and networking enabling the teaching process

Developments in information technology have rendered foundational elements of this old education model untrue. Physical classrooms can be replaced with any variety of learning environments, ranging from the completely virtual to various forms of blended structure. Similarly, automation and virtualization can add enormous levels of productivity to the teaching function. Finally, all of this can operate in an environment where the standalone teacher-as-craftsperson can be augmented with a network of professional helpers. The first wave of key enabling capabilities, which are reality today, include self-paced and distance learning.

However, technology deployed in the spirit of openness sets the basis for the next wave of capabilities. These include a revolution in instruction intellectual property (IP), standard engagement models for students, and a viable model for early career discovery.

Instruction IP capture, reuse, and improvement

Across the world today, teachers build and deliver lessons on a massive scale. But at most points where those lessons get delivered, they are lost because they are not recorded. This means students don't have access to the content other than at the *exact* time it was uttered. It also means that this IP cannot be reused and, most importantly, cannot be improved over time. The traditional "IP capture and reuse" mechanism is the textbook.

In terms of the actual product, the teacher is asked to author, build, produce, and deliver a performance which can clearly communicate complex ideas. In the context of traditional media, a large team of individuals with specialized skills (copy-writing, editing, graphics, and more) would put together such a product. However, today's economics prevent this level of investment for a single class. However, with the advent of new methods of IP capture and reuse, much deeper and more effective investments are viable.

Educators need marketplaces that both allow for the exchange of instructional IP *outside the traditional textbook model* and facilitate contribution and collaboration in order to improve this IP over time. All the technologies necessary for enabling this process exist today (in fact, they've been used extensively in various open source software projects and communities). A more coherent IP strategy for instructional materials can rectify the current system's enormous inefficiencies . And since the vast majority of classes taught in high school and early college are "commodity" (that is, they've become largely standardized through years of refinement), hundreds to thousands of variations on course materials aren't typically necessary. Educators can instead modify and personalize their materials in response to student learning styles—not teacher delivery styles. Further, true innovations in

pedagogy now have a place to be easily distributed for maximum impact.

Standardization of engagement model for the students/parents

Today, because the predominant model for teaching is teacher-as-craftsman, every teacher builds a unique and personal engagement strategy. The net effect for students and parents is an unmanageable diversity of teaching styles. Would we tolerate this from any other large institution? Imagine that your basic banking processes were different every time you engaged a different teller. And yet we all know students who must manage 17 "unique accounts" during a single semester's worth of work in a high school environment. Technology has only made this situation worse. Teachers use technology in varied ways and often use different applications for the same function. The result: Vast complexity for the students attempting to remember and manage the wide variety of applications.

We need to think deeply about a more standard technical engagement model for students. Through education consortia, we could construct an open and collaborative approach that reduces the wasted motion of incoherency for standard simple items such as identity management, structures for working through courses, and feedback systems. This approach is similar to those we engage when developing open standards for other technologies, where common interactions are standardized to reduce the friction of engagement. Much like the standardization of the internet enables enormous innovation, standardization on student engagement can enable broader innovation.

Early career discovery and alumni

After ten years in the K–12 system, students are asked the proverbial question, "What are you going to do in life?" or "What will be your major in college?" Realistically, expecting students to have any real data to make such an important decision is unreasonable.

How are these decisions made today? At best randomly. Perhaps the student happens to know someone in a profession that intrigues them. They could ask teachers or guidance counselors; however, academics are ill-equipped to answer these questions. The nature of the education system is that most people in it have always been educators. Whatever insights into other vocations they *might* have become stale very quickly because of the rapid rate of industry change.

The current system's consequences for career discovery are numerous. The first and most obvious is that a great deal of resources are wasted on degrees that go unfinished. This leads to a student debt situation that burdens students throughout their entire lives. But perhaps most importantly, it forces students to make major decisions with inadequate tools, creating a high stress situation for individuals at a time when they're least able to manage it. The teenage suicide rate at colleges is worrying, and one must imagine that the stress created by the inadequate career discovery process must be a factor.

Before the current information revolution, solving this problem would have been difficult because of limitations driven by physical connection. However, with the advent of the internet, it's possible to build, maintain, and deliver active engaging, structured environments for students (of all ages) to explore careers in a much more meaningful manner. Further, in this world of global social networks, it is certainly possible to build networked resources which can humanize this process. An obvious resource available to most educational institutions are their alumni networks. A combination of openness and networking can allow schools to build a broader community to significantly improve the career advice to students.

Conclusions

The education system in the United States is currently structured in a way that optimizes for economic realities that have been prevalent for hundreds of years. The crux of these realities was scarcity: scarcity of teachers, scarcity of classrooms, and the need

for a "craftsman model" of delivery. At industrial scale, this system —predicated on the banked classroom model—has been a roaring success. However, the system and model also has negative consequences for students with regard to flexibility, differentiation, and access.

With the advent of information technology, remote delivery and teacher-student interaction is possible. And with the advent of computing and intelligent agents, teachers can be much more productive. These core technologies, combined with structures to facilitate greater openness and networking, can enable fundamentally new education delivery structures that not only improve the current issues with education but also address vexing problems, such as early career discovery.

Dr. Rahul Razdan is the CEO of NextGenEdu, which focuses on unique products to transform education using openness and networks. He has more than 25 years experience in startups, academia, and Fortune 500 companies. In academia, he has worked in areas such as STEM education, Autonomous Vehicle Technology, and SemiConductor Design. He has successfully led a number of startups (WiPower, PwrLite, Ocoos) and held senior corporate roles at Cadence and DEC (now HP).

Review and discussion questions

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Truly open education will require sweeping changes

Adam Haigler

It's no secret that American schools have struggled to prepare students for the jobs of today and tomorrow. Critics have blamed schools' shortcomings on a variety of factors: change-resistant bureaucracy, low standards, straying too far from the Three R's, inadequate teacher training, and more. One potential root cause of this fundamental issue is that the education system isn't built to be responsive to a rapidly changing environment.

Public education's aims—providing every student with a free and appropriate education regardless of race, sex, class, disability, etc.—are undeniably admirable. An unfortunate outgrowth of these aims is an emphasis on standardization that can be sluggish and stagnant. This wouldn't be such a problem if the world wasn't evolving so rapidly economically, technologically, politically, and socially. Parents, students, and employers are sounding the alarm about this issue. Clearly a structural shift will have to happen for the education system to become more responsive to the needs of its key stakeholders.

Ben Owens, a former colleague of mine at Tri-County Early College, and I have recently embarked on a journey to see how open source principles could be fruitfully applied to education systems to address this issue.[5] Our thoughts are featured in our book, *Open Up Education! How Open Way Learning Can Transform*

5 https://opensource.com/resources/what-open-education

Schools, published in December 2018.[6] We built on work from both David Price and David Preston by developing a philosophy and a "source code" for a system that can be retrofitted to infinite educational contexts.

The beauty of the open source way is that it can help organizations keep pace with rapidly evolving markets and ecosystems. As Jim Whitehurst outlines in The Open Organization, the ethos of open source applied to management can lead excellent outcomes. The same could be true for our schools. For example:

- By tapping the power of the crowd and employing a meritocratic decision-making framework, the best ideas about education can emerge from anywhere. Currently, principals, consultants, policymakers, and superintendents are the primary decision-makers in education. This governance structure is excellent at perpetuating the status quo!
- By maintaining a "release early, release often" ethos, all educators can test and refine new ideas quickly. Stakeholders' aversion to failure too often disrupts this process in schools.
- A distributed leadership model—like those practiced by open source projects—can cultivate buy-in at all levels. Lack of buy-in has doomed many well-intentioned, but top-down education reform efforts.

Each of these factors could be a recipe for success in the education sector, where educators must stay in sync with the ever-changing needs of employers, democracies, and communities. In our book, Ben Owens and I propose a framework for Open Way Learning (an extension of David Preston's "Open Source Learning"), which rests on three foundational principles:

1. Relentless collaboration
2. Freely exchanging knowledge and resources
3. Culture of innovation

Here's what that means.

6 https://rowman.com/ISBN/9781475841992/Open-Up-Education-How-Open-Way-Learning-Can-Transform-Schools

By instilling an expectation of constant collaboration, educational leaders can challenge the isolation epidemic that plagues teachers, students, and schools. Apparently teachers are rarely collaborating or visiting each others' classrooms—at least in the United States. According to data from a 2013 study by the Organization for Economic Cooperation and Development (OECD), 54% of U.S. teachers say they never teach jointly as a team in the same class, compared with 42% of teachers internationally.[7] Moreover, according to a 2014 OECD study, a full 50% of U.S. teachers say they never observe other teachers' classes and provide feedback. This situation is of dire concern because collaboration can enhance teaching and learning immensely.[8] Emphasis on protocols, processes, and structures that encourage collaboration will make working alone on anything that could possibly be improved by another reviewer become taboo.

Once this collaborative emphasis is in place, teachers, administrators, and students will have created enough trust to begin freely exchanging their best work. Students can present their projects to complete strangers; teachers will offer their best ideas on Twitter; administrators will invite others to witness the magic happening at their schools. Furthermore, teachers will start viewing their roles as curators of knowledge freely available on the internet and through a robust network. They will no longer pretend to be the exclusive purveyor of content to students, but will instead become "Learning Guides" who help students navigate an unfathomably complex tome of human knowledge that can be accessed by any smartphone.[9]

The two preceding principles will enable a third: a culture of innovation that will lead every member of the school community to become an active agent in its continual improvement. An innovat-

7 http://www.oecd.org/edu/school/TALIS%20Conceptual%20Framework_FINAL.pdf

8 https://learningforward.org/docs/default-source/jsd-october-2015/high-quality-collaboration-benefits-teachers-and-students.pdf

9 http://inservice.ascd.org/from-teacher-to-learning-guide/

ing school—one that has all the pieces of the open source education model in place—is indeed a force to be reckoned with. It has the organizational potency to reject the entrenched status quo and say once and for all that there is a better way. Moreover, every community member will be empowered to improve any process that is sub-par. This can manifest as outside-the-box teaching methods, flexible scheduling, novel behavioral management techniques, and alternative assessment methods.

In the months since *Open Up Education!* was published and we launched our website,[10] a flood of interest and support for Open Way Learning has emerged.[11] It appears that many of these ideas are being implemented around the globe in a sprawling network of schools. Though the network is hard to pin down, brand, or track (unsurprising given open source's decentralized nature), we've noticed other "sister" networks that already emphasize components of Open Way Learning. Teacher-Powered Schools,[12] the Innovative Schools Network,[13] and schools affiliated with Education Reimagined[14] are just a few that embody many of these principles.

Moreover, we strongly believe that the changes required to bring more open, collaborative, and innovative environments in our schools cannot be done alone. As such, we're establishing strategic partnerships with forward-thinking organizations who are dedicated to building a new paradigm for education and are eager to elevate and synthesize Open Way Learning in their own networks—organizations such as The NCSU Science House,[15] Curio Learning,[16] Innovation Academy,[17] Re-brand NC Education,[18] The DRIVE

10 http://www.openwaylearning.org/

11 http://www.openwaylearning.org/testimonials

12 https://www.teacherpowered.org/

13 https://www.innovativeschoolsnetwork.com/

14 https://education-reimagined.org/

15 https://sciencehouse.ncsu.edu/

16 http://curiolearning.com/

17 http://devinnovators.com/wpdi/

18 https://www.rebrandnced.com/

Revolution,[19] Hope Street Group,[20] Share Your Learning,[21] Odigia,[22] as well as a number of school systems in North Carolina and beyond.

Open Way Learning has invariably resonated with educators with whom we've spoken around the country and globe. Most educators we encounter seem highly enthusiastic about the framework and are simply looking for how they can inject it into their own schools as soon as possible. Book clubs, Twitter chats,[23] and OWL ambassadors are busy spreading the word and finding traction in their spheres of influence. Perhaps we are reaching a tipping point.

The structural renovation of education towards Open Way Learning is essential. If the noble aims of public education are to continue to have a place in our times, they need to be packaged in a framework that can enable them to remain relevant in an evolving landscape, where 65% of students may be doing jobs that we can't even imagine right now.[24]

Open Way Learning could be the game changer that makes that happen.

Adam Haigler is an educator and leader of diverse people in a wide variety of alternative settings. His experience teaching and mentoring spans ten countries and over nine years. Working as an outdoor school instructor, environmental educator, overseas leader, and community educator, Adam uses his experience in education and leadership to inform his work as a consultant, helping people and organizations develop unique programs and bring bold visions to reality.

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19 http://www.thedriverevolution.com/

20 https://hopestreetgroup.org/

21 https://www.shareyourlearning.org/

22 http://www.odigia.com/

23 https://twitter.com/OpenWayLearning

24 http://reports.weforum.org/future-of-jobs-2016/chapter-1-the-future-of-jobs-and-skills/?doing_wp_cron=1558455728.4337279796600341796875#view/fn-1

Review and discussion questions

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The future of ethical tech education must be open

Justin Sherman

Artificial intelligence (AI) tools and other algorithmic systems are increasingly impacting social, political, and economic structures around us. Simultaneously, and as part of this impact, these systems are increasingly used to inform—or directly make—decisions for policymakers and other institutional leaders.

This trend could have profoundly positive impacts on humanity. Consider, for example, the ways in which AI applications have already proven revolutionary in medical diagnosis. But with and alongside the benefits these systems promise are also serious risks, for the growing unchecked use of algorithms in this fashion risks dangerously amplifying inequality and concentrating power in the hands of the few. Other related problems may accompany this, such as the increased commodification of personal information absent consumer protections, or the buildout of digital surveillance infrastructures that are more often than not turned against already marginalized or oppressed populations.

One of the most promising mechanisms for combating the dangerous encroachment of individual agency and power through algorithms is open education. Policymakers and advisors educated on these ethical technology issues can make informed regulatory decisions, technologists can increase their awareness of the impacts of their designs, and citizens and consumers can adequately understand how algorithmic systems are impacting their everyday lives. Where knowledge is power, education can provide that knowledge.

Twenty-first century educators have both a responsibility and an opportunity to empower this kind of learning about technology ethics in an inclusive and interdisciplinary fashion. Crucially, this education must be open: following principles like transparency, inclusivity, adaptability, collaboration, and community.[25] Government regulation, greater ethical pressure within big tech organizations, and other solutions cannot act alone. Education—particularly education that is open—is essential to addressing these broader challenges brought on by increased interaction with and reliance on algorithms.

Today's state of affairs

Algorithms and AI tools are already changing both the concentration and the homogeneity of decision-making power in our institutions. For example, judges in the United States are using so-called risk assessment algorithms (RAAs) to aid their decision-making around prison sentencing.[26] These automated systems—which vary in sophistication from basic input-function-output formulas to neural networks that use deep learning—will take an individual's profile and run some form of risk assessment on that person. This could be that person's likelihood of recommitting a crime, or it could be the degree to which they're inclined towards violent criminal behavior. Essentially, the pitch is that the algorithms reduce the workload for judges with many cases on the docket and limited time to read individuals' criminal records. Such a pitch also plays, explicitly or not, on the notion that mathematical formulas and algorithms are somehow objective.

Yet when these systems take data from our world—such as a person's number of prior arrests—at face value and use them as proxies for outputs like "likelihood of re-offense," they introduce unfairness into algorithmic decisions. As ProPublica unmasked in a 2016 story on COMPAS, an RAA used to aid prison sentencing in

25 See Appendix.

26 https://dash.harvard.edu/bitstream/handle/1/33746041/2017-07_responsivecommunities_2.pdf

American courts, this bias manifests in disparate impacts on already marginalized groups.[27] COMPAS was likely to falsely flag black defendants as future criminals at nearly twice the rate it did for white defendants, and white defendants "were mislabeled as low risk more often than black defendants." Since the data used (e.g., number of prior arrests) does not (and unfortunately will not, for the near future) have equal values across different demographics, this introduces a risk of systematic bias in the decision machine. Also worth noting is that the COMPAS system used in this particular case is made by a for-profit company that likely has little incentive to disclose or address this issue of its own volition.

Here, as with many other uses of algorithms in public and private institutions—welfare distribution,[28] housing allocation for the homeless,[29] resume reviewing,[30] news feed curation,[31] and much more—decision-making is, in some sense, further concentrated than is already the case more widely. Take the judges example once again. The judicial institution already involves a select number of judges making decisions for collective groups many multiples larger, depending on the jurisdiction of the court in which they serve. Yet when many of these judges from different courts depend on this single COMPAS system for decision assistance in prison sentencing—usually buying into the myth of algorithmic objectivity,[32] because they haven't been educated oth-

27 https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing

28 https://www.npr.org/sections/alltechconsidered/2018/02/19/586387119/automating-inequality-algorithms-in-public-services-often-fail-the-most-vulnerab

29 https://www.amazon.com/Automating-Inequality-High-Tech-Profile-Police/dp/1250074312/

30 https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G

31 https://slate.com/technology/2016/05/yes-facebook-is-biased-now-it-should-admit-it.html

32 https://opensource.com/article/18/1/how-open-source-can-fight-algorithmic-bias

erwise—there is a risk that decision-making influence, in some senses, is concentrated even further into the hands of the few who build the algorithm. (And what happens in the near future, when judges are using this kind of system not just as a reference point on risk or recidivism, but to more concretely get exact prison sentence recommendations?)

This is exacerbated by the fact that those groups designing these technologies are often culturally and racially homogenous, identifying as white and male. Though getting consistent and accurate estimates is difficult,[33] many reports indicate that diversity in the "technology sector" (and in technology roles generally, particularly in executive roles) is terrible.[34] And furthermore, as with any institution, decisions here are going to be much better tailored to populations that look more like decision makers. This can impact everything from the construction and makeup of the technology itself to the terms and services that underpin its use.

Again, these issues are not unique to algorithms, and just like in other situations, this concentrated and homogenous decision-making lends itself to biased and/or unfair decisions as well, this time embedded in the code: sexist hiring algorithms,[35] malfunctioning welfare distribution systems,[36] search engines that reinforce racial and gender stereotypes,[37] and more. The algorithms themselves malfunction—causing disparate impacts on already marginalized groups—because nobody is influencing the algorithmic design process otherwise.

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33 https://www.washingtonpost.com/news/powerpost/paloma/the-cybersecurity-202/2019/04/10/the-cybersecurity-202-there-are-even-fewer-women-in-u-s-government-cybersecurity-than-there-are-globally/5cad44531ad2e567949ec115/

34 https://www.wired.com/story/computer-science-graduates-diversity/

35 https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G

36 https://www.amazon.com/Automating-Inequality-High-Tech-Profile-Police/dp/1250074312/

37 https://nyupress.org/9781479837243/algorithms-of-oppression/

Looking forward

Going forward, there is serious risk that institutional decision-making becomes further concentrated among developers building algorithms—algorithms that increasingly impact institutional decision-making (especially around public policy) for many people. And even *if* decision-making structures in technology and elsewhere become more diverse and inclusive—and that's also a big *when*—the issue of concentrated decision-making through algorithms and their developers persists. This won't impact every institution, certainly, and the impacts on different institutions and the resulting policy outcomes will look different in each case. But this is a path we're headed down.

In a very immediate sense, Joy Buolamwini writes in *The New York Times*, artificial intelligence is poised to worsen social inequality should its design and use go unchecked.[38] And on a broader scale, as Yuval Noah Harari so eloquently highlights in *The Atlantic Monthly*, contemporary digital technologies, without the right checks and design principles, may very well erode human agency and the structures of liberal democracy as we know it.[39] Yet both authors and many others agree: it's not too late. We have not crossed some threshold (if one even exists) at which algorithms are so entrenched in the world that we can't change how they are designed or used or regulated. On the contrary, actions that prevent automated systems from worsening social inequality and denying people agency are certainly possible today.

Solutions through open ethical tech education

Educating students about the power and pervasiveness of algorithmic activity is both a responsibility and an opportunity for open-minded teachers and technology ethicists. And that work should both embrace open organizational values—transparency, in-

38 https://www.nytimes.com/2018/06/21/opinion/facial-analysis-technology-bias.html

39 https://www.theatlantic.com/magazine/archive/2018/10/yuval-noah-harari-technology-tyranny/568330/

clusivity, adaptability, collaboration, and community—and embed them in educational initiatives and materials aimed at fostering an ethics that addresses the potentially dangerous impacts of AI applications and other algorithmic systems on our world.

Secrecy around various algorithms has arguably led to many of the problems we see today: disparate impacts on different groups—such as with the risk assessment algorithms used in prison sentencing—compounded by a lack of public and easily accessible information about how these algorithms were designed and deployed. Because information concerning system design is often hidden or otherwise unavailable, identifying and understanding these systems' negative effects is more difficult. Ethical tech education, in the spirit of fighting these facts, should therefore embrace *transparency*, where the content included in coursework —and how that coursework is structured—is open to scrutiny by others. Feedback on educational materials in such an emerging area will only strengthen such initiatives.

Those developing ethical technology education programs should also be transparent about everything *following* the design stage. Sharing both failures *and* successes with others working on these problems of ethical technology education is important: What worked? What didn't? How well did the course bridge STEM-humanities divides? How relatable were the problems to students of different backgrounds? How "technical" was the material? What kinds of technologies provoked the most discussion? What kind of buy-in (administrators, students, etc.) was most important to getting this coursework implemented? The answers to these questions have the potential to help other educators working on these problems, not to mention those in government, industry, and other sectors also striving to develop ethical tech education for their constituents. Transparency is a powerful principle to embrace here.

Ethical technology education should also embrace *inclusivity*. Part of the problem with algorithm design and deployment today (as previously referenced) is the small size and relative homogeneity of the groups making design and deployment decisions. Few people from the general population have input or influence,

and those who do have input or influence usually aren't representative of the general population. As a result, there is almost inherently an implicit and/or explicit desire to tailor these algorithms to the needs of those who share experiences with the designers—while not designing, or even designing against, the needs of those outside that circle.

Education on technology ethics therefore shouldn't just regurgitate mainstream narratives about technology—like the need to innovate absent regulation, accepting that some things "break" in the process—by tapping into small and homogenous groups. Instead, the design and maintenance of ethical technology education should pursue and embrace inclusivity in design, content, and structure. To understand the impact of risk assessment algorithms on prisoners, for instance, including only the perspectives of white system designers would not do justice; the perspectives of those affected should also be a consideration (in this case, for example, black individuals whose "risk" scores are so grossly miscalculated by the algorithm). Similarly, adopting perspectives just from technologists excludes the views of those in professions from sociology to journalism, and therefore misses important perspectives on technology. More inclusive curricular design and maintenance may therefore not just be fairer, but *better*—more comprehensively assessing the impact of algorithms on different groups. This is essential if we are to fight the concentrated and more homogeneous decision-making threatened by many algorithmic systems.

Adaptability, to use one final example of an open organization principle, is essential for those seeking to educate about ethical technology issues. Technology is evolving at breakneck speeds. Artificial intelligence applications and other algorithms in particular are often deployed with little testing and oversight beforehand. To ensure ethical tech education does not become quickly outdated—to ensure it remains *accessible* and *relatable* to those with varying degrees of knowledge—there must be collaborative processes that quickly pivot ethical tech education to include new technologies, new implementations of those technologies, and new effects of those technologies. Robust feedback loops from ad-

ministrators, students, and others with stakes in ethical tech education can help here. In a similar vein, continuous conversation with those working on technology issues—and continued iterations of the coursework in response—serve the growth mindset that is needed to keep this kind of education current. As algorithmic fairness, data privacy, and other issues evolve, education on ethical technology should adapt in response.

Of course, open education alone is not enough. An inclusive and diverse approach to managing the risks of artificial intelligence's and other algorithms' growing role in society—one that actively engages and leverages input from a breadth of stakeholders, from citizens to regulators to tech developers—is one that should include education as just one component.

Simultaneously, we should not forget the potential positive effects that might result from increased use of and reliance on AI and other algorithms. We should pursue and embrace the ways in which systems can in fact be designed, technically speaking, with fairness, privacy protections, security, transparency, and other human-centered design principles in mind. But as we head down dangerous paths with unchecked use of algorithmic systems, open ethical tech education is a crucial way for education to make its mark on the world going forward.

Justin Sherman is the co-founder and president of Ethical Tech, a nonpartisan initiative at Duke University focusing on research, education, and policy development on ethics and technology across all industries and socioeconomic groups.

Review and discussion questions

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A practical path to open education

Dan McGuire

"Open," "openness," "open source," and "the open way" have all been part of the various organizations with which I've been involved over the past 45 years. The definition of "open" and its various manifestations in educational institutions has been fluid—evolving, expanding, refined. And that's likely to be the case for the foreseeable future.

This chapter provides background on the thinking that has informed one approach to making educational organizations more open—the approach of the Stone Arch Bridge Initiative for Education Resources (SABIER). This approach uses openly licensed content and open pedagogy on open source learning management systems all of which provides results that can then be written about and further expanded upon in open access journals.

In the beginning: Schools without walls

More than 40 years ago, I worked for a company that installed communications equipment in the St. Paul Public Schools Open Schools. The "Open Schools" of those days were buildings with very few interior walls, which is what made them "open." This "open system" of design was becoming more popular throughout the 1970s (and it's still in use in many workplaces, though in new variations). This is where my own journey open education journey began.

One popular criticism of such open structures was their relative noisiness, and my employer had designed some of the first noise masking systems. We installed them in a number of facilities, including the Univac testing facility, where Robert Pirsig worked

when he was writing *Zen and the Art of Motorcycle Maintenance*, about the search for quality—and we might read that book as a precursor to open pedagogy. Pirsig writes:

> ... to tear down a factory or to revolt against a government or to avoid repair of a motorcycle because it is a system is to attack effects rather than causes; and as long as the attack is upon effects only, no change is possible. The true system, the real system, is our present construction of systematic thought itself, rationality itself, and if a factory is torn down but the rationality which produced it is left standing, then that rationality will simply produce another factory.

Open pedagogy and open practices fundamentally restructure the system of education. For so long, education has been dependent on the notion that content is sacrosanct. It was published, so publishers held the keys to the knowledge, and teachers and students couldn't copy, modify, rearrange, remix, or redistribute the content on their own. Open licensing of content changes all of that. Openly licensed content puts the teacher and the student in charge of learning.

This was a definition of "open" that had to do with much more than walls.

Gaining traction

In the summer of 1997, during a summer professional development session for the Connected Mathematics Project (CMP) curriculum in use at the Minneapolis Public Schools, I searched for a communication and collaboration tool that would be free and open source. The tool I found (on the advice of a friend) was Nicenet's Internet Classroom Assistant, an open source platform that was available for free to all of the Minneapolis Public School teachers of CMP. Staff directing the district's mathematics curriculum weren't impressed—they, I later found out, hadn't even been using email, so they thought anything I was introducing was "not an appropriate use of time."

But some schools in the district were not as opposed to open thinking.

Marcy Open School, a K–8 magnet school of the Minneapolis Public Schools, is an example of a building-level commitment to open learning. I was a teacher there for 15 years. The open teaching practice at Marcy was a fluid practice, and it varied depending on individual teachers. But common among many of the classrooms were:

- a focus on project-based learning (PBL)
- specific and significant effort to have students lead their quarterly reviews by giving examples via a portfolio of things they'd learned in lieu of standardized report cards
- a focus on involving as many elements of the community as possible in learning activities
- a well articulated aversion to using district curriculum

The ability to create our own curriculum held particularly high value. None of us had yet heard of open licensing; open source software was just beginning to become available and not something the school district encouraged.

Opening up professional development

I started using Moodle—an open source learning management software system—in 2006 as an instructional tool for Minneapolis Public School teachers' professional development in addition to using it for instruction in writing, reading, science and math in my 3rd and 4th grade mulit-age classroom.[40] That experience led to my involvement with the Minnesota Moodle Users Group, which eventually led to my getting involved with the Minnesota Partnership for Collaborative Curriculum (MPCC). Our collective experience as users of an open source learning management system was foundational to creating an organization that used openly licensed curriculum. Jon Fila and Jon Voss of Minnesota's District 287 were the visionary leaders who led the MPCC.

40 http://dangerouslyirrelevant.org/2010/09/writing-the-elephant-in-the-living-room.html

The story of the MPCC illustrates how an open way of doing things in schools can make a huge difference. The organization is nearly finished completing 40 courses in English, mathematics, social studies, and science that will eventually be released as complete, textbook-like courses available for anyone, anywhere, to use. The MPCC even produced a video featuring several teachers from the 206 Minnesota School districts that have contributed money to pay teachers to create or curate the courses.[41] The potential savings to Minnesota taxpayers is approximately $650 million per year. That's money currently being spent on textbooks that could instead be spent on paying for teachers to acquire skills using openly licensed content and open source software for instruction and learning assessment. Other states could replicate those savings by simply revising the courses to align with their state standards. Making those revisions would provide teachers and teacher preparation institutions in those states valuable professional development in addition to creating locally tailored curriculum.

In 2011, I started SABIER in order to provide used computer equipment to public schools. It quickly became apparent that what was impacting schools was not necessarily a *lack of equipment* but rather a *lack of teacher training* in how to use the computers and software. Many teachers were unfamiliar with using computers for instruction; many *still* don't understand the difference between the different types of licenses for software and content and how that difference impacts teaching and learning.

From 2011 through 2016, then, I consulted with software companies and educational institutions regarding the implementation of open source software (as well as non-open software). I observed that this lack of understanding about types of licenses for software and content wasn't the only thing impeding schools from making changes. Accompanying that lack was confusion about the distinctions between open pedagogy and open access journals—in

41 https://youtu.be/ARBtZYBljVU

addition to the confusion about licenses regarding software and content.

Educating educators about the differences in licenses and types of pedagogy became a key component of my work in establishing SABIER. My motivation for establishing SABIER as a non-profit corporation in 2016 was to create more opportunities for students and teachers to have ownership of the content they were using to learn, to provide opportunities for greater collaboration between teachers and students, and to provide support for teachers within a building, within districts, and within a larger community. The non-profit structure is an important aspect of the work that SABIER does because it enables a larger community to get involved more directly in the work—and ensures that the results of the work will remain in the community and not accrue wealth for others.

Donors have told us they are eager to support implementation of a specific and defined initiative in a school or district. Donors don't get excited about merely writing a check to a district's general fund. It is difficult (if not impossible) for them to see how that donation makes a difference. Supporting the implementation of elementary science curriculum that is aligned to standards and can also serve as a vehicle for STEM, PBL, or Maker Space work is an example of the type of targeted initiative that donors feel more comfortable supporting. Elementary science is an integral component of each of these current popular trends (STEM, PBL, or Maker Space) in K–12 education, which makes it an attractive content area to support with implementation for open educational resources (OER). SABIER is also developing professional development materials for middle school math curricula as well as for high school science, which are also areas very amenable to OER implementation.[42]

SABIER's use of a cohort-style structure of professional development that encompasses a semester or academic year is a

42 https://www.curriki.org/5-facts-everyone-should-know-about-open-educational-resources

result of many years of experience providing professional development in both K–12 and higher education organizations. It is the method that has proven to be most effective for making enhancements in teaching and learning. The problem is that it requires considerable planning and organizational consensus building in order to be successful.

The Augsburg Hybrid Initiative

(with thanks to Lori A. Peterson)

One example of a successful implementation of this cohort style of professional development was the work I did implementing the hybrid program at Augsburg University (then Augsburg College). The reinvigoration of enthusiasm for teaching that resulted when the Augsburg faculty and staff worked transparently and collaboratively over time to create a new model of teaching and learning in graduate and weekend college courses was an example of how an organic but intentional open approach to learning could achieve innovation.

Augsburg College's strategic decision to move all of its adult learner program offerings (undergraduate and graduate) to a blended/hybrid model of teaching and learning was the result of many years of study and dialogue. Before this decision, the college's use of blended and online learning was highly inconsistent and, thereby, difficult for curriculum committees and others to manage. In 2011 the college engaged a higher education market research firm to assist in clarifying where it stood in its use of technology for teaching and learning, how best to move forward, and how to claim a consistent identity in this arena. It became clear that the best path to doing so was deploying hybrid/blended (online and face-to-face) teaching and learning offerings. This strategy could bring together the college's reputation for high-quality, intensive, face-to-face connections with students with consistently high-quality, interactive online teaching and learning techniques. In 2012 faculty members approved a proposal to formally establish hybrid teaching and learning as its approach to adult education—and perhaps more important, to become consis-

tent in its approach to teaching and learning practices with adult learners. By the beginning of 2014, Augsburg had successfully transitioned more than four hundred graduate and undergraduate courses involving more than three hundred faculty members to a hybrid format.

One of the factors that made the work at Augsburg possible was the fact that Augsburg had been using an open source learning management system for many years. In order to make the open source learning management successful, Augsburg had created and nurtured a talented team of academic support professionals to assist faculty in technology implementation and course building using a Moodle open source learning management system. Because the Augsburg community had many years experience making their own enhancements to the learning management system and adapting it to their needs, taking on the daunting task of revising more than 400 courses involving 300 faculty was feasible. Without that experience, it's doubtful the Augsburg Hybrid project could have happened.

In conjunction with the Hybrid Initiative, we also used open source books—like the well-established and respected book on blended learning by Norm Vaughan, Marti Cleveland-Innes, and Randy Garrison, *Teaching in Blended Learning Environments: Creating and Sustaining Communities of Inquiry*. Because the book was published with an open license, digital copies of the book were available to all Augsburg faculty at no cost. And because Augsburg didn't need to spend any money on the digital books, Augsburg was able to hire one of the book's authors, Norm Vaughan, to come to Minneapolis and facilitate several days of hands-on professional development with faculty.

Some lessons from the field

SABIER's focus on openly licensed courses that are equivalent to a traditional textbook is the result of these many years of experience with systemic open practices, as well as the experience of implementing software in schools in both K–12 and higher ed. The same dynamics present in the Augsburg hybrid initiative have

informed the processes SABIER cohorts use to implement openly licensed content in full courses via learning management systems.

In order to be truly effective at tracking student achievement at the level of standards or individual competencies, course content must be used in a learning management system. Moreover, competency-based learning and project-based learning will need to use something like a learning management system in order to document student work. SABIER recommends using an LMS that will work for all aspects of teaching and learning and not just one discipline. It is also important that the LMS be fully functional and not just a document management system (like, for example, Google Classroom is).

Instead of taking money out of the public school system to pay investors in a for-profit company, SABIER will be using philanthropy money to support school districts' efforts to *own* their own curricula and provide their teachers with the skills to revise and edit those curricula to meet their students' specific needs. Doing so has significant potential to lead organically to a more systemic open approach in *other* aspects of the organization.

The current (very successful) OER middle school math curriculum, Illustrative Mathematics, has been adapted by a company that houses the curriculum in a proprietary learning management system and provides access for a fee. SABIER professional development is the "no cost to public schools" version of that model. But in addition to cutting costs by using OER, public schools will also be taking an important step in creating more open organizational cultures. Another important advantage is that schools will have the ability to control their own data and use it as they see fit, rather than rely on the goodwill of a for-profit company. We know this is the future of content delivery in K–12—because it's the approach most big publishing companies are now taking.

Likewise in higher education, publishing companies currently push proprietary "homework system" in conjunction with openly licensed textbooks. The economic dynamics of higher education are somewhat different than in K–12: students currently pay for the textbooks and *also* for the proprietary homework systems.

While openly licensed textbooks are now saving many higher education students a good deal of money, institutions could realize even higher potential savings if they were willing to take on the task of managing the homework systems in their own learning management systems instead of farming it out to third-party, proprietary providers. Increased teacher-student interaction, the ability to create authentic material tailored to specific objectives, and the option to control all student data more locally are advantages that openly licensed content on an open source learning management system will provide for higher education, too—that, and, of course, keeping the money spent in the system increasing teacher and student skills and institutional capacity rather than shipping it out to third parties.

The work of SABIER is to increase the amount of time teachers spend with students and to enable them to better use authentic sources that are specifically tailored to the needs of their students. We believe that openly licensed digital content and wifi-enabled devices are not a passing fad. We also believe that all students will benefit from more professional development regarding open content, but that professional development is especially critical for those teachers who will be teaching students who might not otherwise have access to quality learning that includes a strong teacher presence.

Delivering OER via an LMS is consistent with Education Reimagined's five interrelated elements characterizing student-centered learning, and we could consider it best practice for education in 2019 and beyond.[43] Access to content in a digital format for those who choose something other than English on paper is what will really drive the future of learning. The creation of an electronic record or archive of student work and teacher comments from which reports about *how students actually understand aligned material* is also crucial. There's a lot of chatter these days about the need for "aligned content," but very little talk about how assessment of student learning of the aligned materials gets ac-

43 https://education-reimagined.org/

complished. Using standardized tests is neither adequate nor desirable.

Using openly licensed curriculum with an open source learning management system won't necessarily lead to the educational institution becoming an open organization—but it's also not possible for an educational institution to claim to be open *without* using openly licensed content and an open source learning management system. The issue then becomes: Which is the most practical and efficient way to bring openness to an educational institution?

The answer to that is likely to vary depending on the many different types of educational institutions that exist globally. SABIER believes that implementing openly licensed curriculum with an open source learning management system supported by professional development that is based on and uses both openly licensed professional development content and open source collaboration tools is the most practical way to foster greater openness in most types of schools.

Most attractive to schools is the approach's cost-effective nature; schools must spend very little money to reap the benefits. Instead of spending *new* money, they can begin redirecting money that is currently being spent on proprietary content and proprietary tools to openly licensed content and open source tools.

But an even more significant advantage of this approach is that it helps the open organization philosophy take hold in schools and impact the actual *work* of education. This approach provides resources for creating places where collaboration and transparency are common, and an adaptable, ever-evolving curriculum maintains focus on *what* and *how* students are actually learning.

Dan McGuire taught elementary grades at Marcy Open School in the Minneapolis Public Schools for 15 years after spending 16 years in sales management for telecom and computer companies in local, regional, and international markets. He is currently the founder and executive director of the Stone Arch Bridge Initiative for Education Resources, a non-profit that enables philanthropy and foundation funding to go directly to supporting teachers and students so they can use free, openly licensed content on open source learning management systems.

Review and discussion questions

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M-learning and beyond

Jim Hall

> "Access to computers and the Internet has become a basic need for education in our society."–U.S. Senator Kent Conrad, 2004

I spent seventeen years working in higher education, both as a campus technology leader and as an adjunct professor. Today, I continue as an adjunct professor. I know firsthand that educational technology is invaluable to the teaching and learning mission of universities—and that it changes at a rapid pace.

Higher education is often an entrepreneurial space, seizing on new opportunities to deliver the best value. Too often, however, institutions spend a year or more to designing, bidding on, selecting, purchasing, building, or implementing new education technologies in the service of the teaching and learning mission. But in that yearlong interim, the technology landscape may change so much that the solution delivered no longer addresses the needs of the education community.

What's more, technological solutions often re-entrench traditional educational models that aren't as effective today as they once were. The "closed" classroom featuring the model of teacher as a "sage on a stage" can no longer be the norm.

Education needs to evolve and embrace new technologies and new modes of learning if we are to meet our students' needs.

Shifts in teaching and learning

The next fundamental technological shift at universities will impact how students interface with teaching and learning. To un-

derstand the new learning landscape, let me first provide the context of previous methods.

Learning has always been about students sitting in a classroom, pen and paper in hand, taking notes during a professor's lecture. We've experienced variations on this mode over time (such as small group breakout discussions and inverted classrooms) but most classes involve some version of this teaching model.

In the 1980s, IBM introduced the IBM-PC, which put individual computing power into the hands of everyone, including students. Overnight, institutions needed to integrate the new technology into their pedagogies.

The PC changed the teaching and learning landscape. Certainly students needed to learn the new software. Students previously wrote papers by hand—a methodology that directly mirrored work in the professional world. But with the introduction of the PC, modern students now needed to learn new skills.

For example, writing-intensive courses could no longer expect students to use a standard typewriter to write papers. That would be like expecting handwritten papers in the era of the typewriter. "Keyboarding" became a new skill, replacing "typing" classes in most institutions. Rather than simply learning to type on a typewriter, students needed to learn the new "word processing" software available on the new PC.

The thought process behind writing remains the same, only the tools change. In this case, the PC introduced an additional component to teaching and learning: Students learned the same writing *process*, but now learned new skills in the *mechanics* of writing via word processing software.

M-learning means mobile learning

Technology is changing, and will continue to evolve. How will students access information next year? Five years from now? Ten years from now? We cannot expect to rely on old models. And campuses need to look toward the technology horizon and consider how to prepare for that new landscape in the face of new technologies.

In response to today's ubiquitous computing trends across higher education, many institutions have already adopted electronic learning system, or "e-learning." If you have stepped into a college campus in the last few years, you'll already be familiar with central systems that provide a single place for students to turn in homework, respond to quizzes, interact with other students, ask questions of the instructor, receive grades, and track other progress in their courses. Universities that adopt e-learning are evolving to the classroom of the future.

But these universities cannot rest on the accomplishments of e-learning. How students interface with e-learning continues to evolve, and is already changing.

By my count, only two years ago students preferred laptops for their personal computing devices. Since then, smaller mobile devices have overtaken the classroom. Students still use laptops for *creating* content, such as writing papers, but they increasingly use mobile devices such as phones to *consume* content. This trend is increasing. According to research by Nielsen conducted a few years ago, 98% of surveyed Millennials aged 18 to 24 said they owned a smartphone.[44]

In a listening session with my campus, I heard one major concern from our students: How could they could access e-learning systems from their phones? With loud voices, students asked for e-learning interfaces that supported their smartphones. Electronic learning had shifted from "e-learning" to mobile learning, or "m-learning."

In turn, this meant we needed better mobile carrier reception across campus. The focus changes again—this time, from providing high-quality, high-speed WiFi networks to every corner of campus to ensuring the mobile carriers could provide their own coverage across campus. With smartphones, and with m-learning, students now expect to "bring their network with them."

44 https://www.nielsen.com/us/en/insights/article/2016/millennials-are-top-smartphone-users/

Finding the future landscape

This radically changes the model of e-learning and how students access e-learning systems. M-learning is about responding to *the mobility of the student*, and recognizing that *students can continue to learn wherever they are*. Students don't want to be anchored to the four walls of a classroom.

How will the future unfold? The future is always changing, so I cannot give a complete picture of the future of learning. But I can describe the trends that we will see.

Mobile computing and m-learning will only expand. In the next five years, campuses that have dedicated computer labs will be in the minority. Instead of dedicated spaces, students will need to access software and programs from these "labs" through a "virtual lab." If this sounds similar to today's model of a laptop connected to a virtual lab, that's to be expected. The model isn't likely to change much; education will be via m-learning and mobile devices for the foreseeable future.

Even after education fully adopts m-learning, change will continue. Students won't stop discovering new ways of learning, and they'll demand those new methods from their institutions. We will move beyond m-learning to new modes we have yet to uncover. That's the reality of educational technology.

Our responsibility as stewards of education is to discover the next educational computing methods *in partnership* with the students we serve. To meet the challenges this future technology landscape presents us, we cannot expect an ivory tower to dictate how students will adopt technology. That era is long past. Instead, institutions need to work together with students—and examine how to adapt technology to serve students.

Jim Hall has more than twenty years' experience in IT leadership. After serving more than eight years as Chief Information Officer in government and higher education, he founded IT Mentor Group, LLC (itmentorgroup.biz) to help CIOs and IT Directors with strategic planning and organizational development.

Review and discussion questions

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The most valuable cybersecurity education is an open one

Brandon Dixon & Randall Joyce

Today's world—marked by an increase of Internet-connected devices, digital assets, and information systems infrastructure—demands more cybersecurity professionals. Cybersecurity is the practice of defending these devices, assets, and systems against malicious cyberattacks from both internal and external entities. Often these cyberattacks are linked to cybercrimes, or crimes committed using a computer to generate profit or to affect the integrity, availability, and confidentiality of the data or system. In 2016, cybercrimes cost the global economy more than $450 billion.[45]

Developing a robust cybersecurity workforce is therefore essential for mitigating the effects of cybercrime on the global economy. The United States Bureau of Labor Statistics has predicted a shortage of 1.8 million cybersecurity professionals by the year 2022.[46] The United States has already developed a working group, the National Initiative for Cybersecurity Education (NICE), to promote cybersecurity education. Educators play a critical role helping promote cybersecurity as early as possible in academic organizations. And they should take an open approach to doing it.

It's critical for students to not only become acquainted with the advantages of open source software but also to develop strong skills working openly, since open source software is not only com-

45 http://www.hiscox.com/cyber-readiness-report.pdf

46 https://iamcybersafe.org/wpcontent/uploads/2017/06/Europe-GISWS-Report.pdf

mon in the IT industry in general, but is specifically necessary in the field of cybersecurity. With this approach, students can learn within the safety and guidance of the classroom while also naturally acquiring research and troubleshooting skills by facing challenges that are presented or arise during exercises.

In this chapter, we'll explain how experiencing these challenges in the classroom environment is imperative for preparing students for the industry and equipping them to face the unforgiving challenges that await them in the IT industry—especially in the rapidly evolving cybersecurity field.

Developing an open approach to cybersecurity education

Open source software, open source communities, and open source principles have been pivotal in the adoption of computer automation that is so common today. For instance, most smart devices are running a version of the Linux kernel. In the cybersecurity field, it's common to find Linux at the heart of most operating systems that are running on security appliances. But going beyond the operating system, Ansible has taken the management scene by storm, allowing for simplified automation of management tasks that even professionals without programming or scripting experience can quickly grasp and begin to implement. In addition to the benefits of automation, a variety of open source applications provide seemingly limitless capabilities for computer users—such as the ability to create video, music, games, or graphic designs on par with proprietary software. Open source software has often been the creative spark that has enabled countless individuals to pursue goals that would have otherwise been unobtainable.

Open source has had the same democratizing effect for cybersecurity professionals. Like other open source projects, open source cybersecurity tools receive extensive community support, so they're often some of the most-used security tools in existence today. Such tools include Nmap, OpenVAS, OSSEC, Metasploit Framework, Wireshark, and the Kali Linux distribution, to name a

few. These open source tools are an invaluable asset for educators, as they provide an opportunity for students to use the same cybersecurity tools currently being used in industry—but within a safe learning environment, a factor that is critical for student growth in the field.

In Murray State University's Telecommunications Systems Management (TSM) program, we're developing curricula and resources aimed at getting students excited about cybersecurity and motivated to pursue it. But students often enter the program with little or no understanding of open source principles or software, so bringing participants up to speed has been one of our biggest challenges. That's why we've partnered with Red Hat Academy to supplement our materials and instill fundamental Linux skills and knowledge into our students.[47] This foundation not only prepares students to use the open source security tools that are *based* on Linux operating systems but also equips them to experiment with a wider variety of Linux-based open source cybersecurity tools, giving them valuable, hands-on experience. And since these tools are freely available, they can continue practicing their skills outside the classroom.

Equipping students for a collaborative industry

As we've said, open source software's ubiquity and ample community support makes it critical to the field of cybersecurity. In the TSM program, our courses incorporate open tools and open practices to simulate the environments students should expect to find if they choose to enter the cybersecurity industry. By creating this type of learning experience in the classroom—a place where instructors can offer immediate guidance and the stakes are low—we're able to help students can gain the critical thinking skills needed for the variety of challenges they'll encounter in the field.

Chief among these, for example, are the skills associated with seeking, assessing, understanding resources from cybersecurity communities. In our courses, we emphasize the process of

47 https://www.redhat.com/en/services/training/red-hat-academy

researching community forums and reading software documentation. Because no one could ever hope to prepare students for every situation they might encounter in the field, we help students *train themselves* how to use the tools at their disposal to resolve different situations that may arise. Because open source cybersecurity tools often give rise to engaged and supportive communities, students have the opportunity to develop troubleshooting skills when they encounter challenges by discovering solutions in conversation with people outside the classroom. Developing the ability to quickly and efficiently research problems and solutions is critical for a cybersecurity student, since technology (and the threat landscape) is always evolving.

A more authentic operating system experience

Most operating systems courses take a narrow approach focused on proprietary software, which is an injustice to students as it denies them access to the diversity of the operating systems found in the IT industry. For instance, as companies are moving their services to the cloud, they are increasingly running on open source, Linux-based operating systems. Additionally, since open source software enables developers to repackage the software and customize distributions, many are adopting these varying distributions of Linux simply because they are a better fit for a particular application than. Still others are moving their servers from proprietary platforms to Linux due to the attraction of the accountability that comes with open source software—especially in light of frustrations that occur when proprietary vendors push updates that cause major issues in their infrastructure.

In the TSM courses, our students gain a strong understanding of foundational Linux concepts. In particular, the curricula from Red Hat Academy gives students granular experience with many of the foundational commands, and it allows them to gain an understanding of a popular open source system design. Linux has a well-developed community of other users, developers, and tinkerers that provide an excellent forum for students to engage other open source users for help. Having students develop a strong founda-

tional knowledge in Linux is critical as they progress through the TSM program. As students work through their courses, they naturally develop their knowledge and skills, and by obtaining this hand-on experience they also gain a foundation that prepares the student for a variety of careers—becoming traditional security analysts, for example, or pursuing careers in penetration testing using Kali Linux. No matter their path, having a strong Linux background is essential for students.

Embracing community-driven development

One of the major frustrations in the IT field is being forced to use tools that simply do not work or quickly become unusable. Often, software purchased to accomplish some particular task will quickly become obsolete as the vendor offers "upgrades" and "add-ons" to accommodate the changing needs of their customer—at a price. This experience isn't limited to IT experts; end users also experience this frustration. Driving this practice this is, naturally, a desire to maintain long-term profits, as companies must continue to sell software to survive or must lock their users into subscription models.

The fact that much of the open source software in use today is provided free of charge is enough to draw industry experts to use it. However, open source software is more than just freeware. Because the users of those tools have formed such large communities, they receive proportional support from their communities as well. It's not unusual to see small projects grow into full software suites as users submit feedback to community driven development. This type of feedback often creates products that are superior to their paid counterparts, which do not have such a direct line into the community they seek to serve. This is absolutely true in the case of cybersecurity tools, where the majority of the most popular tools are all open source, community-driven projects. In the TSM program, students are well-versed in tools such as these, thanks to the availability and free distribution model that open source software affords. The result is that through hands-on use, students gain a firm understanding of how to utilize these types of tools.

Future proofing

Staying relevant in the IT industry is a constant battle, especially when dealing with the many products and solutions that are always seeking to gain market share. This battle extends as well to the "soldiers on the ground," who may find keeping a diversified toolset difficult when many of the solutions are kept out of their hands due to a price ceiling.

Open source software provides students, who come from a variety of socio-economic backgrounds, with the opportunity to expand their experience without needing to be employed in a particular field, as the software is readily available to them through open source distribution channels. Similarly, graduates who find jobs in one particular segment of the market still have the opportunity to train their skills in *other* areas in which they may be interested, thanks to the breadth of open source software commonly used in the IT industry.

As we train these students how to train themselves, expose them to the variety of tools at their disposal, and educate them on how widely used these tools are, the students are not only equipped to enter the workforce, but are also empowered to stay ahead of the game as well.

Brandon Dixon is an instructor at Murray State University in the faculty group for Telecommunication Systems Management. He holds a Bachelor's of Science in Computer Science and Mathematics, as well as a Master's Degree in Telecommunication Systems Management.

Randall Joyce is an instructor at Murray State University in the Telecommunication Systems Management program, where he lectures students in the areas of cybersecurity, virtualization, and wireless. He has an M.S in Health Informatics from Northern Kentucky, an M.S. in Telecommunications Systems Management from Murray State University, and B.S. in Telecommunications Systems Management from Murray State University.

Review and discussion questions

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Chapter

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Review and discussion questions

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Three ways university classrooms can be more open

Susie Choi

Institutions of higher education stress the importance of student autonomy in academic exploration—yet the typical configuration of university courses does not take full advantage of students' potential to become actors in their education, rather than just receivers of it. To realize this potential and make university learning more inclusive of—and meaningful for—students, professors could learn a lesson from open organizations.

In this chapter, I'll highlight how the vision of an open organization could translate into concrete classroom change. I identify three problems that are part of status quo course structures and professor-student relationships, and propose potential solutions grounded in the principles of open organizations.[48]

Problem 1: Assuming that professors always know best

College students generally consider syllabus week as the easiest week of the year. For one week, they can sit in their classes and think about which friend to catch up with over dinner as their professors deliver monologues about expectations and projects for the semester; students need only stay awake and offer the occasional nod. Needless to say, the existing design of syllabus week does not set the tone for a semester of academic immersion.

To academically engage students from the first day of class, instructors could make students collaborators in sculpting course expectations. Rather than asserting their expectations as law, pro-

48 See Appendix.

fessors could initially present them as suggestions and act transparently by providing reasoning for those proposed expectations. Before finalizing expectations for the semester, professors could host a student commenting period, so as to be more inclusive of students' concerns and ideas, and potentially better accommodate students' learning styles.

Professor Mary-Ellen Kelm of Simon Fraser University is one professor who embraces the collaborative syllabus model; while she acknowledges the risk and uncertainty of co-created course guidelines, Dr. Kelm has found the resulting manifestation of student engagement and understanding unparalleled.[49]

In *The Open Organization*, Jim Whitehurst writes that, in an open organization, "a leader's effectiveness is no longer measured by his or her ability to simply issue orders." Similarly, in an open classroom, the thoughtfulness of a professor's planning would no longer be measured by his or her ability to issue expectations and announce grading schemes.

Problem 2: Fixed class structure

Though some colleges require end-of-course surveys from all students, periodic evaluations are rare. Even when professors *do* implement periodic evaluations, they offer no guarantee that they'll review them (or adjust the structure of their classes based on them). This is an issue because, as any student can attest, classes have their ups and downs. A professor's flipped classroom approach may be perfect for the beginning of the semester but become overly stressful as concepts become more advanced. Unmoderated class discussions may go smoothly for a few weeks but begin to exclude some voices as the semester progresses.

Periodic, student-accessible evaluations would help create an academic environment that students feel safe and supported learning in. Professors could request anonymous student feedback through online surveys every two to four weeks to accommodate

49 http://www.sfu.ca/tlc/blog/a-history-professor-invited-her-students-to-co-create-the-syllabus.html

for evolving student concerns throughout the semester. Professors could make this student feedback, as well as their direct and actionable responses to common concerns, viewable for all students.[50] This transparency measure would demonstrate to students that their input is valued, and hold professors accountable to evolving student needs, thus increasing student engagement and support.

Problem 3: Professors as authoritarians, and grades as retribution

Miss a class? Lose points—end of story. Miss a homework problem? Lose points—end of story. In classrooms operating according to the status quo, grading schemes tend to penalize student mistakes, rather than reward learning. And professors are the strict penalty-enforcers.

To move toward a growth- and learning-oriented classroom, professors should prioritize the value of adaptability over a reputation for tough grading. One way of achieving this would be to allow students to re-do assignments or exams for an improved grade. Such a policy would encourage students to view projects and exams as the means to a greater end (a deeper understanding of the material) rather than ends in and of themselves.

Let me illustrate one possible implementation: My high school Calculus teacher allowed her students to re-attempt incorrect exam answers with step-by-step justification to earn back half of their missed points. The half-credit provision ensured that the test correction policy would not detract from students' incentive to prepare for assessments, yet the policy still served as a source of relief, an opportunity for reflection, and an encouraging reminder that my instructor's priority was to teach, rather than to assign grades. Implemented at a university level, a re-do policy could similarly help in connecting students to both the course material and to their professors.

50 https://www.facultyfocus.com/articles/teaching-and-learning/using-multiple-course-evaluations-to-engage-and-empower-your-students-and-yourself/

To further the positive redefinition of the instructor role, professors could prioritize establishing trust over establishing authority. One way this could manifest is through a more understanding approach to student absences. Rather than immediately penalize absences, professors could allow students to provide thoughtful verbal or written reasoning for missing class. This reasoning would not be considered an excuse, but rather an explanation intended to build a more transparent relationship between professor and student. A reasonable explanation could be, "I have an interview for my dream job that conflicts with class time and that I cannot reschedule," or "I feel so mentally exhausted that I do not foresee myself being a productive member of discussion today. I will work on my time management, and arrive next class ready to fully immerse myself."

In the spirit of organizational openness, this policy would imbue greater trust and transparency in professor-student interactions, and facilitate the proactive diagnosis of student problems with course structure and material.

By integrating a few measures to respond to student input and allow room for students' trial-and-error, universities can innovate in a faster and more informed way, and in doing so, foster greater student engagement. All that's needed to start? A few insights from open organizations, a desire to connect with students, and a little creativity.

Susie Choi is a full-stack software engineer who learned about the open source movement during her time as a computer science student at Duke University. She is interested in what open principles like transparency and inclusivity look like in professional and academic contexts, and likes to challenge "whether" and "why" a technology should be built before exploring "how" it should be built. When Susie isn't coding or learning about cybersecurity, she can be found entranced in a fiction novel or running.

Review and discussion questions

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Open education is more than open content

Jim Whitehurst

The famous playwright George Bernard Shaw once said: "If you have an apple and I have an apple and we exchange apples, then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas."

I love that quote, and in May 2016 I shared it with a room full of educators, administrators, and open source advocates at New York University during the Open Summit, an open conversation about education.[51] I believe it reveals something critical about the future of education and the positive role openness can play in the future, if we embrace it.

As I shared in *The Open Organization*, the nature of organizations is changing, because the nature of how we organize to create value is changing. Educational organizations are realizing this more than most, because their stock-in-trade isn't something primarily physical (like apples). It's ideas. And ideas are becoming more plentiful, not less.

How we prepare people for life in these new organizations—where an ability to innovate and produce the new is much more important than an ability to work efficiently and reproduce the same—has to change just as significantly. We need to use the power of open to rethink education.

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51 https://opensource.org/node/832

Unfortunately, much of what I read about "open" in education applies to the sharing of educational content: the materials educators use to teach students, from lesson plans to activities to syllabi to entire curricula. While sharing content is certainly valuable, I think we can do more to make education more open.

To me, what makes openness such a compelling path forward for education has less to do with specific licensing decisions and more to do with the attitude we adopt toward educational practices altogether. It's the way we both imagine and work to build value around educational experiences (the "downstream" benefit of being open, as open source developers might say). More specifically, thinking openly changes how we *create*, *interact in*, and *sustain* educational organizations.

Creation beyond control

By default, most traditional educational organizations aren't inclined toward sharing. Just look at the ways many activities central to them—like tenure, publication, and advancement—tend to emphasize solo authors, thinkers, and inventors. In the context of higher education, we like to imagine scholars and scientists toiling away in isolation, dreaming up big ideas and releasing them to the world in brilliant form.

But we tend to forget a critical piece of the scene: The ever-present "Works Cited" or "References" pages that list every idea and innovation a scholar builds on when creating something new. Instead, educational organizations' cultural norms push against open exchange and collaboration and reward individual careers built on singular efforts—even though this isn't how innovation occurs.

And that's more evident today than it ever has been. Take big data, for example. In this exciting new field, every major innovation has been open sourced and shared, and what's been possible has been because of developers' desire for transparency and collaboration.

Thinking of ideas as possessions individual people create and control is a relatively new historical development, of course. In the

context of the industrial era, people wanted informational goods to function more like physical goods, so they invented things like copyright and patent law to make ideas work more like apples. And those inventions influence not only how we think about our creations and their value, but also how we build them.

When open education advocates focus too narrowly on content distribution, they can miss the act of *content creation*—and then risk missing ways we might change the pace and quality of the work we're doing together. Quite simply, co-creation allows better, richer, more diverse solutions and insights. It also allows us to succeed or fail faster, so we can accelerate the pace of innovation necessary today. Reforming our criteria for valuable educational contributions might help us begin rewarding an open approach to creation rather than discouraging it.

Interaction beyond prescription

When openness *does* become a default attitude, people's interactions change dramatically. Today we're enjoying the fruits of some of the largest distributed groups we've ever seen: organizations of creators and innovators spread across the entire globe. Each of them has something to teach us about the way we relate to and communicate with one another.

This is no less true for educators. But educational organizations (like public schools, to name just one kind) are still rooted strongly in certain values that emerged during an era of industrialization—where the purpose of education was preparing people to perform rote tasks repeatedly in closed organizations with little contextual perspective.

And yet, as we're seeing, the organizations that graduates join when they leave school (especially in the global West) are less and less industrial—and even the ones that are industrial are reinventing themselves for largely post-industrial activities. These organizations demand new models of both cooperation and leadership: new ways of working together, new standards for effective interaction, and new rules for distributing authority.

In the meritocracies that so frequently form inside open organizations, formal titles mean less than reputation with regard to power relationships. Leading an increasingly educated and savvy workforce involves creating context for great work rather than prescribing and specifying every detail in order to mitigate deviation. Directing is less important than catalyzing. What might happen to classrooms if we began teaching this way?

We need to think seriously about how we're educating tomorrow's organizational participants and leaders, because—for now, at least—we're emphasizing modes of interaction that are just outdated.

Sustainability beyond transmission

Thinking about educational organizations as catalysts raises one other interesting point: What happens to these organizations in an age of abundance?

This is a particularly hot topic among folks in higher education, who are beginning to realize that imagining universities as machines for the transmission of information is no longer working. Under traditional models, schools market themselves as places with the best educational "content" for students. But today—a time when we're celebrating much easier access to information—these organizations no longer have a monopoly on ideas. Many are even putting their courses online and making them available at little or no monetary cost to students. The "content" is losing its place as a key value generator.

That's prompting educational organizations to face a kind of existential crisis—one that raises difficult questions. When abundance is the default, what happens to an organization that depends on scarcity? How does its purpose change? And what happens to the revenue-generating mechanisms that allow it to persist, thrive, and grow?

These aren't easy questions, by any stretch. But they're exactly the ones that challenge us in the open source software business, where our ongoing task is to *create business models around abundance*.

Red Hat's product, for example, isn't software. The software is open source, easily accessible to others, and licensed to promote sharing. Development is community-oriented. The "content," in other words, is free and abundant.

Red Hat adds value to the open source ecosystem by leveraging abundance to create more and better abundance. We support people using the software. We contribute to communities creating new, more advanced versions of the software. We patch and secure the software. We sift through the abundance, make sense of it, and help other people leverage it effectively. That's our product (and we're very good at making it!).

As they ponder their place, role, and function in an age of relative abundance, educational organizations must find new ways to generate value from that abundance. The longer we conceive of education as an enterprise focused solely on "content," the longer we're going to miss opportunities to help those integral organizations survive.

Reimagining education today might begin with a few simple questions:

- What value do educational organizations provide?
- What is their product?
- What role can they play today?

Answers to these simple but difficult questions will differ for everyone involved. But in an age of abundance, the educational organizations that survive will be those most focused on what they can add, what they can catalyze—and how they can best harness the power of openness to change the ways they create, interact, and sustain themselves.

Jim Whitehurst is president and chief executive officer of Red Hat, the world's leading provider of open source enterprise IT products and services.

Review and discussion questions

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Case Studies

A hybrid model of open source in academics: The Rensselaer Center for Open Source

Wesley Turner, David Goldschmidt & Mukkai Krishnamoorthy

The Rensselaer Center for Open Source (RCOS)[52] is a project-based, experiential learning center where students work on open source software for course credit. RCOS was founded in 2007 by a gift from RPI alumnus Sean O'Sullivan,[53]who stated at the time of the gift:

> We have a duty to our fellow man to improve life on this planet. While technology has always been a huge enabler in improving quality of life, we now are at a point where, through open software and open content, these improvements can come at close to zero cost, opening up opportunities to all, particularly in Third World situations, but also in government and consumer applications, open source solutions can cut through economic, political, and social divides, and enable people to simply get the job done. This center at Rensselaer may very well become a model for accomplishing this. With the global perspective and global reputation of Rensselaer research, I hope this hands-

52 https://rcos.io

53 Along with the gift from Sean O'Sullivan, RCOS has also had financial support from Red Hat. Other donations of money, material, and time have come from Google, Datto, IBM, Microsoft, Mozilla, the Humanitarian Open Source Foundation, and the Open Source Initiative. We sincerely thank all of our donors.

> on development center will both engage students and engage the world.[54]

Included in this statement are several important concepts. First is a belief in the overall benefits of technology and in the ability of open software and open content to improve outcomes worldwide. Second is the belief that open models can succeed where other forms of development and distribution cannot. And third is the importance of exposing students to this open source world in a way that engages them and opens their eyes to the potential of this new paradigm. RCOS has distilled this down to an even simpler mission statement, "To cultivate an inclusive, creative, and entrepreneurial community that seeks to empower students to develop open-source solutions to real-world problems."

While the demands of a university environment require that RCOS operate on the academic calendar, the nature of open source allows us to go beyond the normal bounds of semester based projects. RCOS projects typically run multiple semesters and along with the more than 200 students getting course credit, there are also 10–15 receiving a stipend, and 20–40 just working on projects. A companion course, CSCI-4961: Open Source Software, supports this Free and Open Source Software (FOSS) work by providing the cultural, historical, and technological underpinnings of the open source movement.[55]

In this chapter, we explain how RCOS is organized to meet its dual roles as both a student-led club and an academic organization. We then explore the calendar of activities that comprise a semester, and continue with a brief discussion of some notable projects. We conclude with goals for the future.

The RCOS Model

RCOS combines aspects of a student-led club with independent study. Students take on multiple roles as coordinators and

54 http://www.cs.rpi.edu/~moorthy/rcos/donors.html

55 This course is hosted on GitHub at https://github.com/rcos/CSCI-49XX-OpenSource and can be freely accessed and used.

mentors to lead club activities and work with faculty instructors on the curriculum. Instructors are responsible for ensuring academic rigor and for providing guidance and expertise to students.

To meet class requirements, RCOS meets for two hours, twice a week. During the first three meetings of the semester (and then about once a month), RCOS holds "large group" meetings. These mandatory meetings occur in a large lecture room. They not only allow us to efficiently reach all students, but also help us explore open source topics through lightning talks, quick announcements, student-led technical talks, and guest speakers. These talks help teach students how to effectively work in open source communities and expose them to humanitarian and commercial open source projects.

When a large group is not scheduled, RCOS holds small group meetings. Small groups are working meetings in a lab room overseen by two or three mentors or coordinators. Each room hosts roughly two to eight projects (20–25 students). Rooms are "themed" based on application area (e.g., music, cryptocurrency) or on technology area (e.g., machine learning, full stack, game development). Together, the large and small groups form the backbone of the RCOS curriculum.

Finally, mentors must each host one workshop. These workshops are held outside of class hours and are tutorial explorations of specific technologies. Mentors have freedom on workshop topics, but specific topics such as git and project management are presented every semester. Students must attend at least one of the mentor workshops.

Instructors, coordinators and mentors

RCOS is led by a team of two instructors, four to six student coordinators, and an additional 15–20 student mentors. All are important to maintain RCOS at its current scale. Students take leadership roles in multiple aspects of RCOS. Coordinators perform an administrative role (helping to develop instructional material, documentation, and community standards) while the coordinators and mentors guide other students (peer mentoring, running

events, and helping to evaluate the semester's accomplishments). Coordinators and mentors also serve as small group leaders and provide peer mentorship to the projects within their groups. The faculty support all of this—manage the overhead of more than 200 independent study students, assign all grades, and ensure academic standards. Coordinators are the primary link to the faculty and have weekly contact to discuss plans for the week and other activities (such as workshops, outreach, speaker invitations, and other events). Generally, this ends with action items assigned to the coordinators and instructors. Additional meetings with the coordinators, and the entire team ensure that all ideas are considered.

Classwork aspects

Grading more than 200 independent studies is non-trivial, and the visible progress students make is dependent on both the type of project and the experience of the student. The progress we expect for students working on new projects differs from the progress we expect on established projects, or from external projects, or from combined hardware/software projects. This makes a single, standard grading rubric difficult. At the same time, we do not want to constrain our students to a project just to make grading easier. Our approach is to try to embrace differences by measuring effort and progress instead of outcome. In some sense, RCOS is the course at RPI where students are allowed to "fail" and still succeed.

That said, we do have a basic grading rubric defined for the class:

- 50%: Open Source Contributions (contributions are measurable artifacts typically in the project repository)
- 25%: Status Updates and Project Documentation (non-project repository based updates)
- 15%: Presentations and Outreach (class presentations or extra-curricular outreach)
- 10%: Attendance (large and small group meetings and at least one mentor workshop)

All course material is available online in the RCOS Handbook repository.[56]

Anatomy of a Semester

Unlike working on open source "in the wild," where people join and leave projects at irregular times and may have erratic and unpredictable schedules, RCOS needs to work according to the normal cadence of a college semester. During the course of a semester, students must join or initiate an open source project, make significant contributions to that project, and present their results to the RCOS community.

Phase 1: Getting started

During the first phase of the semester (about four meetings), the goal is to get all students to pick a project and to initiate an independent study by submitting an Undergraduate Research Proposal (URP) referencing it. Meeting this two week goal is critical to a successful semester.

This phase has two distinct activities: elevator pitches and speed dating. Beginning with the first meeting of the semester, every project presents one or two slides and gives an "elevator pitch." Elevator pitches are short—no more than two minutes—and provide a brief overview of the project: significance, technologies, and type of help needed. An eye-catching graphic is recommended. Students, external mentors (in person or via web), or faculty can give these pitches. Pitches can cover new projects, existing RCOS projects, or existing external projects. Pitches continue into the second meeting and (possibly) the start of the third meeting, all of which are in the large group room.

Following the pitches (but still within the third meeting) we proceed to the "speed dating" phase. All project leads line up at the front of the room, and students without projects circulate among them looking for interesting ones to join. Instructors, coordinators, and mentors circulate as well, guiding students who are lost and

56 https://github.com/rcos/rcos-handbook

brokering matches. After a project has fully formed, everyone sends elevator pitch slides and completed rosters to coordinators, who use this information to assign small group rooms.

For the fourth meeting, projects meet in their designated small group rooms to compose formal project proposals, which include a series of milestones, and to fill out their individual URP forms.

Phase 2: Project development

After the proposals have been submitted, we enter the project development phase, in which students work on advancing their projects according to their proposed milestones. Note that these milestones are nominal. We do not penalize projects for missing milestones, but we do expect the students to address why they may have missed milestones and to formulate revised plans as they learn new information.

Throughout this phase, students attend small and large groups on a published schedule.

Phase 3: Wrapping it up

Near the end of the semester, we transition to the final phase: reports and wrap-up.

We've used several approaches to reports, beginning with having each project present during large groups. Our most recent implementation recognizes that having more than 30 projects report to the entire group is not optimal. So beginning with the spring 2019 term, we began scheduling presentations by small group room. Each room is given a specific presentation date, and on that date all of the projects in that room meet in the large group room prepared to present. Rooms not scheduled for that day can continue to work on their projects. Note that final evaluation of projects does not occur until the end of the semester, so those projects that present early can continue to progress. This new organization allows us to have more small group meetings while also increasing presentation time for each project.

Our final RCOS event is a class pizza party held during the final (large group) meeting of the semester.

RCOS Authored Projects

Projects at RCOS span a wide variety of topics and have life spans from one semester to several years (and ongoing). Sample projects include:

- YACS (Yet Another Course Scheduler)[57]
- Observatory[58]
- Submitty[59]
- Automatic Door Control [60]
- Shuttle Tracker [61]

These projects are making a tremendous impact on—and in some cases off—campus, improving the community and demonstrating the incredible capabilities of RPI students. For example, computer science instructors heavily leverage Submitty to grade programming assignments, making large project courses such as CSCI-1100 Introduction to Computer Science (Academic year 2017-2018 enrollment of 925 students) possible. By the time they graduate, every CS student has turned in at least one homework assignment via Submitty. Other projects, such as YACS and Shuttle Tracker, provide improved services to students such as a user friendly course scheduler (YACS) and a real-time, graphic depiction of the campus shuttle location (Shuttle Tracker). Students create these and other projects to meet their needs and improve campus life.

Lessons learned: Continued refinement

Building on these initial and ongoing successes, RCOS is ready to grow—in size, visibility, and collaborations beyond RPI, and in the quality of both students and projects produced. In addition, RCOS is a key partner in the RPI Computer Science

57 http://yacs.cs.rpi.edu

58 https://github.com/rcos/observatory-server

59 https://github.com/submitty/submitty

60 https://github.com/AutomaticDoorControl

61 https://github.com/wtg/shuttletracker

Department plan to further increase the diversity of RPI CS graduates. RCOS is also actively reaching out to non-CS majors by making sure that the academic aspect of the RCOS curriculum is approachable to them and by stressing the importance of non-code contributions and project leadership in open source development.

Externally, RCOS is working with groups at other universities (like New York University and Northeastern) and other open source organizations (like the Open Source Initiative,[62] the Mozilla Open Source Student Network,[63] and Teaching Open Source[64] to enrich the student experience. In fact, RCOS was the first student led organization to be an affiliate of the Open Source Initiative. Further, Submitty, an RCOS project described above, has been installed at three other colleges: King's College, Sapienza Universita di Roma, and Walla Walla University. Subsequently, students at Walla Walla were able to submit a successful pull request to Submitty. This outreach opens the door for a new kind of FOSS project that may be well-suited for student participation.

Dr. Wesley Turner is a senior lecturer and the current Director of RCOS at Rensselaer Polytechnic Institute. Prior to joining RPI in 2016, he worked for multiple commercial companies including for General Electric Global Research Center, Kitware Inc. and SimQuest where he used and developed open source software. At one time, he was also the Director of Open Source Operations at OSEHRA.

David Goldschmidt is neque aliquam vestibulum morbi blandit. Mauris sit amet massa vitae tortor condimentum. Volutpat diam ut venenatis tellus in metus vulputate.

62 https://opensource.org/

63 https://ossn.club/

64 http://teachingopensource.org/

M. S. Krishnamoorthy received the B. E. degree (with honors) from Madras University , the M. Tech degree in Electrical Engineering from the Indian Institute of Technology, Kanpur and the Ph. D. degree in Computer Science, also from the Indian Institute of Technology, Kanpur. From 2007 till 2017, he was the co-director of Rensselaer Center for Open Source Software.

Review and discussion questions

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Teaching students to critically evaluate textbooks

Christopher McHale, Ian McDermott & Steven Ovadia

In Spring 2018, the LaGuardia Community College Library department was awarded a New York State grant to train students to evaluate textbooks. LaGuardia is an urban community college in Queens, New York, and is part of the City University of New York (CUNY). Textbooks—and their high cost—have become an important issue in American higher education. Many schools, systems (including CUNY), and (as in this case study) states provide financial support for the creation of open education resources (OER), with the goal of decreasing the financial burden on students.

The term "OER" is commonly associated with cost-free, digital textbooks; however, it encompasses all of the material related to running a class, from the syllabus to assignments to slide decks. Faculty around the world are creating and modifying OER to use in their own classes; some schools are creating entire programs around them.

Driving these efforts is a powerful ideal: Students can receive a degree without ever having to pay for a textbook. As a result of this push, more and more students are encountering OER materials in their college classes. Unfortunately, in too many places where such adoption takes place, students and their views are an afterthought.

That's what led to the project we'll describe in this chapter. We designed it to bring students' voices into the OER movement

and leverage their perspectives, improving the quality of their education.

Project overview

Students shouldn't just receive or "ingest" OER; they should be partners in building and evaluating the materials their professors ask them to adopt. This project involved creating a map to guide students into the complicated textbook evaluation and selection process.

Led by Professor Christopher McHale, with Professors Ian McDermott and Steven Ovadia serving on the project team, the group sought to combine service learning and information literacy. The underlying idea was to give students not only a scholarly grounding that would help them as they move through their academic careers but also a practical vocational orientation to help them succeed in the workforce, and, hopefully, become future contributors to the free culture movement.

The information literacy component of the project involved teaching students the basic tenets of information evaluation. What makes a source authoritative? How does one know if information can be trusted? Using the Association of College and Research Libraries (ACRL) Framework for Information Literacy for Higher Education, the current professional standard for information literacy, the project also encouraged students to evaluate resources in terms of their own needs and their personal concepts of value.[65] What features made a textbook effective? For instance, many students commented on font size. While it seems like a small thing (often, literally, *too* small), it matters to students and makes a difference to how they interact with textbooks. One of the ACRL frames is "Information Has Value." The seminar encouraged students to think about features they want in a textbook, like appropriately readable font sizes, and consider the value (both intellectual and financial) those features would offer.

65 http://www.ala.org/acrl/standards/ilframework

The service learning component, on the other hand, involved training and paying students—giving them a marketable skill. Students received a tuition credit of $1,100 for participating in the seminar, as well as a digital badge. Digital badges are increasingly popular tools for students to demonstrate specific job skills to employers.[66] The generous tuition credit created a strong response rate to the call for participation. Ultimately, we selected 18 students using a two-step interview process (email and in-person). Fifteen students successfully completed the seminar.

An additional goal of the project was to give faculty a toolkit to help students critically evaluate the textbooks being used in their classes. We didn't expect faculty to use *all* of the tools we presented in a 16-week seminar; we simply wanted to provide college instructors and administrators with options for determining how textbooks are working (and not working) for their students in a way that makes sense for individual faculty members. Using the survey tools and evaluation procedures in the toolkit encourages educators to continuously engage students in the selection, creation, and adaptation of textbooks and other learning aids.

The seminar was hosted in the CUNY Academic Commons,[67] a combination social network and learning management system providing a variety of free and open source tools to anyone associated with CUNY[68] (the project is available for other institutions to implement).[69] The seminar used a combination private group/public blog built upon WordPress.

We're still combing through project data but, anecdotally, we can say that students reported the seminar was helpful. They felt it taught them about the economics of textbooks and helped them understand which features of textbooks they find most useful. A common theme that emerged from student feedback was that text-

66 https://www.insidehighered.com/news/2016/08/09/digital-badging-spreads-more-colleges-use-vendors-create-alternative-credentials

67 https://commons.gc.cuny.edu/

68 https://en.wikipedia.org/wiki/CUNY_Academic_Commons

69 https://commonsinabox.org/

books are not something students typically think about. Textbooks are simply something students are assigned and that they must pay for. But having completed the seminar, students said they are more aware of what goes into making a good textbook. This includes an awareness of textbook economics; while the price of OER textbooks is favorable, commercial textbooks, for some students, offered features worth paying for.

Why go open?

An important component of OER is that material is freely available, "free" in this case meaning both "freely accessible" and "free of charge." With that ethos in mind from the beginning of the project, we always intended to release all of the course-related material as a toolkit. In essence, the idea was to create OER material to aid in the adoption and evaluation of OER material. Our intent was to make the content open.

But at its core the seminar was about opening up not just intellectual material but also processes—in this case, the *process* of guiding students through a critical examination of their textbooks.

In order to increase discovery, we uploaded the course materials to CUNY's Institutional Repository.[70] We uploaded the files both in their original format (a mix of word-processed documents and PowerPoint files) and in Markdown, a flexible, transformable markup language that facilitates easy alteration of text into different formats. Markdown's flexibility facilitates easy cut-and-paste into different applications; the end-user isn't locked into one format. For instance, the seminar's final reflection was posted on the class blog, which was formatted in HTML. Sharing the text as Markdown means users can easily convert text into various formats—perhaps a word-processed document, a PDF, or even a presentation slide. Sharing in this way ensures end-users can focus on the content of materials, not their formatting.[71] However, not all

70 https://academicworks.cuny.edu/lg_oers/72/

71 https://preprint.press.jhu.edu/portal/sites/ajm/files/19.1ovadia.pdf

users are familiar with Markdown, which is why we included more familiar word-processed files as well.

We also shared course materials on GitHub (again, as Markdown-formatted files). While GitHub is primarily a platform for sharing code, its collaborative model could work well for OER content too. GitHub makes working with OER easier—both accessing it *and* adapting it for new uses and contexts. Critically, it also allows users to share their remixed work *back* to the original creators. For this reason, GitHub has a strong following among librarians.[72]

At the end of the class, the project team assembled its material into the following parts:

- a class syllabus[73]
- final reflection[74]
- pre-[75] and post-evaluation surveys[76]
- a qualitative survey[77]
- a quantitative survey[78]
- a document outlining participant responsibilities[79]
- some Amazon-esque review prompts[80]

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72 https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1133&context=kb_pubs

73 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/syllabus.md

74 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/final.reflection.md

75 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/pre.survey.md

76 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/post.survey.md

77 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/qualitative.survey.md

78 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/quantitative.survey.md

79 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/participant.responsibilities.md

80 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/amazonesque.md

- slides associated with the class (in PowerPoint)[81]
- a handout on the parts of a textbook[82]

The challenges of openness

The team was aware of the importance of sharing the final products we developed throughout the seminar; nevertheless, keeping track of everything still proved challenging. Part of the challenge was that content existed in multiple places. We handled much of the planning via email, Slack, and Google Docs. Class materials, like the syllabus and participant responsibilities document, lived in Google Docs. Slide decks sometimes began as local files before eventually being moved to Google Slides. However, discussion prompts and the final reflection wound up in the course shell. And the survey questions were in Qualtrics.

This meant that assembling the toolkit required a bit of work, exporting content out of each unique "container" and cleaning up the formatting. It also entailed manually converting each piece of the toolkit into Markdown. Because the slides relied heavily on formatting and images, we kept those in their original format (PowerPoint), as we did with a graphic-intensive handout on the parts of a book (a Microsoft Word .docx file).

Finally, the team constructed a brief narrative around the toolkit, in order to frame the work, so it made sense to end-users. This required more time and attention than the team initially anticipated.

One could argue that a solution to this challenge is to work solely in flexible formats like Markdown, but given the timing of the seminar (and the relentless, unforgiving nature of an academic term), the team had to revert to familiar collaborative tools. Yet we note this challenge here to underscore just how difficult creating open materials can be. If projects like this one—which aimed to be open, shared, and collaborative from the start—encounter difficul-

81 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/lessons

82 https://github.com/stevenov/textbook-evaluation-toolkit/blob/master/handouts

ties sharing material in the most flexible way possible, then imagine the greater potential problems for academics who want to share their class content but haven't made these provisions from the start.

Making class content accessible is more than just deciding to make it open. It requires planning and massaging. It's not always a matter of simply clicking a paperclip icon to upload files or sharing the URL to a folder of documents when a semester has concluded. Just *getting* to the "upload" and "sharing" stages takes a good deal of time.

Conclusion

The work of this seminar was incredibly rewarding. But ultimately, after one semester, it proved unsustainable. Its grant-funded nature (which introduces limitations on how funds can be spent) made the project non-viable beyond its pilot. The team spent too much time navigating procurement systems and brainstorming workarounds while still maintaining the day-to-day duties of faculty librarians. We simply no longer had time to squeeze in the seminar.

But the beauty of OER is that while the project does not work for our current institution, the team is able to share with others both the materials and the lessons we learned. They might adapt the project as a whole or adapt pieces that make the most sense for their needs. But the project can live on—in one form or another.

Christopher McHale is habitant morbi tristique senectus et netus. Nisi lacus sed viverra tellus in hac. Egestas fringilla phasellus faucibus scelerisque eleifend.

Ian McDermott is habitant morbi tristique senectus et netus. Nisi lacus sed viverra tellus in hac. Egestas fringilla phasellus faucibus scelerisque eleifend.

Steven Ovadia is habitant morbi tristique senectus et netus. Nisi lacus sed viverra tellus in hac. Egestas fringilla phasellus faucibus scelerisque eleifend.

Review and discussion questions

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What happened when I let my students fork the syllabus

Heidi Ellis

I teach a traditional "get to know college" course for freshmen. It's designed to help new students work on the skills they'll need to be successful in college, such as time management, personal management, and communication.

It's also become a prime opportunity for me to introduce freshman students to the guiding principles of open culture.

I've developed a method for treating my class as an open organization. To create a more collaborative and inclusive environment, I let the students co-construct the official course syllabus.

Here's how I do it—and what students have taught me about the value of making our classrooms more open.

The open syllabus

I taught two sections of the course in fall 2017 with a total of 27 students. We met twice each week, for 50 minutes each time. My goal was to afford the students as much control over the course as possible within the constraints set by the course description and requirements. In the spirit of open and transparent problem-solving, I facilitating a few activities that involved:

- identifying an aspect of the course yet to be specified (for example, a"disruption policy"),
- discussing (as a group) the constraints of the problem, and
- helping students generate a solution.

Early in the semester, we used these techniques to construct some course policies. Later on in the term, we employed the same methods to construct some homework assignments too.

Building the policies

First I challenged the students to collaboratively compose a "disruption policy" for the course. I offered the following instructions:

> The Code of Conduct currently has no policy for attention and handling classroom distractions, such as cell phones. We will create one during this activity. This policy will apply to all of Heidi Ellis' sections of LA-100. We are attempting to solve the following problem: "Computer noises, cell phones, messenger apps, IM, whispering, music, talking, etc., can all potentially draw learner attention away from learning. How do we ensure that class can proceed without interruptions or distractions? How do we ensure that class meetings are a time and place where we can focus on learning? How do we ensure that everyone in the class has an equal opportunity to learn?"

This exercise was a learning experience for both my students and me, as we clearly had different visions of what constituted a "disruption." While we all agreed that students should pay attention to the instructor and engage in all classroom activities, students thought they should be able to take "important" calls during class time and that texting during class was acceptable. I thought that cell phones should be turned off entirely during class. Students also thought that leaving the classroom to get a drink without asking permission was acceptable, while I thought that they should handle thirst needs before or after class.

This resulted in a discussion about professionalism and the expectations associated with college-level work. We discussed what constituted a distraction and agreed that making sounds, whispering, and talking in class all counted as distractions. This in turn led

to a discussion of the impacts distractions can have on a learning environment and the importance of paying attention in class. We also explored the impact various learning technologies can have on a classroom—for example, the tools students with disabilities require to fully participate in class, such as a screen reader—and agreed that noise generated by these was acceptable under the policy we intended to construct.

In much the same way, I also involved the students in co-constructing the course's policy regarding work submitted late. This was the challenge:

> The Code of Conduct currently has no "late policy" that determines when assignments are considered "late." The problem we are trying to solve is this: "This policy applies to all out-of-class work. How do we ensure that everyone in the class has the same opportunity to complete assignments? What is a 'timely' submission of a deliverable? End of class? Beginning of class? End of day? What should be done when a submission is not timely? How do we handle legitimate lateness due to extreme illness or death in the family? What is a legitimate lateness? We need a policy that ensures fairness to all class members, including the instructor."

As with the disruption policy, the students and I had very different views of what constituted "late" work, which led to fruitful discussions. Students thought that submitting homework a day or two after the deadline should not be considered late, while I thought that anything submitted after a deadline should be considered late. We then discussed what happens in a professional environment when work is submitted late and when someone arrives late to a meeting. In this case, students still wanted some leniency when handing in assignments, so we agreed that all deliverables would have a one-day "grace period" after which students' scores on those assignments would decrease by one letter grade

per day late. Collaboratively, the class produced the following statement:

> A deliverable is late when it is submitted after the due date and time. Legitimate lateness reasons include approved illness, family emergencies and death, and athletic events. All deliverables have one grace day after the due date. Submissions that come in after the grace day will be docked one grade per day. *Deliverables that will be discussed in class have no late days allowed*.

I hosted both the disruption and late policies on GitHub, and in order to make changes students were required to fork the Code of Conduct, make changes, and submit a pull request for group review. A small number of students jumped right in, forking the document and making changes; however, this number was small (perhaps two or three students at most). The majority of students either did not try to make any changes—or tried at the very last minute.

In retrospect, I think the joint construction of portions of the course policy was a real learning opportunity. In the future, I would provide students with a clear understanding of professional behavior *before* attempting the policy construction and preface this with activities to convey an understanding of professional behavior. I would then use the construction of policy as a real-world example of professional behavior.

Building the assignments

Later in the semester, I again tried an open approach to creating assignments, which I found to be more successful.

The most successful of these was the assignment to fulfill the Oral Communication requirement for the class. The requirement includes creating a presentation and being able to deliver that presentation clearly.

We began with a brainstorming session, during which we identified possible ways of fulfilling the objective. Students came

up with the traditional presentation, but also came up with a number of interesting ideas, including:

- Lecture: 2–3 people create and deliver a presentation followed by quiz. Quiz results displayed on the board interactively.
- Individual, related presentations: Multiple speakers with connected topics where one talk leads into the next.
- Jeopardy game: 3–4 people, one person per category. Clues would be facts about the open source topic. The person responsible for the topic would introduce the topic, expand on each clue, and conclude the topic at the end.
- Classroom debate: Six debates on six topics, with 2–3 people per team. Audience takes notes, asks questions, and assesses performance.
- Movie: 3–4 people, 1 or 2 topics per movie. Choose a story that explains the point. Could use still images with narration.

In addition to the ideas listed above, students also suggested Socratic Seminar and Fishbowl. However I eliminated these ideas as I could find no way to assess these approaches based on the necessary rubrics.

We then discussed which was the most popular idea and jointly decided that a mock Jeopardy game was an ideal way to fulfill the requirement. Students selected a topic related to open source and created questions and answers for the game. Students were then organized into teams of five.We used a modified answer/question approach: Rather than asking questions across categories, each student provided an introduction to their topic and presented five "answers," and the rest of the class were encouraged to provide the "questions." Once all "questions" had been asked, the student provided a summary of the topic.

Students were engaged throughout the process of constructing the assignment and were enthusiastic about the game itself.

Open organizations and university classrooms

Overall, the "open syllabus" exercise taught me a lot about both open organizations and about student preparation for learning in one.

In the future, to better support an open classroom, I would make the following changes:

- Beginning the class by providing students with information about how open organizations work and examples of open organizations
- Creating one or two in-class activities (early in the term) that allow students to experience open principles and how they work in an organization
- Creating activities to instill a foundation of professionalism (in order to employ open organization principles, students need to have an understanding of the boundaries of professional behavior)
- Progressing to using an open organization approach to developing assignments by starting small (perhaps by having students develop a small assignment first, rather than attempting to create self-governance as their first effort)

Keeping student work open and accessible has value for *subsequent* groups as well. I could foresee, for example, teaching successive sections of the same course in which current students reviewed the actions and decisions of previous classes to better understand open organization principles.

I do see a good deal of potential for running classrooms using principles derived from open organizations. The Jeopardy assignment was the most popular and most successful at engaging student interest. Clearly, provoking interest is an important factor to employing open principles in the classroom.

I found that students were more creative when I gave them more space to create. They came up with very interesting ideas in response to fulfilling a broadly defined assignment. This type of creativity is key for supporting learning.

Moreover, students clearly felt empowered to exert some agency over their learning. They felt more like they were part of

the education process rather than just a consumer of knowledge. I expect that further use of an open approach would allow students to be more invested in their learning, thereby producing students who are better prepared for real-world complexity.

Heidi Ellis is Professor and Chair of the Computer Science and Information Technology department at Western New England University. She has a long-time interest in computing education and has been supporting student participation in open source software since 2006.

Review and discussion questions

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An open process for discovering our school's core values

Beth Anderson

When I joined The Hill Center in Durham, North Carolina, as Executive Director nearly two years ago, I realized immediately that I had joined a wonderful, successful, highly conventional education organization. Hill has been transforming students with learning differences into confident, independent learners for nearly 40 years, and many of the faculty and staff (including the outgoing Executive Director) had been at Hill for most of that time. Hill has a strong culture, and its faculty and staff all consistently deliver high-quality programs for students and teachers alike—all despite evident tensions, misunderstandings, and mistrust between senior administration, faculty, and staff as well as across different programs and teams in this rigidly siloed, hierarchical organization.

From the start, I publicly stated I wanted to address issues of culture, trust, and transparency, in part by establishing organizational core values. But I didn't know how or when to do so. And, candidly, I was scared. I knew I couldn't come into Hill and impose my own core values, yet I was petrified of what might emerge if I opened the value-creation process to everyone—and I didn't how I would respond if I simply didn't believe in, like, or want to adhere to what did.

Hill did have core values posted on its website and included in its strategic plan, but they just didn't resonate with me, and hardly anyone within the organization could articulate them. I saw

both an opportunity and a challenge. Despite my public proclamation, however, I decided to wait.

The time comes

Fast forward 18 months.

I'd read *The Open Organization* (and many other articles along the way) as I tried to navigate the path forward, discover my authentic leadership and management style within this (still very foreign) context, and lead change in a non-threatening manner. I'd adopted and promoted "All Hill" language and events to help break down siloes. We'd engaged in an All Hill "strategic visioning" process that was faculty/staff-centric, rather than being led by the board, and that resulted in some new relationships, dialogue, and common language. We had hired, retired, or exited many faculty and staff, resulting in an organization that was suddenly fairly evenly split—almost exactly one third newer personnel, one third in the three-to-ten-year range, and one third employees who had been at the school more than a decade (half for more than 20 years). And we were still very, very far from being an "open organization."

So I decided it was time to embark on a core values process, and I decided to do it as collaboratively, openly, and organically as felt possible. I had no idea where it would lead or what would result. And I was still scared.

Why did I decide suddenly it was time? First, we were losing veterans to retirement each year, and I didn't want to lose their perspectives on what made Hill successful and unique—and what had made them dedicate decades of their lives to Hill. Moreover, as we welcomed the next generation of faculty and staff, we needed to be able to recruit and retain great people, and clearly communicate and deliver on "Why Hill?"

By soliciting ideas and feedback from staff, I could honor what we'd done well in the past while preparing for future transformations. Second, I knew teachers at The Hill Center often spoke positively about feeling autonomous and enabled in their classrooms, and I wanted to recreate that feeling of empowerment and

involvement at an organizational level. Finally, I recognized that a sense of ownership of shared values could foster parity across staff members with varying levels of experience and authority.

When it comes to adhering to and executing on our core values, nobody is held to a higher or lower standard; consistency of values prevents favoritism or bias in decision making. Anyone should be able to ground a conversation with anyone else—regardless of position, team, or program—in shared core values without making that conversation personal. In short, by asking All Hill to collaborate on "discovering our core values," and then making the final product explicit and alive, I hoped to reinforce the greatest strengths in the pre-existing culture of The Hill Center while continuing the move towards a more open, transparent, and trustful organization.

We just needed to think about how we'd actually do it.

Discovering our core values

Along with Michelle Orvis, Hill's Chief of Staff, I began reading articles and watching videos related to open sourcing core values, and we informally interviewed personnel from other organizations to solicit their advice. In the end, we wanted a hybrid approach: something open and inclusive but not completely democratic or consensus-driven. We also did not want the process to be too time-consuming for our already busy faculty and staff. We wanted to conduct it over several months, but not forever, and we wanted to accept input in a variety of forums.

After announcing the process and sharing multimedia examples from other organizations over email, we had an optional "lunch 'n learn" kick-off (I had learned early on that the only possible window for bringing All Hill together was lunchtime, between morning and afternoon classes!). I provided some context, laid out two guiding principles for our core values—"clear and simple" and "truly authentic"—and folks worked individually, in pairs, and in small groups to describe the "essence" of Hill in words and phrases. We captured the words and phrases, then shared and discussed them via email communications, smaller informal lunches,

and preliminary synthesis and discussion at a half-day leadership team retreat. During this process, we also added two more guiding principles: "Bias towards action" and "All Hill—knit together entire organization."

Following one of the informal lunch discussions, I received an email from Kate Behrenshausen, one of The Hill Center's newest teachers. The note surprised me, given that Kate had opted out of the kick-off meeting at the beginning of the process. Suddenly, she was ready not only to participate in the values-writing process, but also to engage further by collaborating on additional writing (like this book chapter!).

How had Kate made the jump from disinterested to engaged, and what could I learn from this?

Initially, Kate admitted, she did not believe the core values process would apply to her role at Hill; in fact, she admitted, she wasn't even totally sure what "core values" meant. To her, they sounded like sterile, superficial management buzzwords.

But later, when I asked Kate and her coworkers to submit five words or phrases that described the "essence" of Hill, she was intrigued. She'd received a concrete method for providing feedback, and she appreciated the implication that her opinions mattered. In fact, she said, that feeling of appreciation had guided her decision to join Hill in the first place. During an early interview, Head of School Bryan Brander had reassured her that Hill gives its teachers the freedom to do what is best for student learning. Bryan's words inspired her—especially after several years in the public school system, where decisions seemed to come from far-off offices of people who did not know her students and would never see her classroom. In her estimation, the follow-up core values activity had reinforced those feelings of reassurance, encouragement, and inclusivity.

All (Hill) in

I recently shared draft core values with All Hill at one of our bi-monthly, post-board meeting lunches. The draft was an updated version of what our leadership team synthesized from the "words"

activity at the kick-off lunch, then modified to reflect the other feedback I had been collecting in formal and informal ways. We've posted them on the wall in the mailroom with markers, post-its, and dots in hopes that folks will share their reactions, ideas, questions, concerns. We'll go from there, working towards unveiling "new" core values at our August Back-to-School kick off.

What currently hangs on the wall are not the core values I'd have written myself (though many of my original themes do come through). Some of them raise questions (even concerns). And yet, on the whole, I feel better about them at this point than I might have expected, and I think they will spur more needed dialogue as we progress. I've learned three valuable lessons so far:

- Letting go can be both scary and liberating. While I certainly haven't let go completely, I haven't "backwards planned" or tried to over-engineer it, and I genuinely have listened and sought out the input of everyone. And it's been fun, engaging, stimulating, and affirming of the many great people, ideas and things happening every day at Hill—much less work for me than it could have otherwise been, too!
- "Authenticity" is a simple but challenging guiding principle, for both individuals and organizations. But to me it seems central to being an "open" leader and organization. What seems authentic to some may not to all; what is authentic in certain relationships or circumstances may not manifest itself in others. And what if there are things about "who we are" as an organization that we need to change in order to thrive and survive, or about who we think we are supposed to be that we need to actually embrace more fully rather than let go? I think we may need to have some hard conversations about authenticity as a part of this process.
- Nothing is better than actually sitting down and engaging in dialogue with different people, taking the time to talk less and listen more, and then having the discipline to capture and translate that dialogue into something that is

made explicit and shared. It takes time. It takes planning. It takes effort. But it is so much better than just thinking about things or wishing them to be different or true.

I still have a long way to go and grow as a leader at Hill. And we still have a long way to go and grow as an organization. But the journey is one worth taking. And I am determined to enjoy and learn from the ride. Hopefully, many others feel the same—and will join Kate and me along the way.

Beth Anderson is the executive director of The Hill Center in Durham, North Carolina. The Hill Center is a private-public, K-12 model that serves students who are struggling academically—especially those with learning differences and attention challenges—and their teachers.

Review and discussion questions

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The open schoolhouse: Culture, praxis, empowerment

Charlie Reisinger

In 2010, I confronted a problem common to all public school leaders: *How do we optimize our limited funding to bring powerful learning technology to thousands of students?* Faced with an end-of-life fleet of student laptops, district-wide budget cuts, and teachers pleading for more technology, I made a small bet that open source software could be an affordable path forward. Fast forward to 2019: What started with a few elementary school laptop carts running a Linux operating system and open source applications grew into an award-winning, district-wide, one-to-one laptop learning program and student technology help desk—all built with open source principles and software.

Open source software has saved my district—Penn Manor School District in Lancaster County, Pennsylvania—more than a million dollars on its technology budget. But more importantly, making a deliberate and concerted effort to infuse open principles and practices into our learning environments has cultivated a vibrant and inclusive learning community that cuts across the school. And as a result, student success has exceeded our expectations.

But how do schools put open ideas into practice to foster future innovators and leaders? It's not as simple as installing Linux on 4000 student laptops, holding hands, and singing the alma mater in the high school cafeteria.

An open schoolhouse values all learners' unique strengths and passions to help them reach their potential. This work does not

begin and end with curricula, worksheets, and test scores. It starts with building connections, relationships, and trust with students. In this chapter, I'll explain how we put these ideas into practice.

Building the open schoolhouse

First, school leaders must recognize that traditional school board computer policies and device decisions are retrograde to learning. Tablets do little to help students explore an operating system. Worse, repressive school device management policies lock access to the command line and block students from installing applications. Sealed tablets and locked-down laptops are like kryptonite for classrooms—they weaken critical thinking and crush a student's ability to create, explore, and learn.

Penn Manor designed district technology policies to amplify student curiosity and learning freedom. Each student has root access on their school-issued Linux laptop. Students are trusted—and encouraged—to tinker and experiment with their school laptops. And our students haven't let us down. Five years into our program, we've experienced zero discipline issues resulting from students' being trusted with admin rights.

But access to the terminal isn't enough to turn a school into an open organization. We must elevate student privileges, write a new script, and empower students to be equal partners in their education. What if our classrooms pushed aside lecture and standard curriculum and reorganized as a community of practitioners working toward a common goal?

When Penn Manor High School launched the Linux laptop learning initiative, our team designed apprenticeship opportunities for students to provide technology support to their peers. What better way to help budding technologists learn the craft than through authentic practice? What better way to encourage a culture of collaboration?

Penn Manor School District's Student Help Desk program is an honors-level, independent study apprenticeship course. Students report for the class like they would for math, science, or art. But any similarity to a traditional high school courses ends there.

Apprentices work alongside district IT staff on hardware repairs, software tutorials, system imaging, peer training, and any number of tasks related to the one-to-one program. Daily work assignments are guided by the shifting needs of fellow students and classroom teachers. Visitors observe help desk apprentices fielding questions from students or staff, replacing a damaged laptop screen, or diving into Linux configuration files. Past student apprentices even wrote code for laptop imaging and device inventory. Motivated by authentic use cases, the young programmers developed the very software their peers use today.

The student help desk has no curriculum and no textbook; students search the Internet to discover solutions to problems, or borrow code and ideas that open source communities have freely shared by. Students learn and experiment with the same open source software and techniques that industry professionals use. And assessment? How can a pop-quiz measure a student's elation when their logic board repair is successful, or the joy they feel when the entire school starts using software they've designed?

In this participatory and inclusive classroom culture, traditional power structures dissolve and students are empowered to act, contribute, iterate—and solve real problems.

Teaching in the open schoolhouse

We educators in the open schoolhouse don't lecture and test. We clear obstacles, provide prompts, and create a culture where trial and risk receive encouragement and praise. Together, as a team, students and staff shape the world around them. When we honor learning by doing, students become active agents in their education and they contribute to the school community in innovative new ways.

Beyond the obvious career preparation and technical skill-building experiences, the Penn Manor Student Help Desk provides students an opportunity to explore individual passions via independent study. As part of this program, every student is challenged to create a unique and compelling personal project that breaks new ground. Choice of the project is entirely up to each student. In the

past, they've explored software defined radio, built virtual reality tours, developed a software system for Roll20, produced a podcast series, and even programmed a TurtleBot robot to self-navigate across the school's hallways.

One of our goals is to help technology apprentices discover they can build and command technology—not be content with someone else's technical or marketing decisions. Hacking isn't a concept or skill we teach. It is an ethos we embrace.

A few years ago, I was struck by the wisdom of student one help desk apprentice and hacker, Aytekin Oldac. I asked for his thoughts about the program. The pensive young man paused for the briefest moment and said, "There is a quote from Aristotle, 'Men become builders by building.' I think that applies to the help desk."

Aytekin was indeed becoming a builder. The student help desk needed a visitor registration system, so Aytekin built one. He set to work on a check-in system built atop a decommissioned point-of-sale terminal. The once-obsolete cafeteria terminal was a laughable gray box of thick industrial plastic topped with a fry-grease resistant touchscreen. But Aytekin gave it a new life beyond the lunch line.

Using LibreOffice, he programmed a data-entry form with a large on-screen number pad. When a visiting student entered their student ID, the on-screen form would add a timestamp and log the visit into our database. With no explicit curriculum, he relied on his Linux laptop, the Internet, and his intellect to build a new contraption for the help desk team.

Of course, we could have rushed to an app store for a proprietary registration application for a tablet. But what would our young builder have learned? If there were an "app for that," Aytekin would never have spent weeks prototyping a solution, parsing sample code, debugging, or iterating designs from peer feedback. Empowered with freedom and trust, Aytekin became lost in the flow of discovery, hacking, and problem-solving.

But there's a deeper spirit in the open schoolhouse. The thoughts of former student apprentice, Susan Black, transcend ed-

ucation and hardware. "I cannot imagine a more perfect day than one spent repairing laptops and solving software issues at the help desk. I think of our help desk room not as a class, but as a family. We motivate and teach each other, but we also have a few good laughs. We make memories daily, and I don't have to hide who I am in this class. Nobody dares to judge one another, and we become closer by our differences."

Susan's voice resonates a sense of place, a safe and inviting space untangled from the curriculum assembly line and insulated from high school angst and drama. In this place, she is free to be herself and empowered to learn and create. Shouldn't all students be afforded the same opportunity to build self-esteem and leadership skills? To follow their passions? To find their tribes? When the classroom hierarchy is flattened, when students are exalted, when the roles of student and teacher are blurred, the open schoolhouse emerges.

Charlie Reisinger is the Director of Technology for Penn Manor School District in Lancaster County, PA. He leads the district's award-winning one-to-one laptop learning program and student technology help desk. His first book, The Open Schoolhouse, chronicles how open source principles and software transformed learning at Penn Manor. Follow Charlie on Twitter at @charlie3.

Review and discussion questions

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Flip the script: An open community of practice at the student help desk

Maxwell Bushong

Typically, students in most high schools sit in classrooms, likely listening to an instructor lecture about a topic for hours upon hours. Teachers rave about how much time they have with each class, and how much they are able to teach their students during that time. But how much of that education do students actually retain?

As a student, I can tell you I am not in any way learning from a teacher who stands and talks to me for an hour and a half, and I also do not learn by completing packets filled with immense amounts of information. That's a problem. But as my dad says, "Anybody can be a problem identifier. It is difficult to be the one to solve that problem." So how do we solve this problem with our education system?

Perhaps a better way is to give students the freedom to be part of an open source educational community, be respected, and be allowed to push through and solve problems. This makes the open world of education that much more impactful to a student—maybe without them even knowing it.

I think we can assume that the average high school student has little to no knowledge of open source concepts and software. Then again, I think we can also assume that the average high school student does not have any experience working in an open help desk like the Student Help Desk Apprenticeship program at Penn Manor High School. It is an honors-level, elective course set up like any college or industry IT help desk. What makes the pro-

gram unique is that *students* are the ones behind the help desk to provide support for Penn Manor School District's one-to-one Linux laptop program. Student apprentices have administrative access to laptops, software, programs, and the tools they need to tackle any hardware or software issues regarding school technology devices.

The program runs like a regular class, but there are no formal lesson plans and no curriculum. Students learn from everyday problems presented to them; lesson plans certainly don't work in this situation. It's a unique program, and it's a building block of Penn Manor's "Life after High School" mission. The idea is that students need to be exposed to the real world during their high school career, so they can be successful in their life after graduation.

In this chapter, I'll describe my experience in the program and explain how this open approach has impacted my education.

Collaboration built on trust

The student help desk model is a collaborative work environment. The program puts its students on the same level as the IT staff. The fact that my peers, teachers, and IT staff communicate and interact with me as if I worked for Penn Manor makes me feel like a valued and respected member of the school district. During my other classes, I feel as if I am not developing or making a difference in my school. Sure, my grades reflect our school's performance, but what am I really doing?

When I walk into the Help Desk, that changes. Everything else about my life disappears; my mindset is immediately altered, and I no longer feel like the average high school student. In fact, I tend not to think of myself as a student whatsoever. Working alongside the adults in the room, with the level of responsibility and trust they've given to me, makes me feel like a valued member of the school's IT staff. By helping my fellow peers, by completing a work-related task for the greater good of the school, by having the opportunity to participate in real IT related projects, I feel like a valued member of the Penn Manor community.

A recent conversation with one of my peers illustrates my point. When I mentioned I had fixed hardware problems on four or

five laptops that day, my friend was in utter disbelief. He was shocked that I was trusted to dismantle thousands of dollars of equipment. I think his surprise reflected his experience with other classes. Other high school courses do not allow students to be trusted in that capacity. But student apprentices know that they are trusted. In fact, it would be difficult—maybe even impossible—for a student to be effective in this environment without being fully trusted.

Making an impact

As a freshman student, I have a long road of papers and assignments to write before graduation day. After I have turned in those papers for grading, I often think nothing of them. Don't get me wrong—I feel some level of accomplishment for receiving a good grade on an assignment. But compared to working at the Help Desk, that feeling is almost laughable. The feeling of achievement when I fix a laptop or solve a computing problem is immense. An "A" on a history paper can never compare.

Collaborating with IT staff and working on day-to-day problems without fear of receiving a grade based off a rubric or grading policy adds to this feeling of empowerment. Most other courses are so structured that I base 90% of my class project decisions off a grading rubric because there is a certain way that assignments have to be done. But I find myself disappointed with the end result of a project in those classes because that's not in any way how I would have completed it. The Help Desk course structure is just the opposite. I base 100% of my project decisions off my own thoughts about how I would like certain things to be completed. I can explore alternative methods of doing and presenting tasks, and that allows for new innovation to occur in our school—ultimately the world.

In other courses, students worry about submitting assignments or performing well on an exam. That performance impacts the grade, transcript, and that class solely. But with the Help Desk, you quickly realize that decisions you make and the tasks you complete have the potential to impact the entire school district, or even

the world. I feel I am contributing to something much bigger in the world.

Here is an example: Penn Manor High School is currently undergoing a major renovation and construction project. During construction, the original 1950s portion of the school will be demolished, taking memories with it. I am working to archive the original Penn Manor High School via photos, drone footage, and 360 degree virtual reality tours, to preserve the original school. As anticipation of the new school builds, I am also working to capture the construction process during the entire four year project. The images and footage will last for a lifetime and impact my community, as well as future students and alumni.

Think back to when you were a high school student (or maybe you are still in high school). If given the option, would you want to make a difference in a classroom of 20 students and one teacher, at most, or would you prefer to impact an entire school district of 5,400 students and 600 staff members?

An authentic experience

Schools typically measure their students' success with letter grades. But the Help Desk course offers an authentic learning experience with real technical issues posed to us every day. We work by problem solving—learning from what went wrong and exploring how to fix it. Students' drive and determination to learn about a problem, and then solve it, is what engages them in learning.

Project-based learning is also a major portion of the Help Desk course. Student apprentices work on projects designated to help us expand our technical knowledge on a wide variety of topics. Apprentices individually craft and design their own projects based on what they want to learn. The possibilities as to where these projects can go are endless.

We learn what we are drawn to learn. We are not forced to learn something that isn't of interest to us. I see it as a difference between "learning wants" and "learning needs." "Learning wants" are something you are eager to expand your knowledge on. In contrast, "learning needs" are something that you will need to survive

life after high school. The project-based nature of the Help Desk course combines both types of learning. I can tailor my project to my individualized "learning wants," but along the way I can work in new "learning needs" as I discover them. Now this what makes learning interesting!

Earning respect

As part of an established school's Technology Help Desk, my peers treat me with respect, and often relate me to a staff member of Penn Manor. When one of my fellow students visits the Help Desk and I repair or fix their laptop problem, install a new software application for them, or simply answer a question they have, their response is often, "Wow, how did you do that?" The fact that another 15-year-old high school student is saying this to me is often one of the most empowering things I hear during my school day. When you are the one who successfully completes a support request for someone else, you earn their respect. Each time this happens, the respect that others have for you begins to steadily accumulate throughout a community. This can help build your reputation in a school and community.

I think our program helps make a distinction from the typical paper and pencil learning environment. I do not think many students realize it, but our laptop program creates a new form of educational collaboration. Students work together on class projects, which then creates a conversation within the school. As a team we are creating *more* than a technology conversation; we're creating a conversation about the *relationship between life and technology*. This new shared conversation leads to more new ideas, more thoughts suddenly unleashed into the school. And that leads to more discussion and more change in our community.

Life beyond the schoolhouse

I think we can now return to Penn Manor's "Life After High School" mission. What will I remember from my high school career? Will I remember every detail about World War II from my history class? Probably not. Will I remember exactly why volcanoes

form from science class? Maybe. Will I remember the Pythagorean theorem from algebra? Definitely not. But I will remember the Help Desk, and the lifelong skills that will stick with me throughout my lifetime. And I will remember making a long-lasting difference in my community.

How can we solve what's lacking in our education system? We can do it by giving students the opportunity to take ownership of their learning, give them the tools they need to explore their interests, and help them solve new problems. Students can be their own educators. When we do this, we open a world of educational opportunity for young minds to freely explore and grow their knowledge through a partnership of ideas. And when this happens, I think education itself becomes just that much more impactful.

Maxwell Bushong is a high school student and Student Technology Apprentice attending Penn Manor High School in Lancaster County, PA. He plays boys volleyball year-round on both club and school teams, and manages the Penn Manor's girls volleyball team during their season. His goal is to impact the world through technology with ambitions of holding an IT based occupation after high school.

Review and discussion questions

- Massa id neque aliquam vestibulum morbi blandit. Mauris sit amet massa vitae tortor condimentum. Volutpat diam ut venenatis tellus in metus vulputate.

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Open education has a POSSE

Shobha Tyagi

Global education is truly struggling. Fixing it demands a paradigm shift—from conventional teaching techniques to new techniques inspired by open organization principles.[83] Organizations in various industries around the world clearly understand the benefits of operating according to open principles, and they're embracing them. It's time our schools did too.

Our very definitions of "teaching" and "learning" are changing drastically. We shouldn't necessarily view this as a negative trend, because it's part of a broader transition the world is undergoing: the maturation of an Information Age that began 1970s and is now reaching its peak. The relative abundance of information today has many effects, and among them is a shift in student attitudes toward classroom experiences. Today, students do not want to learn simply by sitting in a classroom and following precise directions from instructors. They can do that online, through any number of reliable online course offerings such as NPTEL, Coursera, Edx, and Udacity (to name a few). As more self-guided learning materials become available online, students are expecting new forms of engagement from their instructors. And those instructors will need to respond—especially if they're going to continue fulfilling their social mission of preparing human beings to survive and thrive in a new era.

In this chapter, I'll describe a program that's equipping and empowering teachers to adjust their teaching methods in response to changes in student learning preferences. The Professors' Open

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83 See Appendix.

Source Software Experience (POSSE) is a non-profit, teacher-led initiative to help educators understand how to run their classrooms more like open organizations—and produce more engaging learning environments as a result.

A brief history

POSSE began life as a Red Hat-funded initiative for the higher education community. Led by both professionals at Red Hat and contributors from other open organizations, the program aimed to help instructors learn about free and open source software (FOSS) so that they could incorporate learning activities that engage computing students with FOSS into their classes. That was POSSE's first iteration—call it "POSSE version 1.0"—and it functioned in this form from 2005 to 2010.

The next version of POSSE—that is, "POSSE version 2.0"—dates from 2010 to the present. Its facilitators are a mix of instructors and FOSS contributors. As POSSE has grown, it now also benefits from support from the National Science Foundation (NFS) and has assumed a more explicit focus on engaging with Humanitarian Free and Open Source Software (HFOSS) projects and initiatives. HFOSS refers to the large and growing collection of open source projects that provide some social benefit. This includes projects that seek to address aspects of healthcare, disaster management, accessibility assistance, economic development, education, and other areas of social need.[84]

POSSE's focus has shifted over years in order to provide a more useful and comprehensive experience for educators. Today, it trains participants not only in technical topics related to FOSS but also in open-focused pedagogy and curriculum matters.

Teaching teachers to teach open source

Three stages comprise POSSE's faculty development model.

In the first stage, participants perform online activities independently, with POSSE facilitators, and with their fellow

84 http://teachingopensource.org/hfoss/

participants. The length of that stage ranges from six to eight weeks, requiring roughly one to three hours per week (read on for more details of what happens during this period).

The second stage is a face-to-face workshop that lasts for two to three days. At this meeting, participants learn how the material introduced in the first stage is used in actual FOSS projects. Participating faculty members also get the opportunity to learn the ways in which they can incorporate that material into their classes and create actual assignments for their students.

The third stage involves ongoing participation—and it's the most important and challenging, as it requires practical implementation of FOSS/HFOSS techniques learned during the previous stages. The Faculty Development Model is depicted in Figure 1.

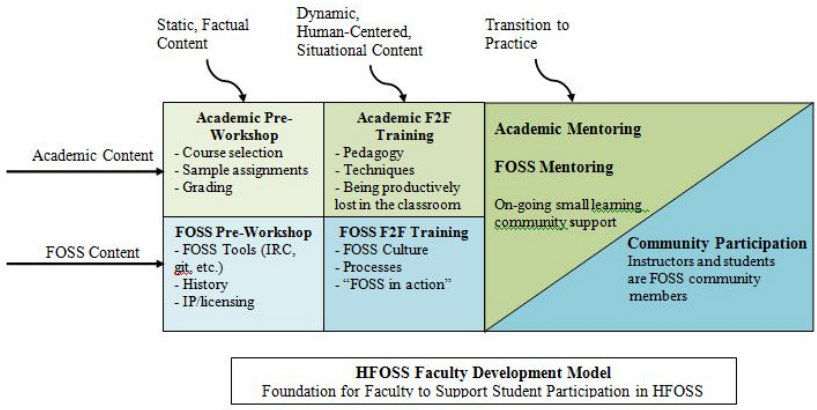

Figure 1: The HFOSS faculty development model
http://foss2serve.org/index.php/POSSE

As an outcome of the POSSE workshop experience, POSSE alumni introduced FOSS into their classes. And they continue to share their experiences at foss2serve.org.[85]

The outcome is a positive one. Students enjoy relating course topics and material to real-world problems and projects. Working

85 http://foss2serve.org/index.php/Instructor_Experiences

with open source in the classroom means students can download source code, view it, and appreciate how that code has come from multiple contributors. Though the learning process is slow, students are much more engaged in their learning and eager to continue—and that is the matter of utmost importance.

Joining a POSSE

I was a member of the 2017 POSSE cohort,[86] which met in Bologna, Italy, on July 1 and 2 of that year.[87] People from almost every continent participated in the workshop. It was a fantastic workshop and that spawned a great community.

But as I described above, our work began long before we met each other in Bologna.

Stage 1

Stage 1 activities occurred May 15 through June 30, and Stage 1 was itself divided into three parts—A, B, and C—each focused on learning a different aspect of FOSS development and culture. And before beginning any session, we participated in an Internet Relay Chat (IRC) meeting in order to learn basic IRC etiquette.

In Part A, participants received a basic introduction to the FOSS world, explored the anatomy of an open source project, and learned about the most popular communication tools among contributors to these projects (such as IRC and wikis).

Part B focused on helping us specifically incorporate FOSS into our courses in a variety of ways. For example, we embarked on a "FOSS field trip," a guided tour through GitHub and Open Hub that explained their uses and differences. We also conducted a FOSS project evaluation—for example, of the openMRS project, which made understanding that and similar projects simpler. As part of this activity, we learned to evaluate a FOSS project in order to determine whether it was an appropriate fit for the courses we

86 http://foss2serve.org/index.php/POSSE

87 http://foss2serve.org/index.php/POSSE_2017-07

were teaching (this, in turn, helped us decide if we'd like to contribute to it by introducing that project in our classes). We learned to identify certain important characteristics of FOSS projects: patterns of contributions, patterns of commits, programming languages used, and more. Ultimately, we developed the capability to identify HFOSS projects that seem appropriate for new contributors. Finally, we received an introduction to copyright and licensing issues, as we learned about the number of open source licenses (like the GPL, MIT, Apache, MPL, and more).

And Part C provided in-depth knowledge of GitHub. We also learned about bug tracking tools and explored additional ways we could integrate FOSS tools and techniques into our classrooms. To record our progress, we composed reports after every activity in each segment.

Stage 2

Stage 2 consisted of a two-day, intensive face-to-face workshop, at which faculty could interact with each other and talk at length about integrating open source software into our computer science courses. The workshop was a mix lectures and group activities dedicated to extending and applying what we learned in Stage 1. By now, we were slowly and gradually understanding the need to and the importance of introducing open source principles into our classes. And we all learned about how to support one another after we departed, using FOSS learning and teaching materials in the repositories at teachingopensource.org and foss2serve.org.

Never in my life had I experienced a workshop like POSSE. It was a wonderful experience that really helped me sharpen my teaching methods.

Stage 3

Now came that hardest part: integrating these new knowledges and skills into my classroom activities.

Initially, I taught Introduction to Open Standards and Open Source Software (IOSS) to first-semester students who, incidentally, were also learning the C programming language that same

semester in another course. I was ready to introduce all that I'd learned in POSSE to this class.

After a basic introduction to FOSS, I assigned students a simple task: install git onto their computers and create GitHub accounts. After doing this, they had to clone and fork a repository from my own account, which contained code for a simple calculator application implemented in C—with few bugs, of course! The bugs were simple: typos, easily visible syntax errors, etc. Students cloned the repository locally, forked it, then ran the code to identify bugs.

I advised all students to correct only one bug. Students especially good at programming in C could easily identify the bugs and resolved a bug of their choice. After staging and committing the desired changes using basic git commands, the majority of students in the class could even send me a pull request on GitHub.

Students enjoyed sharpening their C programming skills using git. Setting up the activity this way allowed me to stress many simple but important open source principals, such as collaboration, contribution, identifying problems collectively, and sharing the solutions to them. A similar approach to experiments could be easily occur in many other types of courses—not just those in computing.

But for that to become a reality, faculty members have to become aware of and embrace open source techniques and principles.

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Review and discussion questions

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- Massa id neque aliquam vestibulum morbi blandit. Mauris sit amet massa vitae tortor condimentum. Volutpat diam ut venenatis tellus in metus vulputate.

Confronting linguistic bias: The case for an open human language

Race MoChridhe

As scholars in the digital humanities continue to transform scholarship, they're increasingly noting a "black-box" problem with the tools they're using—not to mention the resources and artifacts they're creating as a result. As Tara Andrews describes it:

> ...we are, implicitly or explicitly, constructing models of our objects of study; all such models contain a certain amount of domain knowledge, and all of our computational tools operate on the basis of that domain knowledge. These facts ... directly give rise to ... the black box question: can we truly know what models, assumptions, and inferences are made within the source code of a particular software tool? If so, how? If not, how can we justify a blind use of it?[88]

Open source—that is, making the code of digital tools and datasets accessible to anyone—is a popular approach to improving the methodological transparency of this work in educational organizations. The field's broader open access movement stresses skepticism about the proprietary nature of algorithms, data, and code involved in humanistic research more generally—and cautions researchers about the impact that ownership can have on the research process itself.

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88 https://doi.org/10.1080/03080188.2016.1165456

This perspective has tremendous implications for the way we think about the embedded biases and assumptions in humanistic research. What if we subjected our *human* languages to the same rigorous assessment we do with our *computational* languages? What biases might we discover in them? How might those biases impact our scholarship?

And does that mean open educational organizations and open scholarship require an open language?

Confronting linguistic bias

The language researchers and educators use to conduct and report research frames how that research unfolds and impacts its conclusions. Many debates about the boundaries and "proper methods" in the humanities and the sciences are exacerbated (if not driven) by the use of the English language. For example, English-language scholarship distinguishes between the "humanities" and "science," dividing realms of scholarship that in German and many other languages fall under a single heading (in German, "*Wissenschaft*"). In the English-speaking world, researchers commonly work in a single language, and the paradigms that language establishes—the effects of its specific structure and lexicon—often go unchallenged.

While few languages are private intellectual property in a legal sense the way that computer code can be (Quenya and Klingon are probably the most notable cases of privately owned human languages), "proprietary" is nonetheless a useful label for the less explicit (but no less powerful) rights of "ownership" that a native-speaker population exercises over language. It includes things like: the implicit "right" to assign new meanings to existing words, to employ non-standard semantic or rhetorical constructions, to import words from other languages, and to engage in all these activities while having the results regarded as legitimate lines of development within a descriptive grammar, rather than as deformations, errors, or inadequacies of language acquisition. A whole host of freedoms vitally important to innovative and imaginative communication are assigned almost exclusively to native speakers.

While there are approaches (like the "World Englishes" paradigm) that do more to affirm and enfranchise second-language speakers, these have some strict limits when trying to guarantee the common frames of meaning and relatively easy reproducibility demanded by academic research, whether humanistic, scientific, or technical. Putting scholars (and students) on more equal footing and obtaining a more critical perspective on the biases inherent in the use of "proprietary languages" for teaching and research will require a different approach.

Luckily, this isn't the first time researchers have addressed the issue of linguistic "openness" in educational organizations. The International Academy of Sciences San Marino (AIS) was founded in 1985 with the aim of creating an academic framework that, to the greatest possible extent, would encourage openness, collaboration, and transparency. Thesis and dissertation defences at AIS, for example, must be both publicly announced and open to the public. In particular, AIS's founders sought to enhance openness in language. The first paragraph of the AIS constitution states that members shall "*komunikadas inter si precipe per neŭtrala lingvo*" ["communicate with one another principally by means of a neutral language"]—in other words, a language belonging to no particular group or nationality, such that no users would be linguistically privileged and no group would have a special right to the definition of linguistic norms.

An open language

Among possible candidates, Esperanto—created by Ludwik Zamenhof in 1887 to serve as a neutral, "international" language for all purposes—was selected as the only one in which a significant body of scientific literature and a suitable terminology for higher educational contexts had already been developed (over more than a century of use, it has been employed for everything

from the scientific paper that first described the jet stream[89] to works of poetry[90] nominated for the Nobel Prize).

What the language's creator and many of its promoters have described as "neutrality" we might better understand as "openness": Esperanto is the only widely-spoken language explicitly "licensed" for general use. In 1905, Zamenhof and representatives of leading Esperanto organizations at the time promulgated the Boulogne Declaration, which established that Esperanto was "no one's property" and that "[t]he primary master of this language is the whole world," such that everyone was entitled to use it "for any possible purposes" and all fluent speakers were to be regarded as equal Esperantists, without respect to their background, ideology, or membership status in any organization. The document also specified that, beyond the sixteen basic grammatical rules laid out in the *Fundamento de Esperanto [Fundaments of Esperanto]*, not even Zamenhof could establish any narrower restriction, so that all Esperantists could express themselves "in a manner which they deem the most correct."

Although there are now approximately two thousand native speakers of Esperanto, there is no special native speaker role in establishing linguistic norms.[91] Sociolinguistically speaking, every speaker who has acquired fluency has equal influence on the development of norms of usage. While not everyone agrees on Esperanto's purported "neutrality," it does seem productive to talk about the language as "open" in the same way we talk about code.[92]

This "openness" contrasts meaningfully with the "proprietary" status of ethnic languages, where the "ownership" of the native speaker population controls the establishment of idiomatic

89 https://www.airspacemag.com/as-next/as-next-may-unbelievablebuttrue-180968355/

90 https://www.theguardian.com/theguardian/1999/sep/29/features11.g22

91 https://doi.org/10.1016/j.langsci.2016.10.003

92 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.492.4267&rep=rep1&type=pdf

norms that, if not mastered precisely, adversely impact acquiring speakers. Even the most advanced second-language speakers of English encounter systemic barriers to acceptance of their research for publication, for instance.[93] But there is another sense—more metaphorical and more impactful—in which the use of Esperanto has promoted openness in the Academy's scholarship, and that is in the simple fact of having a common second language-medium available for research and pedagogy. At AIS, every degree candidate is required to work on a dissertation in their own native language and in Esperanto—a process which observers of the AIS have found to be demonstrably effective in raising students' metalinguistic awareness and exposing assumptions and biases that might otherwise have gone unchallenged.

What would happen if we viewed an ability to express academic arguments across two dissimilar languages as a key metric of "reproducibility" in humanities research? At minimum, we could begin increasing confidence that the arguments made in the research are not dependent on the idiosyncrasies of a particular linguistic model or cultural horizon. But the use of Esperanto offers two additional forms of openness that deserve consideration:

Transparency of grammar. Every part of speech in Esperanto is marked by a distinct ending and can be transposed to any other part by changing that ending. Likewise, a wide range of affixes are available for meticulously documenting transitivity, verbal aspect, and other grammatical features. This factor in the language's design has proven effective for language pedagogy in what is known as the Paderborn Method, which teaches Esperanto as a foundation for later language study much as the recorder is used as a general introduction to playing musical instruments. To return to our analogy with software, though, we might think of Esperanto as a kind of "verbose output," that lays the logic of expressions bare by making the grammar expressing them more visible.

93 http://dx.doi.org/10.1087/095315103320995096

Global accessibility. Esperanto was created for international communication and its world-wide speaker base is near two million. It is taught at universities in Hungary and China, broadcast by state media in Cuba and the Vatican, and promoted by thousands of local clubs, small publishers, annual conferences, and other infrastructure. As a complement to the current major languages of scholarship, its wider adoption in educational organizations and research institutions would offer possibilities to transcend and break down language barriers that currently inhibit scholarly communication. Were the model of the International Academy of Sciences San Marino to be followed globally, or even just at European scale, the open access ecosystem of the future could potentially guarantee access to research free not only of financial restrictions on access but of linguistic ones as well.

Even just at the scale of the AIS, however, their experiment has shown that a standard second language has important benefits for open education. It renders transnational study and collaboration more egalitarian and, perhaps most importantly, it forces educators to critically reflect on a tool of scholarship so basic that many of us scarcely think of it as a tool at all.

As we become more aware of the capacity for computer languages to hide threats to the integrity of our research, we must paraphrase Tara Andrews' question and ask ourselves: *Can we truly know what models, assumptions, and inferences are made within the vocabulary and grammar of a particular language? If so, how? And if not, how can we justify a blind use of it?* Esperanto is no more immune to such embedded "models, assumptions, and inferences" than any other language, but working in tandem with students', instructors', and researchers' ethnic languages, it can illuminate what hides in the famously dark space within our skulls, and it might just help us crack open the black boxes so pervasive in our teaching and research.

Race MoChridhe is a Master of Library and Information Science student at the University of Wisconsin Milwaukee and currently serves as the Open Access Publishing Intern of the American Theological Library Association. His primary research interests center on applications of interlinguistics to improve library and information services, scholarly communication, and language pedagogy.

Review and discussion questions

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Crowdsourcing our way to a campus IT plan

Curtis A. Carver

When I became CIO at the University of Alabama at Birmingham in 2015, I confronted the same mandate every new IT leader faces when assuming the role: outlining, developing, and executing a strategic plan. The pressure to do this swiftly and immediately can be immense—and I think many CIOs feel compelled to articulate and hand down fully formed plans on Day 1. After all, that's typically the quickest way to assert your position and vision as a leader.

But I like to take a different approach. I don't dictate my team's initial goals. I open them up.

Working this way felt especially important in my new role at UAB, which I knew was going to be the last gig of my career. I wanted to make the largest contribution I could—not only to the university, but also to higher education in general.

What better way to do this than to let them openly contribute to the goals my team would be tackling during my tenure?

So I let the entire university community help me determine and prioritize our most pressing IT problems. The results were astounding, a perfect example of the benefits of taking an iterative, adaptive approach to this kind of development.

Let me share what happened.

Just a SPARK

My first day as CIO at UAB was June 1, 2015. That was also the day we launched a new, university-wide idea collecting and brainstorming platform. The platform (which we code-named

"SPARK," in honor of UAB's mascot, Blaze the Dragon), was a crowdsource-style tool for collecting and surfacing the best ideas for ways IT could improve the lives of students, administrators, and faculty.

Anyone could use the platform to submit an idea. "Help us understand the issues you're facing and what would make the biggest difference in your life," we told anyone interested in participating. "You can submit an idea that anyone can comment on, and as long as you play nice, everything is in scope."

Our goal was ambitious but clear: Identify 100 potential "wins"—100 things we could do to improve university life—in 100 days, then implement all of them within a year.

Within the initiative's first 55 days, 386 users posted 73 ideas, made 367 comments, and cast 1,747 votes. (Keep in mind, too, that this activity was spurred almost entirely by word of mouth during the summer, when a sizable portion of the faculty and students aren't even on campus.) As a result, we became aware of issues and ideas like:

- Electronic signature of documents as part of moving to a paperless system
- One gigabit bandwidth to the desktop
- Technology training and certification for IT pros and IT consultants
- Unlimited storage for all students, faculty, and staff
- Orientation for new IT employees

And those are just a few. While the ideas were flooding in, my team and I were taking meetings—hundreds of meetings (collectively), including several town hall-style gatherings to solicit feedback from the university community in an open forum.

In the end, we amassed an unbelievable amount of data. How were we going to sort it so the best ideas could rise to the top?

Making sense of it all

We began by arranging our crowdsourced suggestions into four primary categories:

1. Ideas that are great, but not directly applicable to the customer/community
2. Ideas for solutions that were actually already available as part of our current IT infrastructure and resources
3. Ideas that were clearly "quick wins," something we could implement in a day (or less)
4. Ideas that were groundbreaking and needed to be rolled into a broader strategic plan with a longer timeline

Believe it or not, most of the ideas we received fell into the first three categories. So our list of priorities was already becoming clear.

At the same time, our team was working with the insightful feedback we'd gleaned from our in-person meetings. Using mind-mapping software, we charted common responses and pain points, and connected these to our broader strategic goals and imperatives. All senior members of the IT leadership team contributed to this effort.

With that, we'd found our 100 potential wins. And true to our word, we got to work acting on all of them within the year.

The results are in

I'm proud to report that we actually achieved *147 wins* before the following June. I can't possibly recount all of them here. Many, however, were so startlingly simple—and yet so profoundly game-changing—that they seem almost laughably obvious in hindsight.

For example, take our approach to passwords on campus. Our policy really was outdated and ineffective, and we quickly learned that people disliked our approach to password security. So we modified aspects of it—first, our requirements for acceptable passwords (making them much stronger) and, second, our required interval for mandatory password changes (lengthening and aligning it with the operational rhythm of a university, so users needed to switch passwords less frequently). Members of the campus community appreciated these changes so much that they were literally

hugging me on the street in gestures of pure joy—the first time in my career, I can honestly say, that's ever happened to me.

In line with another frequently received request, we worked diligently to increase the data storage limits for users on campus. This work seemed especially pressing—and the need so very obvious—when I learned from faculty researching Parkinson's disease that they weren't able to store all the high-resolution brain scans they needed to do their work efficiently and effectively. Once we removed their data caps, they told me they were finally able to spend more time seeking a cure for Parkinson's and less time sorting through data files to make space for new work.

As we were steadily chipping away at our 100-win checklist, people around the campus couldn't help but take notice. My provost threw my team a surprise party (complete with delicious cake) to celebrate our crossing the 100-win milestone. Even the most skeptical members of the faculty senate stood up and applauded my team at a budget meeting (and our fiercest critics began saying things like "Well, while I don't think this is going to last long-term, I'm suspending disbelief because you've demonstrated you can achieve results"). And in another career-first moment for me, I got to serve as an honorary coach during the opening home football game. That's really when I realized that our community now viewed the IT staff as trusted partners in campus innovation. How many other IT organizations get recognized on the football field?

Lessons learned

I learned some valuable lessons during those 100 busy days. Here are a few of the most valuable:

TRUST THE COMMUNITY. Opening a feedback platform to anyone on campus seems risky, but in hindsight I'd do it again in a heartbeat. The responses we received were very constructive; in fact, I *rarely* received negative and unproductive remarks. When people learned about our honest efforts at improving the community, they responded with kindness and support. By giving the community a voice—by really *democratizing* the effort—we

achieved a surprising amount of campus-wide buy-in in a short period of time.

Transparency is best. By keeping as many of our efforts as public as possible, we demonstrated that we were *truly listening* to our customers and understanding the effects of the outdated technology policies and decisions that were keeping them from doing their best work. I've always been a proponent of the idea that everyone is an agent of innovation; we just needed a tool that allowed everyone to make suggestions.

Iterate, iterate, iterate. Crowdsourcing our first-year IT initiatives helped us create the most flexible and customer-centric plan we possibly could. The pressure to move quickly and lay down a comprehensive strategic plan is very real; however, by *delaying* that work and focusing on the evolving set of data flowing from our community, we were actually able to better demonstrate our commitment to our customers. That helped us build critical reputational capital, which paid off when we *did* eventually present a long-term strategic plan—because people already knew we could achieve results. It also helped us recruit strong allies and learn who we could trust to advance more complicated initiatives.

It's more work. Sure, acting alone to sketch a roadmap for my first 100 days would have been easier. But it wouldn't have generated the results the crowdsourced version did. Without a doubt, collaborative approaches like ours require more work than solitary, draconian ones. You'll need to think strategically and long-term. (Case in point: Launching SPARK on June 1 actually required *three months* of planning and development leading up to that critical day.) But if you really seize this opportunity to engage with your community, you'll realize better results.

Our yearlong lesson in community-focused crowdsourcing revealed the benefits that *adaptive* approaches to strategic planning can have for our organization. I'm sure they can do the same for yours.

Curtis A. Carver Jr., Ph.D. is the Vice President and Chief Information Officer for the University of Alabama at Birmingham.

Review and discussion questions

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How our non-profit works openly to make education accessible

Tanner Johnson

I'm lucky to work with a team of impressive students at Duke University who are leaders in their classrooms and beyond. As members of CSbyUs,[94] a non-profit and student-run organization based at Duke, we connect university students to middle school students, mostly from title I schools across North Carolina's Research Triangle Park.[95] Our mission is to fuel future change agents from under-resourced learning environments by fostering critical technology skills for thriving in the digital age.

The CSbyUs Tech R&D team (TRD for short) recently set an ambitious goal to build and deploy a powerful web application over the course of one fall semester. Our team of six knew we had to do something about our workflow to ship a product by winter break. In our middle school classrooms, we teach our learners to use agile methodologies and design thinking to create mobile applications. On the TRD team, we realized we needed to practice what we preach in those classrooms to ship a quality product by semester's end.

This is the story of how and why we utilized the principles we teach our students in order to deploy technology that will scale our mission and make our teaching resources open and accessible.

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94 http://csbyus.org/

95 https://www2.ed.gov/programs/titleiparta/index.html

Setting the scene

For the past two years, CSbyUs has operated "on the ground," connecting Duke undergraduates to Durham middle schools via after-school programming. After teaching and evaluating several iterations of our unique, student-centered mobile app development curriculum, we saw promising results. Our middle schoolers were creating functional mobile apps, connecting to their mentors, and leaving the class more confident in their computer science skills. Naturally, we wondered how to expand our programming.

We knew we should take our own advice and lean into web-based technologies to share our work, but we weren't immediately sure what problem we needed to solve. Ultimately, we decided to create a web app that serves as a centralized hub for open source and open access digital education curricula. "CurriculaHub" (name inspired by GitHub) would be the defining pillar of CSbyUs's new website, where educators could share and adapt resources.

But the vision and implementation didn't happen overnight.

Given our sense of urgency and the potential of "CurriculaHub," we wanted to start this project with a well defined plan. The stakes were (and are) high, so planning, albeit occasionally tedious, was critical to our success. Like the curriculum we teach, we scaffolded our workflow process with *design thinking* and *agile methodology*, two critical 21st century frameworks we often fail to practice in higher ed.

What follows is a step-wise explanation of our design thinking process, starting from inspiration and ending in a shipped prototype.

Our Process

Step 1: Pre-Work

In order to understand the *why* to our *what*, you have to know *who* our team is.

The members of this team are busy. All of us contribute to CSbyUs beyond our TRD-related responsibilities. As an organiza-

tion with lofty goals beyond creating a web-based platform, we have to reconcile our "on the ground" commitments (i.e., curriculum curation, research and evaluation, mentorship training and practice, presentations at conferences, etc.) with our "in the cloud" technological goals.

In addition to balancing time across our organization, we have to be flexible in the ways we communicate. As a remote member of the team, I'm writing this post from Spain, but the rest of our team is based in North Carolina, adding collaboration challenges.

Before diving into development (or even problem identification), we knew we had to set some clear expectations for how we'd operate as a team. We took a note from our curriculum team's book and started with some rules of engagement. This is actually a well-documented approach to setting up a team's social contract used by teams across the tech space.[96] During a summer internship at IBM, I remember pre-project meetings where my manager and team spent more than an hour clarifying principles of interaction. Whenever we faced uncertainty in our team operations, we'd pull out the rules of engagement and clear things up almost immediately. (An aside: I've found this strategy to be wildly effective not only in my teams, but in all relationships).

Considering the remote nature of our team, one of our favorite tools is Slack. We use it for almost everything. We can't have sticky-note brainstorms, so we create Slack brainstorm threads. In fact, that's exactly what we did to generate our rules of engagement. One open source principle we take to heart is *transparency*; Slack allows us to archive and openly share our thought processes and decision-making steps with the rest of our team.

Step 2: Empathy Research

We're all here for unique reasons, but we find a common intersection: the desire to broaden equity in access to quality digital era education.

96 https://www.atlassian.com/team-playbook/plays/rules-of-engagement

Each member of our team has been lucky enough to study at Duke. We know how it feels to have limitless opportunities and the support of talented peers and renowned professors. But we're mindful that this isn't normal. Across the country and beyond, these opportunities are few and far between. Where they do exist, they're confined within the guarded walls of higher institutes of learning or come with a lofty price tag.

While our team members' common desire to broaden access is clear, we work hard to root our decisions in research. So our team begins each semester reviewing research that justifies our existence. TRD works with CRD (curriculum research and development) and TT (teaching team), our two other CSbyUs sub-teams, to discuss current trends in digital education access, their systemic roots, and novel approaches to broaden access and make materials relevant to learners. We not only perform research collaboratively at the beginning of the semester but also implement weekly stand-up research meetings with the sub-teams. During these, CRD often presents new findings we've gleaned from interviewing current teachers and digging into the current state of access in our local community. They are our constant source of data-driven, empathy-fueling research.

Through this type of empathy-based research, we have found that educators interested in student-centered teaching and digital era education lack a centralized space for proven and adaptable curricula and lesson plans. The bureaucracy and rigid structures that shape classroom learning in the United States makes reshaping curricula around the personal needs of students daunting and seemingly impossible. As students, educators, and technologists, we wondered how we might unleash the creativity and agency of others by sharing our own resources and creating an online ecosystem of support.

Step 3: Defining the Problem

We wanted to avoid scope creep caused by a poorly defined mission and vision (something that happens too often in some organizations). We needed structures to define our goals and maintain

clarity in scope.[97] Before imagining our application features, we knew we'd have to start with defining our north star. We would generate a clear problem statement to which we could refer throughout development.

This is common practice for us. Before committing to new programming, new partnerships, or new changes, the CSbyUs team always refers back to our mission and vision and asks, "Does this make sense?" (in fact, we post our mission and vision to the top of every meeting minutes document). If it fits and we have capacity to pursue it, we go for it. And if we don't, then we don't. In the case of a "no," we are always sure to document *what* and *why* because, as engineers know, detailed logs are almost always a good decision. TRD gleaned that big-picture wisdom and implemented a group-defined problem statement to guide our sub-team mission and future development decisions.

To formulate a single, succinct problem statement, we each began by posting our own takes on the problem. Then, during one of our weekly 30-minute-no-more-no-less stand-up meetings, we identified commonalities and differences, ultimately merging all our ideas into one. Boiled down, we identified that *there exist massive barriers for educators, parents, and students to share, modify, and discuss open source and accessible curricula*. And of course, our mission would be to break down those barriers with user-centered technology. This "north star" lives as a highly visible document in our Google Drive, which has influenced our feature prioritization and future directions.

Step 4: Ideating a Solution

With our problem defined and our rules of engagement established, we were ready to imagine a solution.

We believe that effective structures can ensure *meritocracy* and *community*. Sometimes, certain personalities dominate team decision-making and leave little space for collaborative input. To avoid that pitfall and maximize our equality of voice, we tend to

97 https://www.pmi.org/learning/library/top-five-causes-scope-creep-6675

use "offline" individual brainstorms and merge collective ideas online. It's the same process we used to create our rules of engagement and problem statement. In the case of ideating a solution, we started with "offline" brainstorms of three S.M.A.R.T. goals.[98] Those goals would be ones we could achieve as a *software development team* (specifically because the CRD and TT teams offer different skill sets) and address our problem statement. Finally, we wrote these goals in a meeting minutes document, clustering common goals and ultimately identifying themes that describe our application features. In the end, we identified three: support, feedback, and open source curricula.

From here, we divided ourselves into sub-teams, repeating the goal-setting process with those teams—but in a way that was specific to our features. And if it's not obvious by now, we realized a web-based platform would be the most optimal and scalable solution for supporting students, educators, and parents by providing a hub for sharing and adapting proven curricula.

To work efficiently, we needed to be adaptive, reinforcing structures that worked and eliminating those that didn't. For example, we put a lot of effort in crafting meeting agendas. We strive to include *only* those subjects we must discuss in-person and table everything else for offline discussions on Slack or individually organized calls. We practice this in real time, too. During our regular meetings on Google Hangouts, if someone brings up a topic that isn't highly relevant or urgent, the current stand-up lead (a role that rotates weekly) "parking lots" it until the end of the meeting. If we have space at the end, we pull from the parking lot, and if not, we reserve that discussion for a Slack thread.

This prioritization structure has led to massive gains in meeting efficiency and a focus on progress updates, shared technical hurdle discussions, collective decision-making, and assigning actionable tasks (the next-steps a person has committed to taking, documented with their name attached for everyone to view).

98 https://www.projectmanager.com/blog/how-to-create-smart-goals

Step 5: Prototyping

This is where the fun starts.

Given our requirements—like an interactive user experience, the ability to collaborate on blogs and curricula, and the ability to receive feedback from our users—we began identifying the best technologies. Ultimately, we decided to build our web app with a ReactJS frontend and a Ruby on Rails backend. We chose these due to the extensive documentation and active community for both, and the well-maintained libraries that bridge the relationship between the two (e.g., react-on-rails). Since we chose Rails for our backend, it was obvious from the start that we'd work within a Model-View-Controller framework.

Most of us didn't have previous experience with web development, neither on the frontend nor the backend. So, getting up and running with either technology independently presented a steep learning curve, and gluing the two together only steepened it. To centralize our work, we use an open-access GitHub repository. Given our relatively novice experience in web development, our success hinged on extremely efficient and open collaborations.

And to explain that, we need to revisit the idea of structures. Some of ours include peer code reviews—where we can exchange best-practices and reusable solutions, maintaining up-to-date tech and user documentation so we can look back and understand design decisions—and (my personal favorite) our questions bot on Slack, which gently reminds us to post and answer questions in a separate Slack #questions channel.

We've also dabbled with other strategies, like instructional videos for generating basic React components and rendering them in Rails Views. I tried this and in my first video, I covered a basic introduction to our repository structure and best practices for generating React components.[99] While this proved useful, our team has since realized the wealth of online resources that document various implementations of these technologies robustly. Also, we

99 https://www.youtube.com/watch?v=52kvV0plW1E

simply haven't had enough time (but we might revisit them in the future—stay tuned).

We're also excited about our cloud-based implementation. We use Heroku to host our application and manage data storage. In next iterations, we plan to both expand upon our current features and configure a continuous iteration/continuous development pipeline using services like Jenkins integrated with GitHub.

Step 6: Testing

Since we've just deployed, we are now in a testing stage. Our goals are to collect user feedback across our feature domains and our application experience as a whole, especially as they interact with our specific audiences. Given our original constraints (namely, time and people power), this iteration is the first of many to come. For example, future iterations will allow for individual users to register accounts and post external curricula directly on our site without going through the extra steps of email. We want to scale and maximize our efficiency, and that's part of the recipe we'll deploy in future iterations. As for user testing: We collect user feedback via our contact form, via informal testing within our team, and via structured focus groups. We welcome your constructive feedback and collaboration.[100]

Our team was *only* able to unite new people with highly varied experience through the power of *open* principles and methodologies. Luckily enough, each one I described in this post is adaptable to virtually every team.

Regardless of whether you work—on a software development team, in a classroom, or, heck, even in your family—principles like transparency and community are almost always the best foundation for a successful organization.

100 http://csbyus.org/

Tanner Johnson is a digital-era education advocate and technologist. While studying computer science at Duke University, he co-founded CSbyUs, a non-profit aimed at expanding access to quality digital era education. Currently, he's working in Spain as a Fulbright Scholar, teaching and researching at the intersection of technology and the physical classroom.

Review and discussion questions

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Making computer science curricula as adaptable as our code

Amarachi Achonu

Educators in elementary computer science face a lack of adaptable curricula. Calls for more modifiable, non-rigid curricula are therefore enticing—assuming that such curricula could benefit teachers by increasing their ability to mold resources for individual classrooms and, ultimately, produce better teaching experiences and learning outcomes.

Our team at CSbyUs noticed this scarcity, and we've created an open source web platform to facilitate more flexible, adaptable, and tested curricula for computer science educators.[101] The mission of the CSbyUs team has always been utilizing open source technology to improve pedagogy in computer science, which includes increasing support for teachers. Therefore, this project primarily seeks to use open source principles—and the benefits inherent in them—to expand the possibilities of modern curriculum-making and support teachers by increasing access to more adaptable curricula.

Rigid, monotonous, mundane

Why is the lack of adaptable curricula a problem for computer science education? Rigid curricula dominates most classrooms today, primarily through monotonous and routinely distributed lesson plans. Many of these plans are developed without the capacity for dynamic use and application to different classroom

101 https://csbyus.herokuapp.com/

atmospheres. In contrast, an *adaptable* curriculum is one that would *account* for dynamic and changing classroom environments.

An adaptable curriculum means freedom and more options for educators. This is especially important in elementary-level classrooms, where instructors are introducing students to computer science for the first time, and in classrooms with higher populations of groups typically underrepresented in the field of computer science. Here especially, it's advantageous for instructors to have access to curricula that explicitly consider diverse classroom landscapes and grants the freedom necessary to adapt to specific student populations.

Making it adaptable

This kind of adaptability is certainly at work at CSbyUs. Hayley Barton—a member of both the organization's curriculum-making team and its teaching team, and a senior at Duke University majoring in Economics and minoring in Computer Science and Spanish—recently demonstrated the benefits of adaptable curricula during an engagement in the field. Reflecting on her teaching experiences, Barton describes a major reason why curriculum adaptation is necessary in computer science classrooms. "We are seeing the range of students that we work with," she says, "and trying to make the curriculum something that can be tailored to different students."

A more adaptable curriculum is necessary for truly challenging students, Barton continues.

The need for change became most evident to Barton when working students to make their own preliminary apps. Barton collaborated with students who appeared to be at different levels of focus and attention. On the one hand, a group of more advanced students took well to the style of a demonstrative curriculum and remained attentive and engaged to the task. On the other hand, another group of students seemed to have more trouble focusing in the classroom or even being motivated to engage with topics of computer science skills. Witnessing this difference among students, it became important that curriculum would need to be

adaptable in multiple ways to be able to engage more students at their level.

"We want to challenge every student without making it too challenging for any individual student," Barton says. "Thinking about those things definitely feeds into how I'm thinking about the curriculum in terms of making it accessible for all the students."

As a curriculum-maker, she subsequently uses experiences like this to make changes to the original curriculum.

"If those other students have one-on-one time themselves, they could be doing even more amazing things with their apps," says Barton.

Taking this advice, Barton would potentially incorporate into the curriculum more emphasis on cultivating students' sense of ownership in computer science, since this is important to their focus and productivity. For this, students may be afforded that sense of one-on-one time. The result will affect the next round of teachers who use the curriculum.

For these changes to be effective, the onus is on teachers to notice the dynamics of the classroom. In the future, curriculum adaptation may depend on paying particular attention to and identifying these subtle differences of style of curriculum. Identifying and commenting about these subtleties allows the possibility of applying a different strategy, and these are the changes that are applied to the curriculum.

"We've gone through a lot of stages of development," Barton says. "The goal is to have this kind of back and forth, where the curriculum is something that's been tested, where we've used our feedback, and also used other research that we've done, to make it something that's actually impactful."

Hayley's "back and forth" process is an iterative process of curriculum-making. Between utilizing curricula and modifying curricula, instructors like Hayley can take a once-rigid curriculum and mold it to any degree that the user sees fit—again and again. This iterative process depends on tests performed first in the classroom, and it depends on the teacher's rationale and reflection on how curricula uniquely pans out for them.

Adaptability of curriculum is the most important principle on which the CSbyUs platform is built. Much like Hayley's process of curriculum-making, curriculum adaptation should be *iterative*, as it involves learning from experience, returning to the drawing board, making changes, and finally, utilizing the curriculum again. Once launched, the CSbyUS website will document this iterative process.

The open-focused pedagogy behind the CSByUs platform, then, brings to life the flexibility inherent in the process of curriculum adaptation. First, it invites and collects the valuable first-hand perspectives of real educators working with real curricula to produce real learning. Next, it capitalizes on an iterative processes of development—one familiar to open source programmers—to enable modifications to curriculum (and the documentation of those modifications). Finally, it transforms the way teachers encounter curricula by helping them make selections from different versions of both modified curriculum and "the original." Our platform's open source strategy is crucial to cultivating a hub of flexible curricula for educators.

Open source practices can be a key difference in making rigid curricula more moldable for educators. Furthermore, since this approach effectively melds open source technologies with open-focused pedagogy, open pedagogy can potentially provide flexibility for educators teaching various curriculum across disciplines.

Amarachi Achonu is a current undergrauate studying Computer Science. As a member of the Technology Research and Development team at CSbyUs, an open-source website for CS curriculum and support, she has worked to build not only this platform but to bridge the gap in technology careers for underrespresented students.

Review and discussion questions

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Activities

Making those (dreaded) faculty meetings transparent, collaborative, and effective

Aria Chernik & Tanner Johnson

ACTIVITY

Time required: The length of your scheduled faculty meeting, plus approximately 30 additional minutes before the meeting to craft the participatory agenda and approximately 15 minutes after the meeting to send actionable follow ups

Materials necessary: Real-time editable, collaborative document software (such as Google Docs)

Professor Jane has become disenchanted with faculty meetings. She gazes toward the monotonous speaker past a sea of screens (most likely focused on *other* tasks) and concludes that these meetings are either a time sink, an echo chamber, wildly redundant, superfluous, or some other combination of *bad*.

Whatever they are, they're *not* what meetings should be: well-structured, laser-focused on the objective, all-hands-on-deck, and maximally efficient.

Jane has an idea. Realizing the potential of so many brilliant brains in a room, she decides the next meeting she leads will be more focused, collaborative, and time-efficient than ever before—perhaps it'll be a meeting about *how to revamp meeting culture*. Regardless of the meeting objective, she needs some help.

Here's the process, from start to finish, that Jane (and you) should take to transform that next faculty meeting and make it more collaborative and participatory.

Facilitation steps

Step 0. Before you do anything else, determine whether you *actually* need a meeting. Most of us in academia have become accustomed to monthly faculty meetings that are stone-etched in perpetuity. Like Jane, we've often left those meetings feeling like they've undervalued our time or, worse, completely wasted it.

The first step in building community and empowering people is to ask yourself whether the meeting is truly necessary or whether the same ends could be accomplished through different means (like email or Slack). If the only reason you're calling a meeting is to transmit information or because having one is a historical precedent—then don't. Neither is a good reason on its own. These are the meetings that result in disenchantment with meetings.

Instead, set a meeting because you need to:

- Make an important decision
- Solve a problem
- Source feedback
- Retrospect and improve[102]
- Do some other super duper important thing that *requires other humans to be present in the same time and space*

Step 1. Prepare the agenda. Once you've thoughtfully determined that a meeting is necessary,[103] then it's time to get to work. Planning effective meetings is not a trivial task. They require intentionality, attention to detail, thought-scenario planning, and much more behind the scenes. Move forward voraciously attuned to the objective at hand. All communities thrive on authentic collaboration.

Spending time before the meeting drafting an *invite list* and a *participatory agenda* can go a long way in fostering community and meritocracy on your team. Jane has identified two problems that open source principles can address: the room lacks appropri-

102 https://backlog.com/blog/three-ways-run-productive-retrospective/

103 https://www.atlassian.com/blog/teamwork/how-to-run-effective-meetings

ate (and minimal) representation, and discussions demonstrate an inequality of voice.

- Community: If you have any control over the list of attendees at your faculty meetings, then your invite list should include only individuals who will make unique contributions. Aim to keep the list to a minimum, balancing the need for divergent ideas with meaningful participation from each member. Importantly, a participatory agenda asks participants to contribute agenda content prior to the meeting. An editable document shared with your team works well. In your meeting invitation, communicate that everyone should read through and contribute to the document prior to the meeting. This participatory agenda pre-meeting work is a critical time investment and goes a long way to curtailing conversations that are tangential to desired goals.
- Meritocracy: Educators know that their students have unique learning styles, but all too often faculty and administrators fail to apply this principle to their own meetings and interactions. A participatory agenda is a fantastic way to solicit deep participation from those who need more time and space to formulate ideas and opinions; it also sends a message to the community that all contributions are not only welcome but needed. Once ideas are on the agenda, in a healthy community the best ideas should win out—even if they aren't yours.

Step 2. Hold the meeting. It's time to make decisions and document all the important stuff. Thankfully, you're set up for success with a well-structured agenda. But keep in mind, you still need to actively drive the meeting forward. Tuning out is not an option for an effective meeting driver. Jane needs to stay on her toes to keep things on track and on time, and that requires full attention.

Here are three tips for doing that:

- Identify a primary note taker since your attention will be dedicated to keeping the meeting on track. The primary

note taker's role is to follow along with the meeting in real time, writing down the key points discussed under each agenda item. Consider annotating the agenda itself. During the meeting, use the clear structure of the agenda to your advantage; it represents clear expectations of flow and content for purposes of contributing.

- Put non-agenda topics in the "Parking Lot." When the room inevitably becomes stuck on an agenda item that doesn't require immediate resolution, *put it in the Parking Lot*. Throughout the meeting, facilitator Jane tactfully moves to the Parking Lot those items that are important to resolve but are not critical at the present time—and the primary note taker records those items in the documentation. This practice creates a log of *future* agenda items and helps reduce anxiety related to hitting objectives within the given timeframe.
- Use anonymity to source authentic opinions. We've all done it: We're not sure how our friends will react when we suggest a place to eat, so we wait for them to offer some ideas first. Often, external input quells our initial choice. Whether it's with food or other important decisions, our input gets shaped by others (a symptom that is even stronger for agreeable personality types). To source authentic ideas, Jane uses anonymous voting for important decisions and alternative feedback formats. To preserve ideas from external bias, consider an exercise like passing around sticky notes for individuals to silently document their opinion for a decision.

Step 3. Finish on time—and close with actions. *Always end the meeting on time.* Getting accustomed to doing this can take time, but soon participants in your meetings will come to see this practice not as rude but as deeply respectful of their time.

Yet even when your meeting is a great success (you ended 5 minutes early, people are smiling and sighing in relief, and it's clearly time for high-fives all around) your work isn't over.

During the meat and potatoes of the meeting (see Step 2), you kept the team laser focused on agenda items. You brought clarity to those big decisions, or made a plan to integrate feedback, or outlined clear steps for completing that new initiative. Mission accomplished, right?

Always, always, always budget five minutes at the end of the meeting for an actionable recap and distribution plan. Without these precious minutes, you risk losing all that valuable work you just accomplished, as it floats away into the Ether of Unaccountability. Now is the time to look back through the notes and document down specific action items that emerged during the meeting. For each action item, always publicly record:

- The task to be completed
- A due date
- The name of the person (or people) who will complete the work by the date

By deliberately reviewing actionable items and making them as specific as possible, we're setting ourselves up for success via accountability measures. That way, we don't arrive at the next meeting, where Terrance thinks Sue was going to check in with Adam about that one budget item, but Sue thought Terrance was going to do it in two weeks. Or, worse, they both forgot about it all together.

Step 4. Follow up. Jane knows she's surrounded by intelligent team members. They're bright leaders in their fields. But they're also human. And humans forget stuff. That's why it's on Jane, *the meeting lead*, to send reminders and share what everyone accomplished, both within and beyond the meeting team.

Spend some time cleaning up those meeting minutes and writing a short summary with key takeaways. Also be sure everyone listed as accountable for completing an action item receives a copy of the meeting notes that underscores the work they agreed to perform before the next scheduled meeting. Then send these off to the meeting team as well as other key stakeholders. Strive for transparency and *oversharing* whenever possible. And for bonus points, look at that beautiful list of actionables with dates and

names. Now, imagine how lovely it would be to receive a gentle reminder for your actionable as the deadline approaches (we're talking to you, Terrance!). Go do that! You'll find some great tools (even email) that will send a timed reminder to your teammate about that important item you all agreed upon last meeting. Less is *not* more here.

Reflection

We know firsthand that running meetings the open source way is effective. What has surprised us most is that running meetings this way is also creative, inspiring, and fun. Without a doubt, your most important resource is your community of people. Shifting your meeting culture from one where information is simply transferred and the same few voices dominate discussions to one where the community is empowered to draw upon its individual and collective talents to participate will transform work long after the meeting ends—on time!

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Digital forensics the open way: A tabletop approach to common scenarios

Denise Ferebee, Carolyn Butler, Dipankar Dasgupta & Marcus Kelly

ACTIVITY

Time required: 3–8 hours (depending on activity type and audience)

Materials necessary: Varies (see individual activity descriptions)

Digital forensics is the process of collecting, processioning, preserving, analyzing, and presenting computer-related evidence in support of network vulnerability mitigation and/or criminal, fraud, counterintelligence, or law enforcement investigations.[104] Teaching digital forensics concepts can be difficult, because it involves complex situational analysis and understanding (there is no standard format for analyzing a crime!). For an effective implementation of digital forensics, learners need to be active participants in a situated learning environment.

Digital forensics exercises require an activity approach through which learners explore and analyze a situation requiring the use of forensic tools specific to the component requiring analysis. To the greatest extent possible, this approach should be *collaborative* and *adaptable* to maximize its effectiveness. Therefore, in what follows, we share three versions of a digital forensics' tabletop activity, each adapted for a different learning context and

104 https://niccs.us-cert.gov/workforce-development/cyber-security-workforce-framework/digital-forensics

type of student. Each iteration involves the use of open source digital forensics tools.

Why a tabletop session? Tabletop exercises are discussion-based sessions in which team members meet in an informal setting to discuss roles during a critical incident. Hypothetical scenarios allow teams to evaluate their readiness to respond during critical incidents. In the following activities, a facilitator guides participant through an open discussion about a specific critical incident. The duration of a tabletop exercise depends on several factors: the audience, the topic being exercised, and the exercise objectives. Many tabletop exercises can be conducted in a few hours, so they are cost-effective tools to validate plans and capabilities. It is important to allocate the appropriate time for each exercise so that each group can finish.[105]

Cyber Camp Capture the Flag Activity (CCCTF)

Cybersecurity must be everyone's concern. Engaging K–12 learners in activities that promote the development of their cognitive and computational skills is paramount. Therefore, Cybersecurity should be covered in K-12 and post-secondary education curricula. CCCTF activities need to be adapted for specific learning groups on age and learning experience. The CCCTF participants for this activity ranged from ages 11–17 and grouped appropriately.

Learners participate in teams of two or three, while competing against other teams. A sample scenario is illustrated in Figure 1.

- **Required materials:** evidence sheets, character cards, clue cards, passcode/flag, clue hints, penalties, and game rules.
- **Suggested open source tools:** vi text editor, hex editor, Kali Linux[106]

105 https://www.ready.gov/business/testing/exercises

106 https://www.kali.org/

- **FACILITATOR OBJECTIVES:** introduce digital forensics skill sets needed, introduce the scenario, guide the teams through the process without revealing solutions, and give teams the ground rules for the game
- **PARTICIPANT EXPECTATIONS:** all team members must be willing to actively participate and must follow the rules of the game

```
Scenario: AnyCorp has had its internal yearly product launch
meeting.  At this meeting of company officials, a secret
slide deck (PowerPoint Presentation) was discussed. After
the meeting, the slide deck was leaked to a potential
competitor. AnyCorp's Information Security (InfoSec)
Department is investigating the incident. You are an
investigator. You have been given a set of potential
suspects. Use the game clues and the information covered
today to determine the culprit.
```

Figure 1: Example of CCCTF game scenario

Each clue provided in the game covers an example of a digital forensics skill the participants must master. Examples of these are shown in Figure 2 and Figure 3.

```
Clue 2

Objective: email headers

Description: The two parties involved have been
communicating. You are tasked with finding the email
communication in which they confirm that they have the slide
deck and are prepared to exchange the information for money.

Goal: Find the passcode to the next clue.
```

Figure 2: Example of CCCTF game clue objective (email headers)

```
Clue 5

Objective: image file identification

Description: All the files have been downloaded from the
suspect's Facebook account. You are tasked with identifying
the file showing the culprit.

Goal:  Find the final passcode and catch the suspect.
```

Figure 3: Example of CCCTF game clue objective (image file identification)

Facilitation steps

Phase 1: Preparation

Step 1. Cover background topics on email header content.

Step 2. Create a CCCTF game scenario (see Figure 1).

Step 3. Explain how to use a text editor (i.e., vi) to view the content of the text file.

Step 4. Create a text file of the email with available email headers.

Step 5. Include a passcode in the text file containing the email.

Step 6. Include other email text files for search purposes for the game.

Step 7. Create character cards with background information for each of the characters for the scenarios.

Step 8. Create clue cards that pertain to specific digital forensic techniques that learners will explore.

Step 9. For each clue, create a skill worksheet on which following information is both provided and captured:

- Clue number
- Description of technique used to solve the clue
- Passcode
- If a hint was given, a notation of the penalty

Step 10. Set rules for playing the game:

- Teams of two to three people
- Establish a first, second, and third place price
- Hints to clues will incur a two-minute penalty with a max of three hints per game of CCCTF
- Team that finishes the fastest with the right answer wins (i.e., first, second, and third place prices)
- Maximum time limit of two hours

Phase 2: Forensic analysis

Step 1. Divide learners into teams of two to three people.

Step 2. Provide game rules to CCCTF teams.

Step 3. Provide teams with all the manipulatives used during the game as follows:

- a CCCTF game scenario
- character cards
- an evidence worksheet
- the first clue
- the Kali Linux instance that you'll use to perform forensic analysis

Step 4. Provide the image to the learners for analysis.

Step 5. Answer any questions about the game for clarification prior to the start of the game.

Step 6. Remind teams that they can use their notes covered in the earlier session in reference to digital forensic techniques.

Step 7. Start the game.

Step 8. Each time a team solves a clue, they will verify the answer (i.e., passcode or potential criminal is correct) and the facilitator will note (on their evidence worksheet) that their answer has been validated. At this time, determine whether they've reached the end of the game or need a new clue.

Phase 3: Game awards

Step 1. Determine which team is in first, second, and third place.

Step 2. Validate answers (i.e., passcodes/flags and suspected criminal).

Step 3. Award prizes.

Reflection

Learners will be at different learning levels and will have different experiences regarding critical thinking. Particularly, in a K–12 environment, we suggest having co-facilitators with the ability to answer scenario-based questions. In our camp experiences, for example, we fielded questions about techniques or unforeseen game parameters. Having multiple facilitators available to answer questions, made the activities run much smoother and easier. Facilitators had the option to provide teams with hints (along with the

understanding that a hint would result in a game penalty) thus, keeping the game interesting and fun, where anyone could potentially be a winner while introducing group dynamic formation.

2. Workshop Lego-based Capture the Flag Activity (WLCTF)

By constructing a Lego crime scene model, we will focus on cybersecurity from a visual and tactical experiential learning method. This version of the activity is conducive to post-secondary and adult learning environments, because it uses discussion-based and game-related principles (i.e., learning experience and engagement).

In this activity, facilitators will provide teams with a physical model of the crime scenario and a narrative. Each team member is assigned a role, which encourages participation from everyone. We suggest using curriculum models such as POGIL to provide guidelines for this activity.[107] Team/group sizes for this activity should be three to four people. A sample scenario for this activity is illustrated in Figure 4.

Required materials: character cards, clue cards, passcode/flag, clue hints, game rules

Recommended open source tools: MySQL, Kali Linux

Facilitator objectives: introduce digital forensics skill sets needed, introduce the scenario, guide the teams through the process without revealing solutions, give teams the ground rules for the game, and introduce the concept of roles

Participant expectations: all team members must be willing to actively participate and follow the rules of the game, and each team member must select a role

107 https://pogil.org/

```
Scenario:  AcmeHealth has had its medical database
compromised. They are unable to access any patient data.
AcmeHealth's Information Security (InfoSec) Department is
investigating the incident. You are an investigator. You
have been given a set of potential suspects. Use the game
clues and the information covered today to determine the
culprit.
```

Figure 4: Example of WLCTF game scenario

Each clue provided in the game covers an example of a digital forensics skill the participants must master. Examples of these are shown in Figures 5 and 6.

```
Clue 3

Objective: Dropbox[108]

Description: Communications and files were exchanged via the
cloud in preparation for the theft. You are tasked with
finding the user account and location that was used.

Goal: Find the passcode to the next clue.
```

Figure 5: Example of WLCTF game clue objective (Dropbox)

```
Clue 6

Objective: MySQL[109]

Description:  InfoSec, working with area law enforcement,
has discovered that the potential suspect/suspects kept a
database of all the hospitals they were going to attack.
However, they had a novice hacker in their ranks, and he/she
oversaw the database. Determine if he/she can be linked to
the database.

Goal: Find the final passcode and catch the suspect.
```

Figure 6: Example of WLCTF game clue objective (MySQL)

108 https://www.dropbox.com/

109 https://www.mysql.com/

Facilitation steps

Phase 1: Preparation

Step 1. Cover background topics on Dropbox content, like:

- Using a SQL viewer
- Using the support documentation for Dropbox

Step 2. Create a WLCTF game scenario.

Step 3. Create a Lego model of crime scene with appropriate characters.

Step 4. Install a base installation of Dropbox and make an image of the instance.

Step 5. Include passcode/flag in the configuration file for Dropbox.

Step 6. Create character cards with background information for each of the characters for the scenarios.

Step 7. For each clue, create a skill worksheet on which following information is both provided and captured:

- Clue number
- Description of multiple techniques participants can use to solve the clue
- Reflection questions that provide discussion points for the team. For example:
    - What technique did you use to solve the clue?
    - What was the passcode for the next clue?
    - As a team, describe a situation other than the scenario and clue where you could use this technique. Please include the benefit.

Phase 2: Forensic Analysis

Step 1. Divide learners into teams of three to four people.

Step 2. Provide game parameters to WLCTF teams.

Step 3. Provide teams with all the manipulatives used during the game as follows:

- WLCTF game scenario
- character cards
- clue worksheets

- role descriptions for each team member
- the first clue
- the Kali Linux instance that you'll use to perform forensic analysis

Step 4. Provide the image to participants for analysis.

Step 5. Answer any questions about the game for clarification prior to the start of the game.

Step 6. Remind teams that they can use their notes covered in the earlier session in reference to digital forensic techniques.

Step 7. Start the game.

Step 8. Each time a team has solved a clue, they will verify the answer (i.e., passcode or potential criminal is correct) and the facilitator will note (on their evidence worksheet) that their answer has been validated. At this time, determine whether they've reached the end of the game or need a new clue.

Phase 3: Game reflection

Step 1. When all teams have completed the game, begin the discussion of each clue worksheet.

Step 2. Discuss the techniques used for solving the clues.

Step 3. Discuss the issues participants had with solving clues.

Step 4. Discuss how the techniques can be used in other situations outside of the ones covered during the WLCTF.

Step 5. Discuss how the model helped with visualizing and analyzing the situation.

Reflection

We've conducted this version of the activity with professionals at different experience levels. Differences in experience became critical to our managing time. We recommend limiting the overall class size based on the number of co-facilitators present. Otherwise, learners will become idle and the activity will lose its cooperative feel.

Virtual reality–based activities (VRA)

In this section, we will focus on cybersecurity from a post-secondary and adult learner prospective. The VRA makes cybersecurity education accessible to this audience using group discussions, virtual reality immersion, and game-related principles (i.e., learning experience and engagement).

In this activity, teams are provided with a virtual reality model of the crime scenario and a narrative. Each team member is assigned a specific role, which encourages participation from everyone. We suggest using curriculum models such as POGIL to provide guidelines for this aspect.

Team/group sizes for this activity should be around three to four people. A sample scenario for this activity is illustrated in Figure 7.

- **Required materials:** character cards, clue cards, passcode/flag, clue hints, penalties, and game rules
- **Recommended open source tools:** vi editor, hex editor, and Kali Linux
- **Facilitator objectives:** introduce digital forensics skill sets needed, introduce the scenario, guide the teams through the process without revealing solutions, give teams the ground rules for the game, and introduce the concept of roles
- **Participant expectations:** all team members must be willing to actively participate and follow the rules of the game, and each team member must select a role

```
Scenario: AnyCorp has had its internal yearly product launch
meeting.  At this meeting of company officials, a secret
slide deck (PowerPoint Presentation) was discussed. After
the meeting, the slide deck was leaked to a potential
competitor. AnyCorp's Information Security (InfoSec)
Department is investigating the incident. You are an
investigator. You have been given a set of potential
suspects. Use the game clues and the information covered
today to determine the culprit.
```

Figure 7: Example of VRA game scenario

Each clue provided in the game covers and example of a digital forensics skill the participants must master. Examples of these are shown in Figure 8 and Figure 9.

```
Clue 2

Objective: email headers

Description: The two parties involved have been
communicating. You are tasked with finding the email
communication where they confirm that they have the slide
deck and are prepared to exchange the information for money.

Goal:  Find the passcode to the next clue.
```

Figure 8: Example of VRA game clue objective (email headers)

```
Clue 5

Objective: image file identification

Description: All of the files have been downloaded from the
suspects Facebook account. You are tasked with identifying
the file showing the culprit.

Goal:  Find the final passcode and catch the suspect.
```

Figure 9: Example of VRA game clue objective (image file identification)

Facilitation steps

Phase 1: Preparation

Step 1. Cover background topics on email header content.

Step 2. Create a VRA game scenario.

Step 3. Create a virtual crime scene environment.

Step 4. Explain how to use a text editor (i.e., vi) to view the content of the text file.

Step 5. Create a text file of the email with available email headers.

Step 6. Include passcode in the text file containing the email.

Step 7. Include other email text files for search purposes for the game.

Step 8. Create character cards with background information for each of the characters for the scenarios.

Step 9. Create clue cards that pertain to a specific digital forensic technique that the learner will explore.

Step 10. Create a skill worksheet for each clue where the following information is provided and captured for each clue solved:

- Clue number
- Description of multiple techniques that can be used to solve the clue
- Reflection questions that provide discussion points for the team. For example:
  - What technique was used to solve the clue?
  - What was the passcode for the next clue?
  - As a team, describe a situation other than the scenario and clue where this technique can be used. Please include the benefit.

Phase 2: Forensic Analysis

Step 1. Divide learners in teams of three to four people.

Step 2. Provide game parameters to VRA teams.

Step 3. Provide teams with all the manipulatives used during the game as follows:

- VRA game scenario
- character cards
- clue worksheets
- role descriptions for each team member
- first clue
- Kali Linux instance that will be used to perform forensic analysis

Step 4. Provide the image to the learners for analysis.

Step 5. Answer any questions about the game for clarification prior to the start of the game.

Step 6. Remind teams that they can use their notes covered in the earlier session in reference to digital forensic techniques.

Step 7. Start the game.

Step 8. Each time a team has solved a clue, they will verify the answer (i.e., passcode or potential criminal is correct) and the facilitator will note on their clue worksheet that their answer has been validated. At this time, idetermine whther they've reached the end of the game or need a new clue.

Phase 3: Game reflection

Step 1. When all teams have completed the game, begin the discussion of each clue worksheet.

Step 2. Discuss the techniques used for solving the clues.

Step 3. Discuss the issues participants had with solving clues.

Step 4. Discuss how the techniques can be used in other situations outside of the ones covered during the VRA.

Step 5. Discuss how the model helped with visualizing and analyzing the situation.

Reflection

The activity can be done with learners at different experience levels. The key here is managing time. Therefore, you need to limit the overall class size based on the number of co-facilitators you will have. Otherwise, learners will become idol and you will lose the team aspect of the activity. Also, you will need gauge each learners experience with using virtual reality equipment.

Denise Ferebee is

Carolyn Butler is

Dipankar Dasgupta is

Marcus Kelly is

How to collect feedback from your students (or, how to assess the sting of teenage rejection)

Charlie Reisinger

ACTIVITY

Time required: 60–90 minutes

Materials necessary: Red and green paper sticky dots, a color printer or copier, a whiteboard with dry erase markers

How does your school leadership team promote a more inclusive and open culture? Feedback is doubtless part of the process. Schools commonly solicit solicit teacher, parent, and community input when planning new programs and projects. It seems everyone has something to say about the color of the band uniforms or the price of chocolate milk in the cafeteria.

But too often, students are absent from the decision-making table. Yet when costs are high and the stakes are huge, schools can't afford to ignore student feedback.

In January 2019, the Penn Manor School District board of directors voted to approve an $82.7 million high school renovation and construction project. Years of architectural development, financial modeling, and instructional design guided the decision. And equally important was student feedback about their learning spaces.

Before we drew a single pixel on the final construction documents, student feedback was shaping major design decisions. Early in the building construction planning, we asked students to contribute feedback on the design and layout of the forthcoming

facility. A student focus group took part in a visual listening exercise in which they shared ideas on interior concepts, classroom models, and common learning spaces. And even though the student feedback team would never reap the benefits of the renovated high school facility, they were honored to shape the destiny of a building that will serve both their younger siblings and subsequent generations.

The district's architectural partner ran the visual listening activity using a method for facilitating student-centered conversations, and I'll share it here. Although the following steps are specific to a construction project, we can generalize it to any project for which leaders must gather and prioritize concepts, designs, and images. It's simple—and effective.

Facilitation steps

Phase 1: Preparation

Step 1. Collect a wide variety of photos and diagrams and print one image each onto a standard page of printer paper. In our exercise, for example, the images included everything from classroom furniture arranged in different layouts and patterns to pictures of school facility spaces including cafeterias, gyms, libraries, staircases, music rooms, auditoriums, and social gathering areas. Color photos are essential. Here's a chance to test the new color copier!

Step 2. Tape the pictures side-by-side onto a wide wall. Quantity matters. We plastered more than 100 photos in a grid approximately 18 columns wide by six rows tall. The sheer size had a dramatic visual impact on the students.

Step 3. Collect a batch of adhesive, color-coding dot stickers. Try to find sticky dots with a small diameter; large dots will smother the photos. You'll need at least two different colors. Bright green and bright red dots are easy to spot and straightforward to interpret as "like" and "dislike."

Step 4. Gather one eager and inquisitive student focus group. Fifteen students comprised our team. Of course, your stu-

dent group should include diverse representation from every clique, class, and club.

Phase 2: Get voting

Step 1. A designated facilitator should provide each student with green and red dots—perhaps 10 of each color—and kick off the process. Instruct participants to place the green dots on the features and designs they like and the red dots on the features they don't like. The facilitator keeps time. Allow students 15 minutes to place all their dots.

Step 2. Wait for participants to place all their dots.

Step 3. Discuss both the features and spaces receiving a splash of green and those subjected to the red dot of teenage rejection. Some images will receive many dots and clear patterns will emerge. During our discussion and debrief, student opinion was (as you might expect from 15- to 18-year-olds) deliciously frank and unfiltered. Lively student criticism and comments are an authentic perspective on the project. To structure the discussion, consider asking questions like:

- What features of the school design appealed to you? Why did you choose to place your limited dots on these features?
- Given limited funding, we can't build everything. How would you rank order the most popular features? What are your criteria for making that choice?
- Why did you place the red dots? Was it the color, design, or something else? How might those features be modified to be more functional or fun?
- For the features that received no green or red dots, what could be improved to make the designs more appealing and inviting?
- Can the group reach a consensus on the two most important building design features and two features to absolutely avoid?

Step 4. Record the data. I recommend taking photos of the completed exercise before removing the pictures and dots from the

wall. The visual record will be essential for later analysis. For instance, our conversation with students at Penn Manor helped us identify gaps between what our district design team envisioned, and what our students preferred.

Reflection

One crucial tip for running the visual listening exercise—the facilitator must be neutral during the discussion. The facilitator's role is to encourage participation, promote healthy discussion, and seek to clarify student ideas and thoughts. But be mindful of the students who may need time to reflect and process what they saw and heard during the activity. Consider creating an email address or online form to capture student feedback and thoughts well after the focus group adjourns.

Charlie Reisinger is the Director of Technology for Penn Manor School District in Lancaster County, PA. He leads the district's award-winning one-to-one laptop learning program and student technology help desk. His first book, The Open Schoolhouse, chronicles how open source principles and software transformed learning at Penn Manor. Follow Charlie on Twitter at @charlie3.

Performing the collaborative dilemma

Gina Likins

> ACTIVITY
>
> Estimated time to complete: 30–60 minutes (add 15–20 minutes if using the bonus decision framework discussion module)
>
> Materials needed: Two varieties of prizes, one "choice card" for every participant, a whiteboard and markers, signs that read "30 seconds" and "20 seconds," tape measure (if using bonus decision framework module)

I wanted groups to experience open source values in a very concrete, hands-on way—so I created a game called "Candy or Swag,"[110] which is based on The Prisoner's Dilemma.[111] Unlike The Prisoner's Dilemma, however, Candy or Swag tests a negotiation scenario based on reward (rather than punishment) and uses real, tangible prizes of varying value to demonstrate how collaboration and transparency can form the basis of a sound business strategy.

In this chapter, I'll explain how I run "Candy or Swag," including game setup, instructions for play, and hints for facilitation.

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110 Adapted from "Teaching the Prisoner's Dilemma More Effectively: Engaging the participants," by Michael A. McPherson and Michael L. Nieswiadomy (http://www.cas.unt.edu/~mcpherson/papers/mcpherson_nieswiadomy_jee.pdf)

111 The Prisoner's Dilemma (http://www.investopedia.com/terms/p/prisoners-dilemma.asp) is a classic exercise in game theory that explores the "competing" desires of cooperation and self-preservation. I've always been fascinated by game theory and the Prisoner's Dilemma, but found them difficult to explain to others—because they're abstract, existing in the realm of "thought experiment."

Facilitation steps

Phase 1: Preparation

Step 1. Gather materials. For this exercise, you will need four things:

- *Prizes of two different varieties:* "*candy*" *and* "*swag.*" Candy (or "low value" prizes) can be anything with trivial value, like individually wrapped pieces of candy (my typical choice), pennies, or stickers. To estimate quantity, assume that every participant can win a piece of candy every "round" and that you will run at least eight rounds. Swag (or "high value" prizes) doesn't have to be physical objects; it could be "two hours off," for example—but there should be a physical representation of the prize, like a coupon (I've used company-branded items that we usually give away at conferences). To estimate quantity, figure that every participant can have one piece of "swag" and have a few to spare.
- *A* "*choice card*" *for each participant*. On each card, write the name of the "low value" prize on one side, and on the reverse write the "high value" prize. I tend to use candy for the former and swag for the latter (hence the name of the exercise), but you should use whatever works best for you. Throughout this chapter, I'll use the terms "candy" and "swag" as placeholders for these two types of prizes.
- *A whiteboard and whiteboard markers or printed sheets to distribute with the payoff matrix* (see Figure 1).
- Signs (handwritten is fine) reading "30 seconds" and "20 seconds."

Step 2. Place a choice card at each participant's desk.

Phase 2: Game Play

Step 1. Explain the rules to participants. Here they are:

1. *No talking from this point forward. Anyone who talks gets neither candy nor swag.*
2. *You have a choice card in front of you. When I say so, pick up the card and hold it so that your choice (of candy or swag) is facing up and the other side is hidden by your hand.*
3. *I'll come around and tally your choices, so make sure to hold your card so I can see it but no one else can. If you want "candy," for example, hold the card so I can see "candy" when I come around.*
4. *Here's the twist: Whether you receive candy, swag—or nothing at all!—is based on what choices the whole group makes, based on a payoff matrix.*
5. *Here's how the payout works. Pay close attention.*

STEP 2. Explain the "Payout Matrix." I find that constructing the payoff matrix in real-time on the whiteboard (while talking it through) works best. This seems to help participants better understand the choices.

If using a whiteboard is not feasible, you can distribute printed copies of the payoff matrix. The payoff matrix is based on a "target number" of participants, which is the maximum number that can choose "swag" and ensure a scenario where everyone gets something. I usually set the number at roughly 1/10 the size of the group. For example: In a group of 20, the target number is 2, while for a group of 8, the target is 1 (as it's hard to have less than a whole person). For a group of 15, I'd use 2 as the target.

If...	Who gets CANDY	Who gets SWAG
... **everyone** chooses **candy**	**Everyone**	**No one**
... ≤ target# of participants choose **swag**	**Everyone except** the participants who chose **swag**	The participants who chose **swag**
... > target# of participants choose **swag**	**No one**	**No one**

Figure 1: The "payout matrix"

After explaining the payout matrix and taking questions, you're ready to play! (Important: Do not tell the participants how many rounds you're playing.)

Step 3. Ask the participants to choose candy or swag by holding their choice card so that you can see their choice (but no one else can).

Step 4. Count the number of participants who chose swag.

Step 5. Tell the group how many people chose swag (but not who chose swag). Explain what everyone won (if anything) using the payout matrix above, and hand out prizes.

Step 6. Run a few rounds (at least three) like this, then ask for some reflection about what the participants are noticing.

Step 7. By now the participants are usually getting a little frustrated (which is fine), so explain: "*We are going to try playing the game a little differently—in a way that's more 'open.*'"

Step 8. Review the Open Organization Definition (see Appendix) and ask the group if they think it might help if they were allowed to collaborate a little before making their decision for candy or swag. Assuming they jump on this opportunity (and I've never seen a group that hasn't), you can explain some new rules.

Step 9. Explain these new rules:

1. *You will have one minute from when I say "go" to collaborate as a group before each of you again chooses candy or swag.*
2. *I'll hold up signs telling you when you have 30 seconds left, then 20 seconds left, then count down the last ten.*
3. *All the rest of the rules are the same. Remember to choose the card for the prize you want, then hold it so that I am the only person who can see your choice.*

Step 10. Say "*Go.*"

Step 11. At 30 seconds, hold up the "30 second" card. Then, at 20 seconds, hold up the "20 second" card. At 10 seconds, begin a silent countdown using your hands held high above your head. (Note: I'm not incredibly strict with the timing. If there was clear

progress, I let the time run long, for example. This step is primarily a way to ensure participants know there's not room for endless debate.)

Step 12. As above, tally the votes for swag and explain the "payout." If at any time a participant asks how many more rounds there will be, tell them that you don't know. Run at least three rounds this way. Run more rounds if it takes them a while to get collaborating.

Step 13. After a couple of rounds of playing the game this way, ask the group if—based on your discussions about "openness"—anyone can think of a change that would make the process even more open.

Step 14. If the group has had people who said they'd choose candy but really chose swag in the collaboration period (what we might call "cheaters"), they'll usually come up with "transparency" on their own. Even if you haven't seen cheaters so far, though, consider proposing a hypothetical situation asking what would have happened if the group still ended up with too many swag choices and how that would have affected the outcome. (I will often use this opportunity to talk about the open source idea of "trust then verify"—or collaborating with people to find the best solution, rather than competing, but having the code be open and transparent to everyone so it's "checkable.")

Step 15. Change the rules one more time. Now have the participants make their choices in an "open" or transparent way (for example, by placing their choice card face up on the table). This variant is especially helpful if you have groups that are unable to figure out how to effectively manage the collaboration variant of the rules.

Step 16. If using the bonus decision-making framework discussion module, skip to it now (see below). Otherwise, take a few minutes to ask the class for their perceptions of the experience:

- how the first few (non-collaborative) rounds felt to them and what they observed
- how the collaboration changed their process

- which of the three types of rounds they felt was "easiest"

Of course there are no wrong answers—the goal here is to cement the experience of collaborating and working transparently.

Bonus decision-making framework module

Observation of the negotiations during the collaboration rounds provides a useful jumping-off point for discussions of decision-making methods, how software makes decisions, and the implications of developer choices on the ability of software to make unbiased decisions.

For this part of the exercise you'll also need a tape measure —the retractable ones commonly used to measure lumber are perfect.

Facilitation steps

Phase 1: Observation, Recollection & Brainstorming

Step 1. During the collaboration round, notice how participants decide who gets the swag. Often, they'll discuss and discard several alternatives; try to capture and remember them. It may be the case that no overriding principles seem to guide the choices: if so, that's fine too. Participants may believe they are selecting randomly—more on that later.

Step 2. After the final round, ask participants to describe how they selected the swag recipient. Write that on the whiteboard or paper. Here are some "algorithms" I've seen employed:

- Loudest gets it
- First one to speak up gets it
- By seating order around room
- Alphabetical by last name
- By who "deserved it" (according to the participants)
- By who "needed it" (swag was phone charger and one participant had lost hers)

Step 3. Ask participants why they chose the method they did. You may need to prompt them. Say something like: *Was it the first one everyone agreed on? Did it seem to be the fairest? Why?*

Step 4. If you noticed other methods being discussed, remind participants of each method they debated and ask them why they discarded it.

Step 5. Ask participants to brainstorm other ways of making the "Who gets swag" decision. I often ask participants to think about other situations they've been in and how those decisions are made. For example: *How did your teacher decide who got to clean the chalkboard? Who gets to sit in the front seat on a car trip? How do companies choose who wins prizes in giveaways?* List the brainstormed ideas, as well as advantages or disadvantages for each, on the whiteboard. Note that the goal is to get participants thinking about the implications of different decision-making algorithms rather than generating a comprehensive list of pros and cons for each.

At the end of Phase 1, you'll have something that looks like Figure 2.

Algorithm	Why used or discarded
Whoever asks first gets swag	Concern that it wasn't very fair and didn't take into account greater need of some participants
Whoever needs swag most gets it	Since they weren't sure how many rounds they were playing, it seemed fairest to make sure that people who needed the swag most got it
Draw slips out of a hat	Might seem unfair because someone has to hold the hat. Also takes a long time.
Who is tallest	Not fair to short people!
"Merit" based on grades	Shouldn't know everyone else's grade
Person who got swag last picks who gets it next	Might become a popularity contest

Figure 2: Decision-making algorithms

Phase 2: Writing a "program" to choose the tallest participant

Step 1. Say something like: *We're now going to see what it might look like to program a computer to make the decision about who gets the swag for you.*

Step 2. Remind participants that computers can't do anything that they don't have instructions for. So first we need to write the instructions to help the computer make the swag decision.

Step 3. Tell participants: *We're going to use the "tallest to shortest" algorithm for our example, and we're not going to write this program in the most efficient way possible, but that's alright.*

Step 4. Suggest to participants that one way of having the computer choose the tallest participant (who will get the swag) would be to have the computer compare the height of any two participants and choose the tallest of the two. Then the computer would compare that person against another participant and keep the tallest of those two.[112] Lather, rinse, repeat. At the end, the computer will have chosen the tallest participant. In other words, it's just like going to the optometrist!

Step 5. Write the following on the whiteboard. This is not a real program, but it will serve our purposes:

1. For Participant A and Participant B,
2. Get distance [top of head] to [floor] for Participant A. Call it H1
3. Get distance [top of head] to [floor] for Participant B. Call it H2.
4. If H1 > H2, keep Participant A[113]
5. Else, keep Participant B
6. (repeat)

Step 6. Choose between five and seven participants and ask them to come to the front of the room. They are your "subject group." Quickly run through the exercise. Using another participant to help with measuring will speed this step up.

Step 7. Ask participants if they agree that the steps above will result in the tallest participant being chosen. Assuming that they agree, proceed to Phase 3.

112 This is the simplest to demonstrate easily, but it's not very efficient. If you're working with participants who have a background in computer science, feel free to have them suggest an algorithm (bubble sort, tree sort, etc.)

113 For the sake of simplicity, we're ignoring the case where the heights of Participant A and Participant B are equal.

Phase 3: Introduction to machine learning

Step 1. Explain to participants: *We just wrote a "program" with a set of explicit instructions to tell the computer what to do, but that another way for computers to make decisions is using "machine learning." In machine learning (or ML), computers "learn" without being explicitly programmed, sometimes by making "guesses" and comparing those guesses to the correct answer, thereby generating an algorithm. In this case, the computer would be given all of the Height (H1, H2, etc.) values—called a "training dataset"—and the computer would generate the algorithm for picking the tallest person.*

Step 2. Tell participants: *We're now going to pretend the algorithm we just developed was developed by a computer through ML.* (We're skipping a lot of steps here and have glossed over some important differences between ml and algorithmic programming, but they're not relevant for this example.)[114]

Step 3. Ask another five to seven participants to come to the front of the room to be your new "subject group."

Step 4. Choose a participant to be the "computer." This person can only follow the instructions on the board.

Step 5. Ask half of the subject group to sit down (on the floor or in a chair).

Step 6. Run the "program." (Remember: the computer can't ask the participants to stand up, because it wasn't part of the instructions).

Phase 4: Post-mortem

Step 1. Ask the participants to explain how the program the computer created might have been different if the training dataset had included people that were sitting down. Possibilities include:[115]

1. Adding a correction for sitting participants

114 https://towardsdatascience.com/the-hidden-dangers-in-algorithmic-decision-making-27722d716a49

115 Brainstorming other ways of solving this problem is also fun and worth the time, if you have it.

2. Adding a step to ask participants to stand up before getting measured
3. Using a flexible tape measure (like the ones you use when sewing) and measured the linear distance along participants' sides from [top of head] to [base of foot]
4. Having participants lie down before measuring, and measuring [top of head] to [base of foot]

Step 2. Ask participants if the algorithm developed in Step 2 would have been fair to participants who were in a wheelchair.

Step 3. Explain that this issue—how representative the "training data" set is of the entire data set—is a current issue for machine learning. If the data aren't representative, "sample bias" is introduced.

Step 4. Ask participants to reflect on how sample bias might affect machine learning. Use questions like:

1. What would happen if voice recognition software was only trained on people with a southern accent?
2. If medical diagnostic software to recognize the symptoms of a heart attack were trained on a dataset that is primarily men?[116]
3. If a ML algorithm designed by a technology company to pick more successful candidates out of a pool of applications were trained on that technology company's current employee base?[117]

Step 5. Assign some homework. A good homework assignment is asking participants to find a system with which they interact that might be a good candidate for ML and to give at least one example of how the dataset might be biased.

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116 While both men and women can experience the "elephant on the chest" sensation, women may also experience shortness of breath, pressure or pain in the lower chest or upper abdomen, dizziness, lightheadedness or fainting, upper back pressure or extreme fatigue. (from https://www.heart.org/en/health-topics/heart-attack/warning-signs-of-a-heart-attack/heart-attack-symptoms-in-women)

117 https://www.theverge.com/2018/10/10/17958784/ai-recruiting-tool-bias-amazon-report

Reflection

In groups I've facilitated (which typically had about 20 participants with a target number of 2), the number of participants choosing swag each round ranged from four to eight, but it was never fewer than two (so no one won anything). If asked to reflect on what they're seeing, participants typically identify a few issues:

- "A lot of people are greedy (i.e., want swag)."
- "There's no way to tell who is asking for what."
- "There were a lot of people who were trying to do the right thing so everyone could get candy at least."

After I've changed the rules to allow for more collaboration, however, the participants immediately figure out that if they work together they can *all* get candy every round, and they can *take turns* getting swag. Watching the discussions between the participants evolve is fascinating: even though I've just met these participants, I can tell who the leaders are. I've seen groups came up with their own variants of a "sharing protocol." For example, one group chose one person from each table in the first round, then the next person from each table during the next round, while in another group they just moved around the room clockwise. When we enter the reflection phase of the exercise, almost every group I've worked with has observed that they have fared better when everyone was collaborating.

One group was particularly illustrative. Apparently, there'd been some interpersonal drama earlier in the week and tensions in the group were high. When they first played the collaboration round, they came up with a plan—but someone "cheated"[118] (i.e., didn't stick to the agreed upon plan) and ended up causing the swag count to be "3."

So we tried it again, and the same thing happened. And again. By this point, the group had figured out who the rogue was and was becoming quite upset with him. To my utter surprise, on

118 I have "cheated" in quotation marks because in one sense he was following the best possible plan, if you were to discount altruism as a means to obtain future good.

the next round the cheater didn't cheat. I had to laugh, though, when someone pointed out that one of the other participants had taken away his swag card!

The cheater was understandably frustrated, but I used this as an opportunity to talk about what happens in open source communities when people show they are not trustworthy or that they don't have the community's best interests at heart. As I explained to the group, in open communities, if someone is consistently causing problems, the community will attempt to work it out with that person. But if that doesn't work, the community will often have no choice but to remove that person from the community.

The open organization values of collaboration and transparency seem like they should be easy enough to understand. But giving people the opportunity to discover how well they work through experimentation has proven far more effective than all the explaining I could do. This exercise is one way to provide that opportunity.

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Open organizations on Mars

Heidi Ellis

EXERCISE

Estimated time to complete: 90 minutes

Materials needed: The Open Organization Maturity Model, score cards, writing utensils, notepads, and paper

Those who are new to the idea of open organizations (and open source in general) may have a difficult time envisioning how the open organization principles (see Appendix) are incorporated as part of an existing culture. Many of these folks may not be participating in—or even have had extensive exposure to—an open organization, and therefore may not have ready access to a live community from which to observe and from which to learn.

This exercise allows participants to create their own communities and then evaluate them with respect to the Open Organization Maturity Model. It is intended to allow participants to gain an understanding of how open organization principles could be implemented within a culture. The process of creating a community allows the participants to clearly understand how the community works, providing a solid foundation for the process of evaluating the community with respect to the Open Organization Maturity Model. The application of the model provides participants the opportunity to test their understanding of open organization principles by evaluating their inclusion in a known environment.

Facilitation steps

Phase 1: Imagine a new society

In this phase of the exercise, participants will collaborate in teams to imagine a new society. Divide the group into teams with an equal number of members.

Step 1. Explain the exercise's hypothetical premise to participants. Say something like: "*You are part of a team of 50 people that is going on an expedition to Mars. The team will be responsible for creating a new community on Mars including terraforming, exploring, and establishing a government. You are responsible for defining the culture and government for the new community. In this assignment, you must define a society built on open source principles. How do people act? How do people govern themselves? What kind of institutions/organizations do you build?*"

Step 2. Ask participants to imagine a system of government for their new society. Say something like: "*Describe how your community will be run. Will your society be a democracy? A monarchy? A dictatorship? A mixed government that combines elements of several systems? What kind of a constitution will you have? How will your government make decisions? Define a motto for your government. Explain your choices.*" Allow at least 10 minutes for this step.

Step 3. Ask participants to imagine a legal system for their new society. Say something like: "*Your community must have rules. Define a list of at least 10 rules all community members must follow. Provide an explanation for each rule. You will also need a legal system in order to handle those who break the rules or harm others. What sort of a system will you use? How will you address conflict resolution? How will you enforce the rules of your society?*" Allow at least 10 minutes for the step.

Step 4. Ask participants to imagine an economic system for their new society. Say something like: "*Your society's economy determines how resources (goods and services) are allocated. What systems will be in place for the production and distribution of resources? What form of currency will you use? What structure will*

you use for distributing resources? Does the government own all resources and means of production? Are the resources owned by private individuals? Is it a blend? How do people earn a living? What industries and careers are available?" Allow at least 10 minutes for this step.

Step 5. Ask participants to imagine various social programs their society will offer. Say something like: "*Social programs exist to ensure that all members of a community are provided for. How will your government care for the poor? How will your community be housed? What rights to community members have? What are the obligations of all community members?*" Allow at least 10 minutes for this step.

Phase 2: Evaluate the new society

In this phase of the exercise, teams of participants will evaluate each others imagined societies, specifically their relative degrees of openness.

Step 1. Explain the Open Organization Maturity Model[119] to participants. Also explain that everyone will be evaluating the values that underpin the imagined societies with respect to each of the following aspects of a culture:

- Transparency
- Inclusivity
- Adaptability
- Collaboration
- Community

Step 2. Invite a representative from one of the teams to share the details of the society they generated in the first phase of the exercise. That representative should "read out" on the team's collective work and describe all facets of the society in as much detail as the team was able to generate.

Step 3. Other teams around the room will use scorecards (see Figure 1) to "rate" the society's position on the Open Organization Maturity Model. They should place an "X" in the space that

119 https://opensource.com/open-organization/resources/open-org-maturity-model

corresponds with their estimation of the society's degree of openness.

	Transparency	Inclusivity	Adaptability	Collaboration	Community
Level 1					
Level 2					
Level 3					

Figure 1: Scorecard

Step 4. Ask participants from around the room to share the scores they allocated to the society just described. Be sure to ask participants to justify their scores by describing their perceptions of the society.

Step 5. Repeat the steps in Phase 2 until all teams have had an opportunity to report on their imagined societies.

Reflection

Levels of open organizational maturity will vary, both across the aspects of a single team's culture and across the cultures of *all* the teams. The evaluation process may engender lively discussions as participants debate how the parts of the culture map to various levels in the Open Organization Maturity Model. This discussion affords the facilitator the opportunity to highlight some of the differences between the levels in the model, as well as to bring in real-world examples from existing organizations to illustrate the aspects and levels.

An interesting add-on exercise (if time permits) is to have the teams then discuss how their community could be "moved up" the Open Organization Maturity Model. Questions to structure that discussion might include:

- Which aspects of your community are most mature? Why did you design them in the manner that you did?
- Which aspects of your community are least mature? Why did you design them in the manner that you did?
- What underlying assumptions did you make when you designed the culture?

- What changes might you suggest to move the least mature aspects of the community to be more mature? What sort of changes would that require in the community?
- Given the current state of your community, what sort of a process would you envision to help the community become more mature with respect to being an open organization?

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Appendix

The Open Organization Definition

The Open Organization Ambassadors

Preamble

Openness is becoming increasingly central to the ways groups and teams of all sizes are working together to achieve shared goals. And today, the most forward-thinking organizations—whatever their missions—are embracing openness as a necessary orientation toward success. They've seen that openness can lead to:

- **GREATER AGILITY**, as members are more capable of working toward goals in unison and with shared vision;
- **FASTER INNOVATION**, as ideas from both inside and outside the organization receive more equitable consideration and rapid experimentation, and;
- **INCREASED ENGAGEMENT**, as members clearly see connections between their particular activities and an organization's overarching values, mission, and spirit.

But openness is fluid. Openness is multifaceted. Openness is contested.

While every organization is different—and therefore every example of an open organization is unique—we believe these five characteristics serve as the basic conditions for openness in most contexts:

- Transparency
- Inclusivity
- Adaptability
- Collaboration

- Community

Characteristics of an open organization

Open organizations take many shapes. Their sizes, compositions, and missions vary. But the following five characteristics are the hallmarks of any open organization.

In practice, every open organization likely exemplifies each one of these characteristics differently, and to a greater or lesser extent. Moreover, some organizations that don't consider themselves open organizations might nevertheless embrace a few of them. But truly open organizations embody them all—and they connect them in powerful and productive ways.

That fact makes explaining any one of the characteristics difficult without reference to the others.

Transparency

In open organizations, transparency reigns. As much as possible (and advisable) under applicable laws, open organizations work to make their data and other materials easily accessible to both internal and external participants; they are open for any member to review them when necessary (see also *inclusivity*). Decisions are transparent to the extent that everyone affected by them understands the processes and arguments that led to them; they are open to assessment (see also *collaboration*). Work is transparent to the extent that anyone can monitor and assess a project's progress throughout its development; it is open to observation and potential revision if necessary (see also *adaptability*). In open organizations, transparency looks like:

- Everyone working on a project or initiative has access to all pertinent materials by default.
- People willingly disclose their work, invite participation on projects before those projects are complete and/or "final," and respond positively to request for additional details.
- People affected by decisions can access and review the processes and arguments that lead to those deci-

sions, and they can comment on and respond to them.
- Leaders encourage others to tell stories about both their failures and their successes without fear of repercussion; associates are forthcoming about both.
- People value both success and failures for the lessons they provide.
- Goals are public and explicit, and people working on projects clearly indicate roles and responsibilities to enhance accountability.

Inclusivity

Open organizations are inclusive. They not only welcome diverse points of view but also implement specific mechanisms for inviting multiple perspectives into dialog wherever and whenever possible. Interested parties and newcomers can begin assisting the organization without seeking express permission from each of its stakeholders (see also *collaboration*). Rules and protocols for participation are clear (see also *transparency*) and operate according to vetted and common standards. In open organizations, inclusivity looks like:

- Technical channels and social norms for encouraging diverse points of view are well-established and obvious.
- Protocols and procedures for participation are clear, widely available, and acknowledged, allowing for constructive inclusion of diverse perspectives.
- The organization features multiple channels and/or methods for receiving feedback in order to accommodate people's preferences.
- Leaders regularly assess and respond to feedback they receive, and cultivate a culture that encourages frequent dialog regarding this feedback.
- Leaders are conscious of voices not present in dialog and actively seek to include or incorporate them.

- People feel a duty to voice opinions on issues relevant to their work or about which they are passionate.
- People work transparently and share materials via common standards and/or agreed-upon platforms that do not prevent others from accessing or modifying them.

Adaptability

Open organizations are flexible and resilient organizations. Organizational policies and technical apparatuses ensure that both positive and negative feedback loops have a genuine and material effect on organizational operation; participants can control and potentially alter the conditions under which they work. They report frequently and thoroughly on the outcomes of their endeavors (see also *transparency*) and suggest adjustments to collective action based on assessments of these outcomes. In this way, open organizations are fundamentally oriented toward continuous engagement and learning.

In open organizations, adaptability looks like:

- Feedback mechanisms are accessible both to members of the organization and to outside members, who can offer suggestions.
- Feedback mechanisms allow and encourage peers to assist one another without managerial oversight, if necessary.
- Leaders work to ensure that feedback loops genuinely and materially impact the ways people in the organization operate.
- Processes for collective problem solving, collaborative decision making, and continuous learning are in place, and the organization rewards both personal and team learning to reinforce a growth mindset.
- People tend to understand the context for the changes they're making or experiencing.

- People are not afraid to make mistakes, yet projects and teams are comfortable adapting their pre-existing work to project-specific contexts in order to avoid repeated failures.

Collaboration

Work in an open organization involves multiple parties by default. Participants believe that joint work produces better (more effective, more sustainable) outcomes, and specifically seek to involve others in their efforts (see also *inclusivity*). Products of work in open organizations afford additional enhancement and revision, even by those not affiliated with the organization (see also *adaptability*).

- People tend to believe that working together produces better results.
- People tend to begin work collaboratively, rather than "add collaboration" after they've each completed individual components of work.
- People tend to engage partners outside their immediate teams when undertaking new projects.
- Work produced collaboratively is easily available internally for others to build upon.
- Work produced collaboratively is available externally for creators outside the organization to use in potentially unforeseen ways.
- People can discover, provide feedback on, and join work in progress easily—and are welcomed to do so.

Community

Open organizations are communal. Shared values and purpose guide participation in open organizations, and these values—more so than arbitrary geographical locations or hierarchical positions—help determine the organization's boundaries and conditions of participation. Core values are clear, but also subject to continual revision and critique, and are instrumental in defining conditions

for an organization's success or failure (see also *adaptability*). In open organizations, community looks like:

- Shared values and principles that inform decision-making and assessment processes are clear and obvious to members.
- People feel equipped and empowered to make meaningful contributions to collaborative work.
- Leaders mentor others and demonstrate strong accountability to the group by modeling shared values and principles.

- *People have a common language and work together to ensure that ideas do not get "lost in translation," and they are comfortable sharing their knowledge and stories to further the group's work.*

Version 2.0
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github.com/open-organization-ambassadors/open-org-definition

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