Ensuring Educational Technology Innovation Advances Open Education Goals

The Case of U.S. K-12 Education

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Introduction[1]

Among the most promising school reform and improvement strategies being pursued by U.S. K-12 policymakers and practitioners today is the adoption of open educational practices, including the use of open educational resources (OER) in lieu of traditional proprietary textbooks.[2] In addition to the practical benefits that adopting high-quality OER offers students, the values of open education—of equity, access, transparency, community, and empowerment—resonate with school leaders across partisan lines in ways that few other reform initiatives have demonstrated an ability to do.

Open Educational Resources Defined

OER are teaching, learning and research materials in any medium—digital or otherwise—that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions.

(Excerpted from "Second World OER Congress: Ljubljana OER Action Plan 2017." Available online at: https://en.unesco.org/sites/default/files/ljubljana_oer_action_plan_2017.pdf).

1 This paper was prepared with the support of the William and Flora Hewlett Foundation. Versions have benefited from the thoughtful reviews and comments of Cathy Casserly, Angela DeBarger, Bill Fitzgerald, Chris Gilliard, Kristina Ishmael, Karl Nelson, and Beth Rabbit.

2 Ishmael, Kristina (2018). "Making Connections: PreK–12 OER in Practice." Washington, DC: New America. Available online at: https://www.newamerica.org/in-depth/prek12-oer-in-practice/; Tepe, Lindsey and Mooney, Teresa (2018). "Navigating the New Curriculum Landscape: How States are Using and Sharing Open Educational Resources." Wasington, DC: New America and the Council of Chief State School Officers (CCSSO). Available online at: https://www.newamerica.org/education-policy/reports/navigating-new-curriculum-landscape/introduction

At the same time, the growing availability of and reliance on educational technology in schools has served to accelerate the adoption of OER and—in a more limited way—even encourage open educational practices. Indeed, one common justification for school investments in technology made by policymakers and school leaders alike is that by spending money on technology, schools can more easily realize cost savings through the adoption of OER and other free-of-cost digital instructional materials. For their part, leaders in government and philanthropy looking to scale interest in and adoption of OER also frequently look to technology solutions—such as investments in online resource repositories and content interoperability standards—as integral to their success. Indeed, the future of open education and educational technology, especially in the context of U.S. K-12 schools, seems increasingly intertwined.

Being intertwined, however, is not the same as sharing the same values and goals. The interests of those pursuing school improvement and reform via the use of technology are much broader and more diverse than the aims of those advocating for open educational practices. While open education may be reliant on technology for its ability to scale, the embrace of certain technology tools and platforms (or their associated business models) may be orthogonal or even directly antithetical to open education goals. The rise of K-12 online marketplaces to buy and sell teacher-created educational materials (disingenuously marketed as "original educational resources") may serve to illustrate this contrast in values most starkly.[3]

As we look to an increasingly complex future of instructional materials, therefore, a framework or set of guidelines is needed to help shape the work of open education proponents and to help them determine the degree to which a particular technology product or innovation may be worthy of support and when it might be more likely to work at cross-purposes to their aims. To that end, the purpose of this paper is to explore the characteristics of such a framework, explore possible futures for open education in the context of the U.S. K-12 education system, and to suggest a small number of principles that might productively guide future open education investments by governments, philanthropy, and schools.

Toward a Framework for Assessing OER-Friendly Technology Innovation

Existing frameworks for thinking about the relationship between digital OER and technology issues, such as the ALMS[4] analysis framework first proposed by David Wiley in 2009,[5] conceptualize the degree of technical openness of an OER as being defined by the file type and format of the learning object itself. This leads to the consideration a range of important issues such as:

- the operating systems of users;
- whether the application(s) required to *access* the OER are themselves free and open source;
- whether the application(s) required to *edit* the OER are free and open source;
- the technical expertise and specialized training required of users to edit OER;
- the case of proprietary file formats that discourage users from editing them; and,

3 https://www.teacherspayteachers.com/About-Us

4 The acronym ALMS stands for 'access to editing tools,' 'level of expertise required,' 'meaningfully editable,'and 'self-sourced.'

5 Wiley (2009). Creating Open Educational Resources. Materials prepared for an independent study class on Open Educational Resources; "Poor Technical Choices Make Open Content Less Open" available online at: http://www.opencontent.org/definition/

- the case of proprietary file formats that are locked and do not allow users to edit them.

While these issues are fundamental to the concerns of OER producers and users, a broader frame is necessary to encompass the full range of technology/platform choices and emerging technology business models in the U.S. K-12 context. Such an approach would focus not in terms of the freedoms granted to users by learning objects with specific intellectual property licenses but in terms of ***the extent to which they benefit OER producers and users—including teachers and students—acting in a broader, increasingly digital learning ecosystem***. This shift in frame is a shift that moves attention from if and whether a technology or platform merely includes OER learning objects to one that asks how a technology platform advances the goals of open education.[6]

In considering the value of any such framework to guide technology-related choices about OER development and adoption, it is important to recognize that the use of technology for teaching and learning (in and out of schools) is dynamic, context dependent, and subject to change over time. New tools offer new opportunities and allow us to consider new solutions to the perennial issues of educational access and equity.

For instance, in the U.S., the conversations of the recent past about technology in K-12 education have largely focused on the impact of low-cost computing devices, online learning, and the potential of social platforms. Many current conversations focus on the promise of learning analytics, interoperability, and algorithmic feedback mechanisms. Future conversations may focus the educational technology community more squarely on the potential of virtual reality, sentiment analysis, and artificial intelligence.[7] As such, any framework to guide technology-related choices about OER must be sensitive to the dominant technologies capturing the attention of education and technology leaders or risk being irrelevant. This necessitates a framework with a future focus, one that attempts to anticipate the uptake of technology innovation in education.

At the same time, it is important to be modest about how well anyone can accurately predict the future, including about what digital learning tools will offer teachers and learners. Beyond the fact that it is notoriously difficult to make accurate predictions of the future – including about technology in education[8] – too often those offering us these predictions do so with a vested interest in the outcome.

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6 To provide one example of why moving beyond the technical characteristics of individual learning objects may be fruitful, consider the case of a hypothetical high-quality publisher who maintains an online repository that includes OER they have created and curated. Like most other publishers of educational resources, this publisher is interested in seeking to maximize the awareness of their educational resources among educators and learners who could benefit from accessing and using them (i.e., their target audience). In addition to any traditional advertising or marketing the publisher may pursue to find users, they also would benefit from employing advanced search engine optimization (SEO) techniques to increase the odds of discovery by individuals seeking learning resources via internet search engines similar to what the publisher offers. The broader issue of search and discovery in the K-12 digital learning ecosystem– and the importance of educational resource metadata initiatives–is largely unrelated to the file format or the specific intellectual property license of the OER learning objects.

7 See, e.g., Bakhshi, H., Downing, J., Osborne, M. and Schneider, P. (2017). The Future of Skills: Employment in 2030. London: Pearson and Nesta. Available online at: https://futureskills.pearson.com/research/assets/pdfs/technical-report.pdf; KnowledgeWorks (December 1, 2015). "Forecast 4.0 – The Future of Learning: Education in the Era of Partners in Code." Available online at: https://knowledgeworks.org/resources/forecast-4/; The NMC Horizon Project online at: https://www.nmc.org/nmc-horizon/; Schaffhauser, Dian (April 25, 2018). "9 Major Trends That Will Dominate Ed Tech" T.H.E. Journal. Available online at: https://thejournal.com/articles/2018/04/25/9-major-trends-that-will-dominate-ed-tech.aspx.

8 See, e.g., this 2017 assessment of the accuracy of the central prediction of Clayton Christensen and Michael Horn's 2008 book, "Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns" that the growth in computer-based delivery of education will accelerate swiftly until, by 2019, half of all high school classes will be taught

As Audrey Watters reminds us, "the best way to predict the future is to write a press release."[9] Indeed, there are many possible futures for OER in education. In some scenarios, OER adoption may be accelerated by technology innovation, while in others the opposite may be true (where educational technology primarily serves as a means to 'embrace, extend, and extinguish'[10] OER).

Scenario Planning the Futures of OER

One technique that can be useful to illuminating choices and consequences in multi-faceted circumstances such as these is scenario planning, a technique from the field of futures studies. By constructing and interrogating multiple representations of plausible future worlds, the problems, challenges and opportunities of various technological paths forward may become clearer.

Specificity is important to maximize the value of scenario planning. As such, the scenarios in this paper focus exclusively on the U.S primary and secondary (K-12) public education system.[11] Even within the relatively narrow case of the U.S. formal education system in the global context, the incentives and issues influencing the future of OER adoption and use are fundamentally different at traditional 4-year universities, community colleges, primary/secondary schools, and preschool settings. Governance and policymaking authority is vested in different bodies; funding models are different; technology and instructional materials procurement and adoption practices are different; and student needs are different.

To put a finer point on the need for specificity in scenario planning, consider the case of U.S. K-12 technology-related questions in the context of the OER lifecycle:[12]

- Production/Content Creation: Should the tools used to create OER be proprietary? Should they be platform-specific? How user-friendly do they need to be for developers with varied levels of expertise and experience? What metadata (e.g., standards alignment, intended grade level(s)) should be published alongside OER content and should that metadata be consistent with existing standards (or may new standards be necessary)? At what level of granularity (lesson, unit, course) should OER remix be supported? What subject-specific tools may be required (e.g., to produce mathematical formulas or science simulations)? What language and accessibility supports might be needed or desirable? How wide a range of technology platforms/ operating systems should be supported at the time of creation? How important is print-ready OER now and how might this change over time?

- Search and Discovery: How will school districts and/or educators procure/select standards-aligned content in the future? Should core instructional content be selected differently than

over the Internet" at https://www.edtechstrategies.com/blog/are-we-there-yet/ and https://www.edtechstrategies.com/blog/are-we-on-track-part-2/

9 Watters, A. (November 2, 2016). "The Best Way to Predict the Future is to Issue a Press Release." Available online at: http://hackeducation.com/2016/11/02/futures

10 Per Wikipedia, "a phrase that the U.S. Department of Justice found was used internally by Microsoft to describe its strategy for entering product categories involving widely used standards, extending those standards with proprietary capabilities, and then using those differences to strongly disadvantage its competitors." See: https://en.wikipedia.org/wiki/Embrace,_extend,_and_extinguish

11 Others may wish to extend this analysis by applying a similar technique to imagine various futures for OER in other education contexts within and beyond the U.S. formal education system.

12 Orr, D., M. Rimini and D. Van Damme (2015), Open Educational Resources: A Catalyst for Innovation, Educational Research and Innovation, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264247543-en

supplemental content? How important are third-party ‘quality’ rubrics and/or other rubrics that align content to different standards or pedagogical approaches (such as project-based learning)? How important is it to be able to search for content across platforms and repositories as opposed to within them? How important is it to be able to search for content by specific IP licenses?

- Retain and Organize: What are the features that best support the use of OER in content/learning management systems? Should these tools be proprietary and/or platform specific? Do we envision these systems managing a combination of proprietary and open content? How much control should users have over the content they interact with in their tools? How important is it that teachers be able to retain their own collections of content over time and across schools? How important is it that students be able to retain their own collections of content over time and across schools?

- Use/Pedagogical Support: How and what types of support for the use of OER in the classroom can technology platforms provide? Whom do we imagine will be responsible for ensuring the scope and sequence of instructional content throughout a unit or course? What guidance should be provided to make pedagogical frameworks explicit for educators? What supports are in place to inform inclusive design and productive adaptations? How scripted do we anticipate the curriculum to be? Who will provide professional development to teachers on the use of OER? To what degree is any OER professional development generalizable across content areas, student populations, and digital platforms?

- Feedback and Revision: How will feedback be collected (and from whom) about the effectiveness of open educational practices, including specific OER content? At what grain size should that feedback be collected? How much of this feedback will be automated (e.g., via passively collected analytics) and what data sharing agreements may be necessary? How important are version control systems to revising OER over time? How frequently will revisions to OER to be made (within and across school years) and who will be responsible for managing these revisions? How many different versions of similar OER content (e.g., to teach how to divide fractions) will platforms support?

- Dissemination and Redistribution: How much support should be provided, if any, for the export and redistribution of OER to different platforms and operating systems? If exporting of OER is supported, what metadata should be included? Does the provenance of OER matter (whether for reasons of version control or to address other issues)? How important is full and clear attribution to the dissemination and redistribution of OER?

The answers to these and related questions are likely to vary by one's role in the OER and K-12 ecosystems, by one's views on the future of technology in education, and by one’s views on the opportunities and challenges being offered by technology. As such, it may be challenging to draw useful conclusions from more expansive views of the intertwined nature of technology and open education (such as across countries/governance structures and across levels of education).

The Case of OER in U.S. K-12 Education: 2025

Let us suspend our disbelief and imagine the year 2025. While some may hope (and be working earnestly toward) a more dramatic and transformative shift in the future of U.S. K-12 education (even one a mere seven years from now), any plausible alternative future must be informed by the scholarship of David Tyack and Larry Cuban, who underscore the long-term resilience of the K-12 education

system to dramatic change.[13] As such, the future scenarios imagined for the purposes of this paper reject neat resolutions to many of the questions called by current education reform thrusts, including for personalized learning; competency-based education; school and teacher accountability; school choice; teacher induction, roles, and responsibilities; and resource allocation for schools serving large numbers of minority, migrant, and other at-risk students.

After setting the broader stage of the state of K-12 education in 2025, three possible alternate scenarios for the future of OER are presented. These three narratives—and the accompanying exhibit, which explicitly draws out similarities and differences across scenarios—are intentionally constructed so as to be largely mutually exclusive; however, one could imagine ways in which elements of each of these three possible futures are combined or integrated. The paper then concludes with a consideration of the cross-scenario implications for how open education supporters might approach prioritizing technology decision making in U.S. K-12 education.

It is the year 2025.

There are over 56 million students attending 125,000+ public elementary and secondary schools across the U.S., including in charter, online, blended, trade, and other special settings. In line with broader demographic trends, schools are serving increasingly diverse (majority minority) student populations, although some school districts and schools remain starkly segregated. As awareness and the means of diagnosis and treatment have improved, so has the identification of students with disabilities increased: 10 million students now require and benefit from school-based special education supports.

While student-to-teacher ratios vary widely by community and school-type, over 4 million adjunct and full-time teachers are employed by local education agencies and their partners to educate the nation's K-12 students. More teachers than ever before are new to teaching (many in part-time roles), and growing school enrollments, coupled with variable working conditions in schools (especially given cut backs to state-run teacher pension plans), have led to a persistently high rate of teacher turnover.

With no appetite for a knockdown, drag-out fight to recast the federal role in K-12 education and with little bi-partisan consensus, the 2021 ESSA re-authorization largely kept the prior status quo in place. While deeply disappointing to reformers and many advocates, local school leaders (under a well-understood and relatively stable set of federal policies and programs) argue they are making continued steady progress in improving outcomes for the students entrusted to them.

While school accountability data remain difficult to parse, analyses of student achievement data by civil rights advocates tell a different story, pointing to systematic gaps in both opportunity, experiences, and outcomes for students of specific racial/ethnic backgrounds. Studies from some think tanks argue that these racial/ethnic achievement gaps are fake and that aggregate school outcomes have never been better. Researchers at these think tanks argue that studies touted by civil rights advocates are incorrectly relying on outdated school accountability models and regulations that don't adequately account for the growth in the adoption of personalized and competency-based education practices. These debates seem highly technical and academic, but also divorced from the day-to-day reality of many educators and students.

13 Tyack, D., and Cuban, L. (1995). *Tinkering Toward Utopia: A Century of Public School Reform*. Cambridge, MA: Harvard University Press.

Once an object of considerable controversy, most schools' reliance on technology for teaching, learning, assessment and school operations is accepted as a reality of life and school in the early 21st century. While the paperless classroom still remains an elusive goal, the majority of instructional materials in use in schools are digital (or have significant digital components), as are all district-/state-wide mandated assessments. Students routinely access instructional materials (including videos of their classroom lectures) outside of school on their own (or school-issued) computing devices, including on their smartphones, smartwatches and smartbooks™. While the ease of communications and collaboration among students and teachers is remarkable thanks to digital tools, efforts at personalizing learning via technology are more mixed. (Error rates of the algorithms powering some adaptive learning tools have remained stubbornly high—especially for certain racial/ethnic subgroups—and susceptible to manipulation by so-called 'adversarial' teachers, parents, and students.)

If there is good news—and there is plenty to go around—it is that more students than ever before are graduating from high school and going on to postsecondary education. At the same time, economic anxiety is high. Following the stock market correction of 2023, a casualty of rising global trade tensions and technological innovation, job prospects for students—even for those with postsecondary degrees are less certain than ever. In partial response, industry-backed job/skill certification programs have grown in popularity, and it isn't unusual for students to graduate with as many as five or more certifications alongside their academic degree.

In this imagined future of U.S. K-12 education, what comes of the OER movement? Let us consider three possible scenarios:
- Scenario 1: "Buying IBM"
- Scenario 2: "It Just Works"
- Scenario 3: "Vive la OER Révolution"

Scenario 1: "Buying IBM"

Education has always been a sector highly susceptible to fads. While OER enthusiasts would bristle at the notion that the height of their popularity in schools was anything other than authentic and a sign of growing acceptance, the fact that open education's sustainability continues to rely on philanthropic support, donations, and volunteers belies the truth. Despite the attractiveness of open education in theory, perhaps the notion of truly decentralized curriculum was just too radical, too impractical of an idea to take root in a school system as big and complex as the U.S. K-12 system? Perhaps we didn't have the patience and fortitude to see open education through to its logical conclusion? Perhaps we failed to understand the motivations of school leaders who saw political value in outsourcing instructional materials development to publishers (after all, as the adage goes, 'no one ever got fired for buying IBM')?

The Association of American Publishers—dominated as it is by the big three education publishers—reported growing member profits in the K-12 market for the fourth year in a row (after many interminable years of declines and/or tepid growth), thanks in part to ossified instructional materials procurement processes, burgeoning student enrollments, and new mandates related to meeting the

needs of students with disabilities. Astute industry observers note that one reason profit margins are up is that publishers have harvested the best of available OER instead of paying to develop new content. However, given the variable ways that the copyright and provenance of instructional content is obscured by digital platforms, it is hard to be precise about this.

While it is true that in most every school district you can find enterprising educators creating and sharing open instructional materials—sometimes in partnership with one of the actively maintained OER repositories—these 'open champions' are the exception to the rule. Most often, individual teachers who choose to go above and beyond in customizing their course materials do so to seek a few extra dollars in their pockets (something that Amazon's Teachers Pay Teachers platform makes it trivially easy to do).

OER advocates nonetheless persist and continue to advocate for federal, state and local government policies that privilege open education and earmark funding streams. The crux of their arguments are that at-risk students would benefit most from open content and the cost savings it could unleash. Yet, these arguments remain unpersuasive, including from some surprising quarters. On the left, advocates argue that there are better and more direct investments in government programs that more directly help K-12 students in need. On the right, advocates argue that the evidence does not support open education as an effective intervention for at-risk students. Rather, struggling schools and their teachers are least likely to have the capacity to vet, create, or effectively use OER materials. OER advocates reluctantly concede that the most compelling OER success stories (and studies) are set in communities not representative of the nation as a whole.

Nonetheless, OER continues to 'just makes sense' to its supporters and they persist. As it rose in prominence before, supporters are certain that if the 'right people at the right time' are convinced of the benefits of open licensing, it could rise yet again, changing everything that is broken about the instructional materials market to the lasting benefit of every student.

Scenario 2: "It Just Works"

It seems quaint in retrospect that school districts used to purchase new instructional materials only once every six to ten years (depending on the health of their budgets). As the publishing industry has transitioned to becoming a learning sciences industry, one of the most important innovations that has taken root is the annual subscription/update model. While there have been some cost savings to schools —mostly due to the widespread incorporation of OER into publisher's products—the ease with which schools can obtain up-to-date, standards-aligned content and aligned assessments are the real benefit to teachers and their students. Administrators would also be quick to point out the value of dashboards of student and teacher data in helping them manage instruction.

While—in theory—schools are not restricted from mixing and matching curricular and technology offerings from just about any publisher on the market (or use locally developed resources instead), for reasons both political and practical, they tend to be loyal—one might even say, 'locked in'—to one of five major instructional technology ecosystems: Apple/PearsonConnect/AT&T, Google, Microsoft/OpenEduTexts, Liaoning/Facebook, and AHV (Amazon/Hachette/Verizon). The benefits for a school district to remain within one of these major ecosystems of instructional content, software, connectivity, and hardware are substantial in terms of interoperability, security, ease of centralized administration, and costs. Everything just works. The costs to switching—or trying to support more than one—are real (and only pursued by some of the most tech-savvy and wealthy schools).

While there are some important differences among players in these ecosystems, the core instructional content they offer is not as much of a differentiator as one might have expected. Rather, innovations have focused more on the packaging and delivery of that content. For instance, the Liaoning/Facebook platform offers more robust student sentiment analysis tools, Microsoft/OpenEduTexts offers more powerful augmented reality tools, and Google—along with Apple/PearsonConnect/AT&T—have gone big into artificial intelligence. Research evidence on the value of these new approaches to packaging and delivery of content remains emergent, but advocates are quick to point out the need for students to be prepared for a future where these tools are ubiquitous in the job market.

Scenario 3: "Vive la OER Révolution"

While obvious in hindsight, it was inevitable that OER and open source advocates would drive the traditional publishing industry out of the K-12 business. The explosive 2021 Amazon-Bertelsmann settlement with Miami-Dade County Public Schools for the use of allegedly illegally-licensed content was only the most obvious (and egregious) symptom of deeper issues. In the span of the following six weeks, some of the largest school districts in the nation—New York City Schools, LAUSD, Houston ISD, and Broward County—announced their intent to join Miami-Dade and stop buying pre-packaged curriculum from the big three publishers (or their proprietary content management systems) and that was enough to change everything for everyone.

While the nature and reasoning behind some of these announcements varied ('to save money,' 'to better meet the needs of our diverse student body,' 'to empower teachers to do what they do best,' 'to preserve freedom and local control,' 'to protect student privacy,' etc.), the net result was the same: the nation's schools would stand together and no longer rely on fee-based, proprietary materials or technology tools. Never more would schools and educators cede control over the tools of instruction to untrusted third-parties: not publishers, not technology companies, and definitely not federal or state governments. Diminishing school budgets would be re-invested locally.

While it took about a year for most school districts to purge their proprietary content and tools and refocus resources, the instructional materials ecosystem has never been so vibrant as it is today. Some even poke fun at the embarrassment of educational riches. After all, how many different versions of Algebra course materials do you need? It turns out, even small differences in needs and emphasis—to say nothing of pedagogical philosophy—drive educators to release new versions every year.

Most districts manage the complexity by aligning themselves with other districts in one or more 'open teaching guilds.' These membership organizations—anchored by College of Education faculty, open source technologists, master teachers, and other subject matter experts—have taken it upon themselves to design, maintain, and continually improve specific scopes and sequences of the K-12 curriculum (primarily relying on open source software tools to help them). Some are more narrow in focus (like ELOTG, the 'early literacy open teaching guild'), others offer up more comprehensive and coherent curricular offerings (like NCOTG, the 'new canon open teaching guild'), and some are slight variations of a theme (e.g., the 'coding open teaching guild,' which is in some ways derivative of the better established 'computer science open teaching guild'). It is not an exaggeration to say that there is an open teaching guild for nearly any interest or interest group in education today.

The open teaching guilds are primarily staffed by practicing educators whose active participation in these guilds is a new part of their job description and duties. Some of the more progressive educators even involve their students in this work, granting students credit for participating in the collaborative materials development and revision work. (Plus, there are always tasks like translation and graphic

design that need doing.) School district technology staff—and students taking computer science courses—donate their expertise to refining learning management systems and instructional software, including to the implementation and refinement of open interoperability standards and accessible file formats.

While students (and their parents) first greeted these shifts with some trepidation, fears melted away when parents came to recognize that the day-to-day impact on their students' learning was actually quite minor and in some cases demonstrably beneficial. Not only were instructional materials available to every student on day one, families began to amass their own custom libraries of instructional materials (which offered some unexpected spillover benefits for family members looking to improve their mastery of academic content). Wealthier families did supplement these libraries with better software tools (e.g., home education servers, powered by voice-activated AI) and proprietary materials from PpT ('Parents Pay Teachers'), but those with means always did avail themselves of extra help and tutoring.

Cross-Scenario Similarities and Differences

Whether the predictions that make up these three scenarios are correct in whole or in part is in many respects besides the point. Grounded as they are in existing trends, they are all plausible. As such, they are intended to serve to illustrate the necessity of the need to make choices and be opinionated about the future of education, technology, and the role of OER. To shed further light on the distinctions in potential futures for OER and open education in the context of the U.S. K-12 education system, the exhibit on the following two pages builds upon the scenario narratives to explicitly draw out similarities and differences across scenarios.

Choices and Consequences

While this paper has explored the specific and narrow case of the role of OER in some of the possible near futures of a more technologically-reliant U.S. K-12 education system, it nonetheless serves to illustrate some of the stark choices and consequences facing the field more broadly as we contemplate the impact and opportunity of technology innovation. Digital technologies offer great promise in advancing equity and opportunity in education, but we should be mindful that they also serve to advance a particular set of values (and framing of problems and solutions) as envisioned by their creators. Those values—and associated business models—may advance pro-social goals, such as those shared by open education practitioners and proponents. If we are not careful, however, they may instead serve other, less desirable ends, including some directly counter to our goals for open education such as by capturing and co-opting teacher and student labor for private benefit, institutionalizing bias, and even increasing inequality.[14]

For those who care about improving equity and opportunity through OER and open educational practices, there nonetheless remains a need to navigate the increasingly complex and dynamic roles for technology in teaching and learning. When offered a choice of technology solutions to adopt, which one is more likely to advance the cause of open education? How should governments and philanthropies prioritize scarce investments in technology and open education so as to maximize their

14 See, e.g., Eubanks, Virginia (2017). Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor. New York: St. Martin's Press; Noble, Safiya Umoja (2018). Algorithms of Oppression: How Search Engines Reinforce Racism. New York: New York University Press; and, O' Neil, Cathy (2016). Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy. New York: Broadway Books.

Exhibit: Possible Futures for OER in U.S. K-12 Education

Hypothetical OER Lifecycle	Scenario 1: "Buying IBM"	Scenario 2: "It Just Works"	Scenario 3: "Vive la OER Révolution"
Production/ content creation	General purpose proprietary tools are used to author and edit OER (with no to limited support for metadata). Weak support for alternative languages, accessibility, and multimedia. Tools may require a steep learning curve for advanced features. It is possible to attribute content creators, but dependent on user behavior. Support for publishing under a limited set of open licenses, as well as special platform licenses/terms. Given limited demand for remix, it is not explicitly supported by major publishers.	Specialized and user-friendly proprietary tools used to author/edit OER (with limited support for accompanying metadata). Good multimedia support (including for mobile platforms), but subject-specific specialized content creation tools are limited. Language and accessibility support available, but limited to high-incidence populations only. Attribution is acknowledged, but muted. Platform branding is emphasized instead. Support for publishing under a limited set of open licenses, as well as special platform licenses/terms. Remix of content within platforms is well-supported; cross-platform remix is an advanced feature and not well-documented.	Variety of open source tools used to author and edit OER (and accompanying metadata). Good support for specialized content creation (e.g., math formulas, basic science simulations). Good language and accessibility supports. Less support for cutting-edge multimedia. Tools may require a steep learning curve for advanced features. Attribution of authorship (and guild affiliation) is conspicuous and prominent. Built in support for publishing and remixing content under a wide range of open licenses and across OER repositories.
Search and discovery	Only a limited ability exists to search for content within and across platforms; support for open metadata initiatives is generally weak. Only a few repositories support searching by license type. Many obscure the differences between open and proprietary content.	Thanks to the development of robust proprietary metadata schemes, search and discovery *within* a platform is generally quite good. Every major platform mixes proprietary and open content, and obscures the differences to users. Searching across platforms is generally not supported, although some enterprising users have developed workarounds.	With content housed in guild-sponsored OER repositories, internet search functionality is supported but of variable quality. (Different content areas organize content in different ways.) Some cross-guild catalogs exist, but they struggle to stay up-to-date. Within a repository, search features are generally powerful.
Retain and organize	Proprietary and open source tools exist to help school districts manage and use their OER collections. They are of variable quality and most require quite a learning curve to master.	Polished, user-friendly tools are widely available, but are only accessible with paid subscriptions and via proprietary interfaces. Requires users to have access to robust broadband and modern devices.	Open source tools help users to catalog, organize OER and support its use in classrooms and for self-study. Some run on older devices and support use offline.
Use/pedagogical support	It is hard to generalize about the many ways that OER are presented and used. Most are used by educators to supplement their use of district-adopted proprietary materials; in a few cases (in	A single, 'authoritative' (scripted) approach to OER lessons is presented within platforms. Most content is developed by 'experts' (as work for hire) and is tightly aligned with academic standards.	OER are developed by educators, for educators, so content is inherently grounded in professional judgment about what works (although not necessarily on the best available research and

Hypothetical OER Lifecycle	Scenario 1: "Buying IBM"	Scenario 2: "It Just Works"	Scenario 3: "Vive la OER Révolution"
	primarily wealthier communities), districts have adopted OER materials as their curriculum. Some professional development is available on the use of OER (for a fee), but many educators do not avail themselves of it. There is mixed accessibility and language support for OER materials. Informal and secondary uses of OER materials are uncommon.	For an additional fee, teachers' guides are offered, as are a suite of professional development resources (championed by educator 'brand ambassadors'). Lessons are routinely supplemented by multimedia and simulations (some are fee-based add-ons), as well as self-scoring interim assessments. Advanced accessibility and language supports are available for a fee. Informal and secondary uses of OER materials are uncommon and not well-supported by the platforms.	evidence). While many alternate approaches to teaching the same/similar content are available within OER repositories, many teachers rely on trusted 'curators' to ensure standards alignment and a coherent scope and sequence. Educators are encouraged to adjust/modify use to support goals and student needs. Pedagogical support is offered by PD providers affiliated with open teaching guilds, as well as by school of education faculty. Interesting secondary uses of OER materials have been created by students and others interested in informal and life-long learning.
Feedback and revision	Platform dependent and highly variable. Whether free, digital, or open, most instructional content is never updated once published. In general, there are not good mechanisms for soliciting feedback on OER content and little demand for it. Much OER content is never revised and a lack of version control mechanisms lead to a proliferation of similar content. To the degree that local revisions to OER content are made, they are rarely contributed back to the community (e.g., by republishing on an active OER repository).	A simple star rating system is used to solicit feedback on content from educators and students (which is supplemented by systems to flag factual errors). Learning analytics are deeply embedded in the work of platforms. Within platforms, data on users, content, and interactions and are centrally hosted, managed, and analyzed. At the end of every school year, OER is reviewed and revised by experts based on this feedback (lower rated content is reviewed first) and updates are rolled out to all users. This helps justify the annual subscription model employed by most platforms.	Informal and structured feedback is routinely solicited on OER materials from educators, students *and* families. This feedback is used to inform revisions of OER materials, which are continually adjusted and refined. Repositories each manage version control of OER materials in similar (but not the same) ways. Learning analytics, while employed by some districts to good result, are not uniformly deployed across platforms/guilds. There is no central collection of learner data, all data are locally maintained and analyzed by districts.
Dissemination and redistribution	Highly variable depending on the OER platform/repository features. In general, publisher platforms are more likely to support the importing of content than exporting.	Except in rare circumstances, features to export content are not supported. Platforms also aggressively monitor the web for any potentially illegal re-use and routinely issue take-down requests.	Sharing/exporting of OER content is a core value and routinely supported via open standards-based protocols.

impact? What can open education proponents who are concerned about being co-opted by technology innovation do to ensure their work sustains and even continues to flourish? What guiding principles might we extract across the imagined potential futures for OER and technology in the context of the U.S. K-12 education system?

To address those and related questions, a return to the values of open education—of equity, access, transparency, community, and empowerment—may be required. Consider, for instance, what a focus on instructional change, on portability (a key requirement for users to assert the intellectual property rights granted to them by open licenses), and sustainability (and the support of institutional change) might bring to the table in assessing the pros and cons of current and future technologies intertwined with OER.

Instructional Change

In choosing to adopt OER, individuals and institutions are providing for the possibility of changes in teaching and learning and classroom practice. OER can support changes in what is taught, in pedagogical practice in the classroom (whether face-to-face or virtual), in inclusivity, and in assessments of student knowledge, skills, and abilities. The presence of OER in the classroom, however, does not in and of itself necessarily lead to these changes. Indeed, if instructional content is created, packaged and delivered to teachers and students in ways largely similar to traditional, proprietary materials—in ways that are insensitive to the affordances of openness—such changes should be expected to be modest at best.

The fact that research evidence is emerging that suggests benefits to OER adoption in postsecondary settings even in the absence of accompanying instructional change suggests more about financial pressures and inequities facing students in the U.S. than about OER as an instructional change strategy.[15] This is not to discount such improvements in student experiences and outcomes—or the very real problem of access to resources that free-of-cost OER addresses. They are valuable and may be exactly what some individuals and institutions are seeking in adopting OER. Nonetheless, for many, OER's value lies at least as much in the freedoms it offers teachers and students to enhance teaching and learning as any cost-savings it may generate.

As we look to a more technological future for OER, it will remain important to interrogate how new tools and platforms—whether free or fee-based—advance the cause of instructional change, including the relationship of those changes to outcomes for all students. Will new tools and platforms treat students with respect and as agents of their own learning or as data abstractions to be optimized and nudged toward completion of managed programs for their own good? Will teachers be granted roles in creating, curating or revising instructional content or is the role of technology to ensure the fidelity of (i.e., teacher-proof the delivery of) instruction? Do new tools and platforms view instructional content as interchangeable micro-instructional widgets ("*lorem ipsem*") to be deconstructed, cataloged, and re-assembled continuously in an effort to optimize student progress or as nuanced, negotiated, coherent bodies of knowledge? Indeed, the choice to teach a course from a collection of lessons created at different times, by disparate authors, operating in different contexts is fundamentally different from a

15 Colvard, Nicholas M., Watson, C. Edward, and Park, Hyojin. (2018). The Impact of Open Educational Resources on Various Student Success Metrics. *International Journal of Teaching and Learning in Higher Education*, 30 (2), pp. 262-276. Retrieved from http://www.isetl.org/ijtlhe/pdf/IJTLHE3386.pdf

coherence-first approach of adopting a full course curriculum developed within a consistent, research-based pedagogical frame.

OER can be an agent of equity, inclusivity, and opportunity, but it will not be solely because of the cost savings it may offer to students. Rather, it will be because it leads to instructional changes that empower students and teachers to engage more deeply in building the knowledge, skills, and abilities of all students.

Portability

The freedoms that OER grant teachers and students to access, modify, and re-distribute instructional content are significant and foundational to realizing instructional change. While proprietary digital instructional materials share many similar characteristics to digital OER on the surface—for instance, most are trivially easy to copy and share (setting aside the oft-misunderstood issue of permissions)—there is nothing inherent in the digital medium or delivery of resources that serves to advance student or teacher agency, equity, or engagement. Indeed, technology choices by instructional platforms and content repositories (from supported features to file formats to metadata schemes) can respect OER freedoms or serve to limit them.

To help ensure that digital OER are not stripped by technology platforms of the very affordances that can lead to teacher and student empowerment and instructional change, some have advocated for the embrace of free/libre and open source software (such as Moodle or LibreOffice), file formats, and open content metadata standards in schools and classrooms[16]. There are many reasons these initiatives can be beneficial in terms of advancing OER adoption and use (as well as on their own terms). Nonetheless, a concerted focus and investment of human capital and resources would be required for the education sector to be able to rely even mostly on free/libre and open source software and standards for its instructional technology needs.

Other common solutions advanced to address the challenges of realizing the freedoms of OER in a digital medium have focused on interoperability (i.e., technical schemes that facilitate the automated search, analysis, and exchange of digital content). While important, such initiatives seem more likely to be effective in facilitating increased access to OER by teachers and students rather than supporting effective use (or revision or re-use).

Looking toward a future that may be more platform (or even ecosystem) centric, teachers and students are likely to face increasing challenges in being able to express the freedoms granted to them to access, retain, modify, and re-distribute OER over time. This is primarily due to the fact that most platforms and ecosystems devalue the ability to interface with tools developed by competitors (and embrace business models expressly predicated on this fact). As such, a more concerted focus on content and data portability—the ability for users to export and download OER and associated metadata—could serve as an important hedge. Such a focus would benefit teachers and students interested in collaborating with each other across institutions and as they move from institution to institution over time, as well as ease

16 See, e.g., Resinger, Charlie (2016). The Open School House: Building a Technology Program to Transform Learning and Empower Students. Available online at: http://theopenschoolhouse.com/

the cost burden facing institutions in adopting new technology tools that better meet their needs (by reducing switching costs).

Sustainability

Whether created as a proprietary solution to be sold (or rented) to educational institutions or donated as a free community contribution to the cause of teaching and learning, the act of creating instructional materials and providing support for their use requires resources. These resources may be paid for directly (e.g., via a grant or a purchase order) or indirectly (e.g., via new expectations added to pre-existing job duties, via increasing capacity on cloud-based servers already managed by schools, or even via the provision of personal data for behavioral marketing purposes). It is for this reason that for many institutions, a shift to OER as the primary source of instructional materials entails cost-shifting at least as much as cost-savings. While in some cases large payments may not be made to external publishers, there are internal costs to schools in provisioning the content, personalizing it for students (including students with disabilities and English language learners), managing it over time, and ensuring professional development is available for teachers.

It is for this reason that one common critique leveled against OER supporters is that the work is unsustainable if it were not for earmarked philanthropic and government support. OER grants can be instrumental in supporting the production of new OER, as well as the curation of OER into locally managed repositories and learning management systems. They also help hold institutions harmless for losses attributable to revenue sharing agreements with publishers. To the degree that schools resist cost-shifting to internalize the cost of these tasks, including the more challenging work of organizational change management, the sustainability critique is indeed correct.

As we look forward to a future of greater OER adoption and use, the issue of sustainability will remain. Whether high- or low-tech, future opportunities to advance the OER cause should remain attuned both to business model considerations of providers as well to how school policies, procedures, and personnel are organized to select and use instructional content over time. This is especially important given that many educational technology ventures rely on business models that are designed to scale quickly (offering services for free or below cost to deliver) and evolve over time. Indeed, some sizable proportion of early ventures pursuing this model never succeed. Bias should be given toward ventures with transparent and sustainable business models (i.e., transitioning from or not predicated on governmental or philanthropic grants), as well as toward efforts that build the internal capacity of educational institutions to undertake the policy development and cost shifting necessary to institutionalize effective OER use.

We should advocate for the costs of delivering OER-related technology services to be more transparent, as well as for increased options for educational institutions to self-host solutions that they come to rely on. This may require greater technology capacity and business acumen at educational institutions, especially with respect to the instructional materials procurement process. While such expertise could be shared by networks of schools, if left unaddressed the lack of such capacity may place an upper bound on the ability of schools to realize the potential of OER to foster instructional change.

In Closing

Intertwined as the use of OER and educational technology are in the U.S. K-12 context, it behooves education leaders, policymakers, and philanthropists to clarify their future visions for teaching and learning and within that the specific role of open educational practices. Indeed, this paper has argued that choices—about platforms, about tools, about roles for educators—whether explicit or not have the potential to have profound impacts on the future prospects of students. While technology has facilitated access to OER and remains integral to its future success, we must be cognizant that its embrace is not synonymous with promoting good open educational practice. To the degree we attend more closely to these issues in the near-term, we will increase the odds that we can meet our goals for an education system that is more equitable, more inclusive, and more effective over the long-term. With the support of educational technology innovation, this is the real promise of open educational practice.