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Modularity, Labor, and Ideology in Edtech Platforms

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Introduction

The Covid-19 pandemic has accelerated the proliferation of digital education technologies (edtech) in K-12 schools, community colleges, and universities. Learning Management Systems (LMSs), video conferencing platforms, and other proprietary software tools are now instrumental in facilitating remote and hybrid learning. This increased reliance on edtech concerns not only current pandemic (or endemic) circumstances, but raises questions about the quality and labor systems of education. Focusing on higher education institutions, the convergence of edtech and venture capital (V.C.) casts doubts on the educational investments of administrations. Among the points of contention are the dataveillance efforts of edtech providers that seek to increase addressable market share and reconfigure academic working conditions consistent with platform logics. Platform logics fragment learning into discrete units that can be integrated and scaled in evermore online environments and value chains.

In this article, I suggest that the concept of modularity can help explain edtech-platform design, processes, and ideology. I proceed in the following steps: First, I provide a brief overview of learning technologies to situate the discussion in a longer history of computer-mediated learning. In particular, the ambient, perhaps invisible, characteristic of LMSs as learning infrastructure abets the concealment of academic labor relations. Second, I outline the idea of modularity, drawing from literature in media and software studies. While modularity is often conceived as an affordance that enables scaling and automating of systems, critical perspectives in media and software studies highlight its sociotechnical implications, particularly "information hiding." Third, I show how modular design approaches inform platform architectures, such that academic work is streamlined, outsourced, and formatted to accommodate the creation of engagement-driven learning environments.

Edtech: Histories and Presences

Visions of computer-assisted and automated modes of teaching and learning are not new and are well-documented in historical accounts. Educators, technologists, and other stakeholders have long advocated for the implementation of computers to improve learning outcomes and innovate educational conditions. Examples are myriad and range from B.F. Skinner's and Sydney Pressey's personalized Teaching Machines in the post-war era (Watters 2021) to Heinz von Foerster's "cybernetic learning machines" during the counterculture movement (Müggenburg 2020) to recurring policy initiatives of Coding Literacy (Vee 2017) to learning technologies as forms of international development (Ames 2019) and global citizenship (Good 2020). If learning technologies have consistently mediated educational experiences, conversely, advances in hardware and software, mainframe and personal computing, and information and communication networks—projects like Programmed Logic for Automated Teaching Operations (PLATO) (Rankin 2018) or ARPANET, the precursor to today's Internet (Barbrook 2007)—would be inconceivable without research and development in educational settings. Although hardly as prestigious as some of the aforementioned applications, the LMS has been widely-adopted in education institutions and is now perhaps the most impactful technology in the service of institutional education.

LMSs emerged several decades ago, but were not widely adopted until the early 2000s. As Justin Reich writes, "The first cited references to learning management systems appear in scholarly literature in the 1960s and 70s [while the] first commercially successful LMS was Blackboard, released in 1997, and the first widely adopted open-source LMS was Moodle, released in 2002" (2020: 24). Compared to more domain-specific programs and tutorials in computer-assisted learning (CAL), computer-assisted instruction (CAI) and intelligent CAI (ICAI) (Saettler 2004: 456-63), the value proposition of LMSs is elementary: they provide a virtual space for classroom management and administration. In other domains, similarly fundamental value propositions indicate the promise of platforms becoming infrastructure (Plantin et al. 2018). In education, LMSs now serve as central hubs for all sorts of educational participation. LMSs are successful precisely because they are "boring," that is, "they fall into that class of infrastructure [...] that are essential to everyday experience even as they are mostly invisible" (Reich 2020: 24).

The ambient character of LMSs helps conceal widespread practices of outsourcing educational activities to the servers and graphical user interfaces (GUIs) of commercial platforms. Integrating various content development tools, according to some observers, functionally renders today's LMSs Learning Content Management System (LCMS) (Watson and Watson 2007). Definitional uncertainties aside, digital tools like attendance trackers or video conferencing software are now expected to seamlessly connect and interoperate with LMSs via plugin or application programming interface (API) (Snodgrass and Soon 2019). Behind their user-oriented GUIs, providers like Blackboard, Canvas, and Desire2Learn (D2L) frequently embed additional features or expand through vertical integrations and acquisitions to remain competitive in an accelerating market (Hill 2020). The modular design of LMSs helps implement platform dynamics of feature convergence, digital rentiership, and assetization.

While LMSs have become central platforms in and beyond higher education—they also serve K-12 schools, businesses, and government agencies—institutional infrastructures remain complex networks of databases, directories, student information systems (SIS), and other computational administrative tools. Internal complexity and external contingency on historical, social, and regional factors, then, prevent "sweeping" technological "disruptions" (Reich 2020: 9). Reich's situated research on MOOCs, for instance, grounds expectations in technologist and business-oriented discourses, showing that putative innovations tend to offer supply to not yet existing demand. Nevertheless, even incremental change and tinkering with learning platforms might normalize new modalities of teaching and learning, shift pedagogical expertise, and change demands placed on academic workers. Thus, "concentrating on the suggestive and anticipatory qualities of sociotechnical systems" (Perrotta et al. 2021) remains an important task, particularly during public health emergencies that have education institutions hastily turning to digital solutions (Williamson et al. 2020).

Fueled by at least a decade of growth in the tech industry and expedited by the pandemic emergency, edtech sector projections in 2020 ranged from $90bn to $187bn, while expected annual growth rates for the subsequent 4-7 years varied between 14.5% and 19.9% (IBIS Capital 2020; Grand View 2021). Between 2010 and 2020, V.C. investment increased from $0.5bn to $16bn, signifying a 3100% jump (HolonIQ 2021). Given recent economic downturns and geopolitical events, however, such unbridled growth now seems less likely. At the same time, tech companies might again convert crisis into opportunity and seek to fill gaps left by budget cuts across federal, state, and local levels (Fourcade 2021). In other words, even as tech and adjacent sectors correct, companies like Google (Classroom), Microsoft (Teams), and specialized edtech platforms like Instructure (Canvas) or Coursera are likely to capitalize on the structural decline, create new educational needs, and reshuffle institutional working configurations.

Against this backdrop of the edtech political economy, propositions to manage learning through customized engagement enclosures, learning analytics, and algorithmic nudging architectures retain traction among both educational and financial institutions. In such business models, platforms accumulate capital not only through contracts with colleges and universities, but also by turning individuals and their data into assets (Birch et al. 2020) and forming rentier relationships (Komljenovic 2021). It is precisely these prospects of monetizing educational participation that fan the ongoing convergence of V.C. and edtech. Not surprisingly, then, recent mergers and acquisitions in the sector

combine access to student populations and activity with capabilities in data analytics and behavioral modulation (Hill 2022). At once a design feature and ideological screen, modularity informs the ways edtech platforms facilitate and reimagine online and hybrid classroom architectures, institutional relationships, and educational participation and workflows.

Modularity in Organization, Course Design, and Ideology

The concept of modularity has origins in the life and cognitive sciences (Callebaut and Rasskin-Gutman 2005) and has been adopted in computer science and related fields (Gobet 2005). In ecosystems, modularity generates resilience, that is, a system's ability to compartmentalize and absorb shock (Kharrazi 2019). This capacity, in turn, finds application in industrial operating procedures, where modularity speaks to the interchangeability of system-relevant components (Sutton 2015). Historically, production processes such as the assembly of automobiles or personal computers have evinced modular characteristics, allowing output to continue despite partial supply chain breakdown (Langlois 2002: 22-4). In software engineering, meanwhile, modularity describes "how knowledge is indexed, structured, organized, and retrieved" and "the ability to add, modify, or delete individual data structures" (Gobet 2005: 333-4). In both production and programming, a prominent modular characteristic is that of information hiding. Indeed, to the extent that higher education institutions are tasked to produce knowledge, the implications of modularization are traceable to LMS GUIs, departmental practices, and administration. Media and software studies have contributed significantly to reveal the sociotechnical interfaces between programming and institutional organization.

Modularity informs Lev Manovich's media theory, constituting the second of his five "Principles of New Media" (2002). Emphasizing the technical reproducibility of new digital media, Manovich defines modularity as both a principle and an affordance that enables scalable and integrative processes: "the modular structure of a media object [allows] for the automation of many operations involved in media creation, manipulation, and access" (Manovich 2002: 30). Consistent with accounts in software engineering, this view presents scaling and automation as more or less neutral results of modularity. Manovich's formal account, however, contains a blind spot when applied beyond virtual media objects to infrastructural platforms. Whereas in modular design, information hiding can make technical processes more efficient, in a sociotechnical context, it can double as an ideological screen. As "properly modularized code reduces the amount of information required to understand any given portion of the system" (Scott quoted in Galloway 2012: 67), individual programmers (or programs) are, to varying degrees, siloed in information architecture. Defined as the capacity to modify and reuse blocks of code in future iterations, modularity not only "allow[s] for the automation of many operations," as Manovich (2002: 32) would have it, but also engenders information asymmetries and, by extension, changes relationships and hierarchies. In short, modularity enables specialization in programming through hiding components of a given code, while institutional meanings of modularity range from increased organizational resilience to the deskilling of labor.

These patterns are also evident in higher education institutions, where course programming and instruction are increasingly mediated by learning platforms and information technology (I.T.) support staff. Modular LMS design, for instance, ensures the suitability of generic course shells for different academic disciplines and departmental specializations. Such streamlining shifts educational expertise, practices, and expectations further into technical and administrative domains. As Perrotta et al. (2021: 108) argue in an analysis of the Google Classroom API:

> The introduction of automation in the pedagogic environment does not eliminate teachers' labor but reconfigures it by generating new tasks that require teachers to synchronize effectively with the platform and by slowly but perceptibly shifting their efforts from actual teaching to the 24/7 coordination, moderation, and facilitation of student engagement.

Transforming job profiles in such a way is a laborious process in itself, a fact obscured by labels of digitization, automation, or human-centered design. Intensified by the pandemic, norms around effective instruction now involve

robust online components, including LMS implementation, video support, and sometimes asynchronous learning options. Institutions expect instructors to attend live or recorded tutorials and, if necessary, schedule individual sessions with I.T. staff to adequately prepare online course environments. These training activities typically occur outside regular semesters and are thus further made invisible. Tasks that technology officers might bill as seamless integration, such as transferring course content from previous semesters, often call for reading unwieldy instructions and manually entering commands. This is not to say that modular design only streamlines and formalizes. Instructors might find creative openings by developing modules or requesting additional third-party applications. In fact, much of the work of platform development relies on precisely this type of crowdsourced activity, feedback, troubleshooting, and maintenance by educational staff.

While modularization affords individual instructors a reasonable degree of efficient resource management, such as reusing and duplicating course content, it also lets administrations and departments oversee and replicate the work of faculty. According to Daniel Greene's (2021: 112) account of technology-focused charter schools, the emphasis on streamlining and granular data collection on learning platforms often produces an "infrastructure […] more responsive to administrators than teachers or students." Basic technical requirements have considerable consequences. LMSs, for instance, grant backend access to I.T. staff, department support, and other administrators or faculty, sometimes long after semesters end, to allow new faculty members to review or copy course materials. As a result, less domain-specific knowledge is required to modulate and recreate existing content for later course iterations and educational programming. While these practices improve the efficiency of schools, departments, and even individual faculty, they render instructors overall more substitutable and their working conditions more unpredictable, not unlike other contexts in which management closely surveils workflows (Levy and Barocas 2018). Such tendencies fasten under conditions of "adjunctification, austerity, privatization, entrepreneurialization, and shifting costs to students and their families" (Ovetz 2021: 1066). As a design feature, modularity "unbundles" teaching into several components to be redistributed to "nonfaculty academic staff such as content experts, counselors, course designers, technical support, programmers, and […] software companies" (Ovetz 2021: 1068). As an ideology, modularization highlights seamless user experiences while hiding the very working conditions that enable those experiences in the first place.

LMS providers advertise modular design toward two distinct goals: First, to make educational content and programming available at all times and across different devices. The convenience of accessing course materials and assignments 24/7 certainly appeals to a mobile sensibility, but ubiquitous access also normalizes extended working hours and creates on-demand subjectivities in both learners and instructors. For example, Instructure Canvas popularizes learning on its mobile app as "bite-sized" in that "digestible chunks of information can be made accessible anywhere, any time" (Canvas 2020). Learning in chunks—modules—allows instructors to flexibly provide feedback, generating an ambient availability of work. Increased use of remote learning technologies during the pandemic, however, has shown that constant access to content and communication contributes to fatigue among students and faculty alike (Lovink 2020). Second, modular design involves the creation of educational categories that are scalable and machine-legible, an aspect I discuss in more detail below. Modular design encourages instructors to "break learning down into smaller pieces (aka micro-learning) through content chunking to avoid overloading the learner" (Canvas 2020). Reducing pedagogical complexity, such streamlining generates more datasets for quantitative analytics and the potential for behavioral modulation. LMSs and other edtech tools increasingly market such data-driven interventions to raise interest from institutional clients and capital from investors.

Modulation and Acquisition

As staff and instructors build out, integrate, and partition LMS course shells and extended learning environments, they create more discrete spaces for engagement and make the overall system more legible for administrations and statistical inquiries and, in some cases, behavioral nudges. Of course, education already follows modular principles, as syllabi divide courses into units, units into lessons, lessons into activities, and so on. These are common characteristics and LMSs merely formalize and further standardize them. Informed by a disciplinary agnosticism, LMS providers

insist that their platforms accommodate any learning objective through a set of modules that might include text, audio, or video-based lessons, discussion forums, quizzes, and collaborations on integrated software. Anchoring such diverse activities in grade books or statistical engagement reports, further rationalizes different pedagogical practices. Moreover, streamlining education in this way enables software tools to produce granular and large-scale data pertaining to system use, learning progress, at-risk students, and other institutional patterns.

In 2019, for example, Instructure Canvas leadership introduced Insight (née DIG), an assessment tool supplying a bird's-eye view to concerned instructors and administrators. According to a company spokesperson, "What makes this project exciting to Canvas users is that the [...] analytics range from summary statistics to powerful predictions, from simply visualizing Canvas adoption over time to prompting outreach when a student suddenly becomes at-risk of dropping out or failing a course" (Stein 2019). This supposedly learner-centered approach relies on positivist assumptions about the meanings of learning and their representability through statistical analysis and visualization. Canvas Insight confounds positive learning outcomes with trackable participation and fails to qualitatively distinguish between different assignment types. A presentation boasts that Insight recorded over a billion quizzes taken and over four billion assignments submitted through the platform (Gibbs 2019). As metadata supersedes content, courses and modules with varying scopes and aims become calculable and scalable. According to a report, Canvas developed "a machine learning model to predict the navigational complexity of a course website [including] the number of tools and features used and the organisation of content and activities" (eLearning 2015). Critically, "navigational complexity" and "feature depth" are proxies that relate platform activity to academic outcomes. (In this case, they also promote more fully-developed course shells, further inculcating expectations that instructors use their platform.) The approach reinforces educational modes that are legible to similar data audits, cementing the role of LMSs and other edtech providers in learning assessments at academic institutions. Yet, doubts remain about the assumptions, methodological rigor, and pedagogical insights of data analytics championed by Canvas and other edtech actors (Whitman 2020).

While Insight was discontinued after Instructure's acquisition by private equity firm Thoma Bravo (Hill 2020), the sector is replete with similar and even more ambitious approaches to valorization. In particular, promises of automated decision-making, data-driven intervention, and behavioral modulation are becoming more common (Pickup 2021). Thus, a crucial question is the extent to which edtech platforms might emulate logics of ad-based social media, streaming, or gig-economy platforms (Srnicek 2017; Sadowski 2019). Unlike these other platforms, as Janja Komljenovic notes, "Most edtech companies explicitly state that they do not directly sell student or user data. However, there are many different ways for such data to be valorised rather than simply turning it into money" (Komljenovic 2021: 5). Specifically, valorization derives from "processing data into intelligence for either improving an existing product or service, or creating a new one, selling data-based products (such as learning analytics or other data intelligence on students), various automated matching services […]. The key here is that data is not rivalry in consumption, and can be used repeatedly in different operations and combinations" (Komljenovic 2021: 5). Given such open-ended possibilities, it is not surprising that LMSs and other services double down on valorization techniques.

Engageli, a video conferencing tool co-founded by Daphne Koller, exemplifies the fixations with virtual classroom design that creates evermore opportunities for generating, mining, analyzing, and utilizing data towards learning interventions. The software defaults to splitting classrooms into pods—what Zoom calls a breakout room—to ramp up the number of spaces for communication and feedback. As Koller states,

> There are all these engagement tools on the platform–like upvot[ing] something, you can ask a question or there are polls, there are exercises that are integrated into the learning experience–all of those are tracked and stored. You can then start to ask really important questions like, what kinds of engagements are most predictive of ultimate success? What happens if I add an intervention? What happens if the instructor actually calls on a student? Does that actually influence it? (Koller quoted in Carson: 2020)

Koller's vague yet gleeful probe into Engageli's potential is indicative of an emergent speculative element in the entire edtech sector. Indeed, the specificity of the engagements Koller alludes to seem entirely secondary to the generation of engagement in the first place. To ensure adoption and competitiveness, Engageli's leadership encourages both software engineers and instructors to test best practices, as long as experimentation occurs on its platform. The overall tendency to create engagement-driven enclosures is further documented by recent mergers and acquisitions in the industry: Companies that are VC-owned or VC-funded consolidate online learning environments, where prospective learning activities are converted into assets.

A case in point, the acquisition of Blackboard LMS by Anthology, a data analytics company, was, in fact, a deal brokered among three private equity firms: Anthology is co-owned by Veritas Capital and Leeds Equity Partners, while Blackboard was owned by Providence Equity Partners (Anthology 2021; Williamson 2021). These financial institutions assign speculative value to an optimized LMS, where "the 'nudge' has become the source of expected future value to asset owners" while "students themselves [are] assets with value that can be increased through predictive nudging" (Williamson 2021). The reasoning is self-fulfilling: Data-driven interventions to improve learning outcomes appreciate the future value of students, whose activities and subjectivities project value as vectors of data analytics. Consistent with demands to increase the "volume, velocity, and variety" of data (Lycett 2013: 381), Anthology offers a range of services, from streamlining SIS to optimizing enrollment to customizing alumni engagement. Another recent transaction, the acquisition of Blackboard Collaborate by the Zoom-based software Class Technologies, Inc.—a competitor of Engageli—confirms that speculative data enclosures extend their borders beyond LMSs around video conferencing platforms (Hill 2022).

Enabled by modularization in LMS and extended learning environments, multi-modal and continuous engagement more apparently benefits the agendas of commercial actors than the public good. In particular, academic workers are infrastructuralized and employed in the service of turning students into data assets. Given the confluence of these concerns, some commentators unsurprisingly recall Deleuze's (1992:5) warning that "*perpetual training* tends to replace the *school*, and continuous control to replace examination. […] the surest way of delivering the school over to the corporation." For example, a recent study on education under the auspices of the Australian government, *Through growth to achievement*, was found to "push for continuous assessment for continuous improvement, education as personalized learning, and growth mindset as a policy mandate" (Buchanan 2020: 1027). Universities and community colleges are on track to emulate the rampant privatization of K-12 schools, where apps like ClassDojo already manage classroom behavior with avatars, leader boards, and reward badges, shaping "students' subjectivities so that they seek to constantly improve themselves" (Buchanan 2020: 1036). Modularization expedites the implementation of these practices beyond the classroom to include the entire educational experience. In these settings, education is realized increasingly in self-referential terms of engagement with platforms and interfaces.

Conclusion

To situate this discussion, I noted that the history of education contains many forms of computer-based learning media, so that the presence of technology in classrooms is neither new, nor in itself problematic. Indeed, the observation that digital environments now contain entire classrooms, even institutions like online universities, is rather common and might elicit positive feedback, as access to education is rightly considered a pressing social issue. However, the agendas of LMS providers and other edtech platforms go far beyond facilitating normal operations during public health crises and other socioeconomic challenges. Budget cuts and fiscal austerity typically provide favorable conditions in which these actors compete for access to and control over educational activity. A slow but lucrative process, the privatization of online learning infrastructures ultimately positions platforms and their financial backers as pivotal entities seeking to manage more operations at educational institutions. The modular logic that enables the streamlined delivery of course content is likely to benefit the management of academic workers more than the management of learning activities. Specifically, the fragmentation and information hiding inherent in modularization drive shifts from distinct pedagogical expertise towards practices of administering and outsourcing

education. Institutions might realize greater efficiency, at least in the short-term, but the benefits of edtech are not distributed evenly and often come at the expense of primarily contract and adjunct faculty.

Modularity is not a disinterested design approach, but rather a tool that facilitates the fragmentation, deskilling, and data-intensive assetization of education. Programmed into the interfaces of LMSs and video conferencing platforms, modularization, at least in principle, enables academic workers to customize and personalize. In practice, however, instructors stand to lose educational authority and autonomy, as modular configurations subordinate individual contributions of workers to the frictionless functioning of the institution. Although colleges and universities remain, in many ways, distinct from corporations, both contexts align with business strategies of optimizing institutional workflows through design and behavioral intervention. Further research into the ways that edtech providers consolidate educational work across platforms might focus on the enrollment of instructors in generating value beyond education. Conversely, scholars might reflect on research methods that include perspectives on academic labor relations while also engaging with ideas of critical pedagogy to push back against the profitable rendering of learning as engagement.

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