Netflixing human capital development: personalized learning technology and the corporatization of K-12 education

Heather Roberts-Mahoney, Alexander J. Means & Mark J. Garrison

Routledge
Taylor & Francis Group

Netflixing human capital development: personalized learning technology and the corporatization of K-12 education

Heather Roberts-Mahoney[a], Alexander J. Means[b] and Mark J. Garrison[a]

[a]School of Arts, Sciences and Education, D'Youville College, Buffalo, NY, USA; [b]Social and Psychological Foundations of Education, SUNY-Buffalo State College, Buffalo, NY, USA

ABSTRACT

Advanced by powerful venture philanthropies, educational technology companies, and the US Department of Education, a growing movement to apply 'big data' through 'learning analytics' to create 'personalized learning' is currently underway in K-12 education in the United States. While scholars have offered various critiques of the corporate school reform agenda, the role of personalized learning technology in the corporatization of public education has not been extensively examined. Through a content analysis of US Department of Education reports, personalized learning advocacy white papers, and published research monographs, this paper details how big data and adaptive learning systems are functioning to redefine educational policy, teaching, and learning in ways that transfer educational decisions from public school classrooms and teachers to private corporate spaces and authorities. The analysis shows that all three types of documents position education within a reductive set of economic rationalities that emphasize human capital development, the expansion of data-driven instruction and decision-making, and a narrow conception of learning as the acquisition of discrete skills and behavior modification detached from broader social contexts and culturally relevant forms of knowledge and inquiry. The paper concludes by drawing out the contradictions inherent to personalized learning technology and corporatization of schooling. It argues that these contradictions necessitate a broad rethinking of the value and purpose of new educational technology.

There is a growing movement in K-12 education to mobilize new digital platforms and learning technologies to enhance educational efficacy and streamline teaching and learning (McRae 2013; Selwyn and Facer 2013). Advanced by powerful venture philanthropies, educational technology companies, and policy-makers, it is suggested that big data, cloud computing, learning analytic software, and adaptive learning systems hold the potential to fundamentally 'reinvent education for the twenty-first century' through the 'customization of education' and the 'personalization of teaching and learning'. This movement for integrating big data and personalized learning technology into education has been understandably appealing. Foremost, it syncs with a deeply held cultural belief in the power of technology as a key driver of progress and the need for educational systems to both adapt and prepare young people for rapidly changing circumstances. For instance, it is broadly recognized that we live in an era of dramatic social, economic, and technological change defined by the emergence of a global 'knowledge economy' and 'information society' based on integrated digital networks (Benkler 2003;

CONTACT Alexander J. Means ✉ meansaj@buffalostate.edu

Castells 2009). This has heightened global economic competition and calls for educational systems to produce the high-end cognitive and analytical capacities said to be required in the new economy (Peters and Bulut 2011). Advocates for personalized learning technology thus suggest that if digital platforms such as Google, Netflix, Amazon, and Facebook have transformed the way we conduct business, work, shop, communicate, travel, organize, and entertain one another, then it only makes sense to apply the operational logics of these platforms to educational systems in the name of progress and innovation. Moreover, personalized learning technology is often presented as a means for promoting efficacy and equity whereby all students are viewed as unique individuals with the capacity to learn if provided with the right conditions and tools. We certainly recognize the appeal of these narratives and acknowledge that new personalized learning technologies do indeed hold interesting possibilities for education and society. However, as our analysis in this paper suggests, in their current form, personalized learning technologies reflect narrow corporate-driven educational policies and priorities such as privatization, standardization, high-stakes assessment, and systems of corporate management and accountability. Insofar as personalized learning technology is mobilized to serve these neoliberal policy goals, we argue it will remain at odds with achieving truly innovative learning environments.

As philosophers of science and technology have long observed, technology is historically determined and socially contingent (Latour 1987; Haraway 1991). What this means is that technology is never simply a neutral or objective mechanism, but a tool that is subject to and embedded within specific governmental rationalities and relations of power (Dean 2007; Foucault 2007). Educational technology is, of course, no different (Garrison and Bromley 2004). It must therefore be critically analyzed according to the values and assumptions that animate its use and define its purpose. In this study, we empirically examine and document how current advocacy for personalized learning technology reflects the market-oriented rationalities and private interests of corporate control and standardization of K-12 education. Through a content analysis of US Department of Education reports, personalized learning advocacy papers, and published research monographs, the study details how big data and learning analytics are functioning to redefine teaching and learning in ways that transfer educational decisions from public school classrooms and teachers to private corporate spaces and authorities. The analysis shows that in regard to personalized learning, all three types of documents position teaching and learning within a reductive set of economic goals and purposes that emphasize human capital development and training future workers. The documents advocate for the expansion of data-driven instruction and decision-making, while conceptualizing learning as the acquisition of discrete skills and behavior modification detached from broader social contexts and culturally relevant forms of knowledge and inquiry. The paper concludes by drawing out the contradictions inherent to personalized learning and the corporatization of schooling. It argues that these contradictions necessitate a broad rethinking of the value and purpose of new educational technology.

Corporate school reform and personalized learning technology

We define corporate school reform as an interrelated set of post-welfare, neoliberal policy initiatives that situate market competition and business management as the key to educational improvement (Apple 2006; Ball 2012). This includes an emphasis on privatization and marketization of schools through charters, vouchers, and tax credits. It also includes an emphasis on holding schools and teachers accountable for student academic performance through the standardization of curriculum, teacher evaluation systems, and high-stakes testing. These reform efforts have been supported in the United States by major federal policy initiatives such as the No Child Left Behind Act, Race to the Top, and the Common Core State Standards. Social science research has consistently shown that these policies are rooted in narrow assumptions concerning educational purpose and that they have largely failed to meaningfully improve schools, particularly for low-income and racially marginalized communities (Berliner 2013; Berliner and Glass 2014; Garrison 2009; Hursh 2015; Ravitch 2013)[1]. However, this has done little to slow the momentum for corporate reform. As has been documented by a growing body of scholarship, corporate school reform represents an interlinking network of well-funded free market

think tanks, educational entrepreneurs, venture philanthropies, Wall Street firms and hedge funds, billionaires like Bill Gates and Michael Bloomberg, opportunistic politicians from across the political establishment, and transnational corporations such as Walmart, Pearson, and Rupert Murdoch's News Corporation (Burch 2009; Saltman 2010, 2012). Through the advocacy of these powerful interests, corporate school reform has come to dominate every aspect of US public education from curriculum to governance, blurring the once fairly clear lines between public and private, as private corporations assume ever more control over publicly funded endeavors.[2]

The corporate reform movement has enthusiastically embraced new educational technology (McRae 2013; Selwyn and Facer 2013). This enthusiasm is derived from the assertion that integrated digital platforms such as big data mining, algorithmic computation, learning analytics, and adaptive learning systems can support and enhance educational quality and efficiency through 'personalized learning'. In some respects, advocacy for personalized learning technology mirrors reform efforts in the early twentieth century that sought to apply the managerial logic and organizational structure of the factory in order to rationalize all aspects of mass public education (Callahan 1964). However, departing from this earlier efficiency movement, which was oriented squarely within an industrial paradigm of scientific management, the stated goal of personalized learning is to break down the older inefficient bureaucratic hierarchies associated with a 'public monopoly' and a 'one-size-fits-all' formula in order to 'reinvent education for the twenty-first century'. The corporate reform advocate and former republican congressman Newt Gingrich captures these sentiments in an op-ed for CNN:

> Get schools out of the 1890s … In an age when most information and knowledge is transmitted digitally and is increasingly personalized – think about how Netflix, Pandora, Twitter and Facebook work – we should be able to do much better than that. Pioneering projects like Khan Academy, Udacity and Coursera are pointing toward a future of learning that is more like Netflix than the chalk-and-textbook system we have today. (Newt Gingrich, quoted in Selwyn, 2015)

Corporate reformers thus suggest personalized learning technology represents a cutting edge alternative to traditional public models of school policy, organization, and pedagogy that are considered irrelevant in a digital age. As Gingrich argues, personalized learning technology explicitly mirrors digital platforms such as Netflix, Google, Amazon, Pandora, Facebook, and iTunes. Through our interaction with these digital platforms, billions of data points are produced that are then routed through algorithms in order to track our behaviors, preferences, create personalized targeted advertising, and generate new knowledge products in an endless feedback loop. This is precisely the logic and promise embodied by personalized learning technology. As outlined in a US Department of Education report *Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics* (2012), personalized learning is formulated as student interaction with digital screen interfaces and with analytic learning software powered by predictive algorithms (Bienkowski, Feng, and Means 2012). Students work on scripted tasks that produce endless streams of 'learning data'. In turn, algorithms feed back to the student new problem sets and tasks (i.e. 'learning content') based upon the data produced through the learning process. Within the model of adaptive learning presented in the report, teachers are largely reduced to facilitators and data analysts placing the expertise driving the educational process in the power of the algorithm and its creators.

Through the production of student data and use of adaptive learning systems, advocates for personalized learning promise that it will deliver a more efficient, cost-effective, and dynamic learning experience. It will do so, according to advocates, by controlling the pace, difficulty, environment, and content of learning to specifically meet the developmental needs of each individual student (Lemke 2013). Personalized learning technology is quickly becoming a key pillar of corporate school reform and is being aggressively pursued and funded by venture philanthropists, corporate foundations, and Wall Street firms. While scholars have offered various critiques of the corporate school reform agenda, the role of personalized learning technology in the corporatization of public education has not been extensively examined, particularly in relation to the official narratives and justifications regarding the use and purpose of the technology. In what follows, we examine 12 documents that discuss and advocate for big data, learning analytics, and personalized learning technology in K-12 education. This includes four US Department of Education reports, four personalized

learning advocacy papers, and four published research monographs. Our content analysis is particularly interested in how official rationales for personalized learning technology compliment a broader redefinition of educational purpose and reconceptualization of teaching and learning in ways that serve a corporate movement toward privatization and standardization of K-12 education. As our analysis suggests, the claims made on behalf of personalized learning technology contain fundamental contradictions that undermine assertions of efficacy and innovation.

Methodology

This content analysis is based on a larger study that adopted a purposive (or relevance) sampling strategy for document selection (Krippendorff 2012, 120–122). Our aim was not to sample from a universe of documents to make statistically significant and thus representative claims about that universe. Instead we aimed to identify key documents that represent prominent academic, government, and corporate advocates of personalized learning, and to discern how these narratives conceptualized teaching and learning. While these narratives may not be representative of the universe of relevant educational technology writings, their importance rests in the academic notoriety or economic and political power associated with the selected document authors.

Document selection

The search of relevant documents included US Department of Education reports, personalized learning advocacy papers, and learning analytics research monographs, selected from July 2013 through February 2014. Documents were screened to see if they contained content related to four thematic questions: how do prominent 'personalized learning' narratives: (1) conceptualize the purpose of education; (2) conceptualize the role of data in education; (3) conceptualize the role of the teacher; (4) and conceptualize learning. Twelve documents were chosen (four USDE Reports, four personalized learning advocacy papers, and four published research monographs) as the sample for analysis. Each document was chosen because it emphasized official personalized learning advocacy, analysis, and legitimation. Each document either represents an official government position, the views and findings of leaders in the field of learning technology, or the arguments of leading corporate reform entities. A sample of the 12 documents was initially coded to examine the utility of identified themes and the meaningfulness of highlighted text for exploring corporate redefinitions of teaching and learning.

A brief description of the 12 selected documents (see Table 1) follows, presenting relevant background information about the content, purpose, publisher, or organization associated with each document.

US government reports

The first report is the National Education Technology Plan entitled *Transforming American Education: Learning Powered by Technology* (2010). This report from the US Department of Education's Office of Technology discusses the importance of technology-based learning and assessment to improve student learning and generating data to improve all levels of the educational system. This is a foundational report defining personalized learning and calls for the application of technological practices from the business and entertainment industries to K-12 education. The second document entitled, *Promoting Grit, Tenacity, and Perseverance: Critical Factors for Success in the twenty-first Century* (2013), promotes the study of noncognitive factors which high achievers supposedly draw on independent of intellectual ability, such as grit and perseverance. This report represents an increasingly influential belief that personalized learning technology can serve to develop both the cognitive abilities and affective dispositions of students said to be required in the new economy. The third report, *Enhancing Teaching and Learning through Educational Data Mining and Learning Analytics* (2012), discusses the use of big data and learning analytics to identify learning patterns and predict student outcomes. The fourth report, *Expanding Evidence Approaches for Learning in a Digital World* (2013), defines the concept of

Table 1. Content analysis documents.

Title	Authors	Type	Short title
Promoting grit, tenacity and perseverance: critical factors for success in the twenty-first Century (2013)	Shechtman, DeBarger, Dornsife, Rosier, & Yarnell	US department of education report	The grit report
Expanding evidence approaches for learning in a digital world (2013)	Cator & Adams	US department of education report	The evidence report
Enhancing teaching and learning through educational data mining and learning analytics (2012)	Bienkowski, Feng, & Means	US department of education report	Educational data mining report
National education technology plan entitled transforming American education: learning powered by technology (2010)	Atkins, Bennett, Brown, Chopra, Dede, Fishman, Gomez, Honey, Kafai, Lutglass, Pea, Rose, Thille, & Williams	US department of education report	The national education technology plan
Impacts of the digital ocean on education (2014)	DiCerbo & Behrens	Advocacy narrative	The digital ocean
Big data for education: data mining, data analytics, and web dashboards (2012)	West	Advocacy narrative	Big data for education
Pathways to personalized learning, tapping the potential, realizing the benefits (2012)	Frame	Advocacy narrative	Pathways to personalized learning
Innovate to educate: system [re] design for personalized learning (2010)	Wolf	Advocacy narrative	System [re] design for personalized learning
Learning analytics: the emergence of a discipline (2013)	Siemens	Published research monograph	
Data-driven research to support learning and knowledge analytics (2012)	Verbert, Manouselis, Drachsler, & Duval	Published research monograph	
Mining LMS data to develop an 'Early Warning System' for educators: A proof of concept (2009)	Macfayden & Dawson	Published research monograph	
Using learning analytics to assess students' Behavior in open-ended programming tasks (2011)	Blikstein	Published research monograph	

an 'evidence framework' and highlights how big data can be used to uncover patterns of behavior that can be used to foster improvement, personalize learning, guide intervention for struggling students, and provide feedback to educators and students.

Advocacy papers

In addition to government reports, we selected four advocacy papers. The first, *Impacts of the Digital Ocean on Education* (2014), was published by Pearson, one of the largest for-profit education companies and book publishers in the world. The report discusses how big data and learning analytics will soon transform all levels of education in order to efficiently meet and streamline the educational and training requirements demanded by the twenty-first century economy. The second document, *Pathways to Personalized Learning, Tapping the Potential, Realizing the Benefits* (2012) is from the Center for Digital Education (CDE), self described as a resource for the 'education market,' extols the benefits of personalized learning technology. The third advocacy report, *Using Technology to Personalize Learning and Assess Students in Real Time* (2011), is from the Center for Technology Innovation (CTI) at the influential Brookings Institute. This report also highlights the effectiveness of personalized learning and the importance of assessing students in real time through technology.

The fourth document, *Innovate to Educate: System [Re] Design for Personalized Learning* (2010), is a report generated from the a symposium of education leaders sponsored by the Software & Information Industry Association (SIIA), Association for Supervision and Curriculum Development (ASCD), and the Council of Chief State School Officers (CCSSO). It makes a case for implementing the specific policies, practices, supports, systems, and technologies to reengineer K-12 education with the aim of 'personalizing learning for all students.'

Research monographs

Alongside the US government and advocacy papers, we selected four peer-reviewed research monographs using the same thematic categories. The first article, *Learning Analytics: The Emergence of a Discipline* (Siemens 2013) identifies the research fields and technologies that have contributed to the development of learning analytics. These fields include social network analysis, user modeling, knowledge discovery in databases (KDD) and E-learning. The second article, *Data-set-Driven Research to Support Learning and Knowledge Analytics* (Verbert et al. 2012), discusses the availability and use of open datasets as benchmarks to develop new algorithms and compare them to other algorithms in educational settings. The third article, *Mining LMS Data to Develop an 'Early Warning System' for Educators: A Proof of Concept* (Macfayden & Dawson 2010), is a quantitative study that uses student-tracking data to extract information about students that can be used to develop a customized dashboard tool for educators. The authors discuss the benefits as providing real-time data on student engagement and the ability of the system to predict student success. Conference proceedings from the first Learning Analytics and Knowledge conference (LAK2011) entitled, *Using Learning Analytics to Assess Students' Behavior in Open-ended Programming Tasks* (2011) is our fourth research monograph. In this document, the authors discuss how politicians, educators, business leaders, and researchers, all agree that schools must be redesigned to teach the twenty-first century skills of innovation, creativity, problem-solving, and collaboration. The authors argue that these skills cannot be measured using typical assessments that focus on end product as opposed to intellectual and cognitive processes. In contrast, new sensing and data-mining technologies are required to accurately measure these learning processes.

Document analysis

Each of the 12 documents was treated as its own unit of data and was systematically coded and analyzed using the four thematic questions: how do 'personalized learning' narratives: (1) conceptualize the purpose of education; (2) conceptualize the role of data in education; (3) conceptualize the role of the teacher; (4) and conceptualize learning. Text coded across these four themes was subjected to discourse analysis in order to divulge overt and explicit meanings as well as latent meanings (Van Dijk 1985). We were particularly interested in examining how each thematic unit positioned personalized learning technologies in relation to the rationalities of the corporate school reform movement discussed above. All documents were subsequently coded followed by a discussion of emergent themes, followed by second round of coding for consistency across documents. In what follows, we present our findings (see Table 1 for the Short Titles used to reference each report). In conclusion, we discuss the implications of the findings in relation to the contradictions and limits of corporatization and personalized learning technology.

Findings

Netflixing human capital development

The documents are remarkably consistent in framing the purpose of public education in the corporate reform language of business and the economy. For instance, the Evidence Report (2013) defines education as the key to economic growth and the 'best guarantee of the American dream' (Cator, Adams,

and U.S. Department of Education, Office of Educational Technology 2013, 1). The National Education Technology Plan (NETP) calls education 'the key to America's economic growth and prosperity' (Atkins et al. 2010, 1). Even when the documents mention the public good or critical thinking, these concepts are rendered narrowly in economic terms. We thus identified two themes that emerged in the analysis: education serves to train workers and education is customizable.

Education serves to train workers

The purpose of education, as defined in the sample documents, is to augment human capital and train workers to develop twenty-first century skills. Phrases such as 'acquiring skills for the twenty-first century workplace', 'competing in the global economy', 'developing twenty-first century competencies', and 'career and college readiness' are found throughout the US Department of Education reports and advocacy papers (Atkins et al. 2010, 1, 3, 4, 7, 9; & 23; Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013, 1, 11, 12, 48, & 53; Frame, 2012, 26; Shechtman et al. 2013, 1, 4, 5, 26, 31, 33, 58, 61, & 75; West 2012, 1 & 4; Wolf 2010, 5–6). None of the documents directly mention social justice or participation in a democratic society as central or even secondary goals of education. Rather, students must be able to 'compete' in a global economy, and if they do not develop the necessary 'twenty-first century skills,' they will invariably lose the competition and become a drag on economic growth. There is thus no mention of the role of knowledge in supporting human development and/or the intrinsic value of dialog and the negotiation of meaning as foundational to liberal, progressive, critical, and democratic conceptions of education (Dewey 1944; Freire 2003). It is taken for granted in the documents that the central or indeed only purpose of education is to produce high-end human capital for the global labor market and train compliant twenty-first century workers.

Education is customizable

Along with narrowly defining the purpose of education as job training, the documents render personalized learning as a service or customizable product. There are many analogies in the texts that compare education to something that one shops for and purchases. For instance, the Educational Data Mining Report (2012) uses Netflix, Amazon, Overstock, and Pandora as examples of how personalized learning should function in practice. These platforms generate billions of data points based on online behavior that are then routed through algorithms in order to track behaviors, preferences, create personalized targeted advertising, and generate new knowledge products. The difference here is that within personalized learning it is specifically *schools and students* that become the producers, consumers, and products as they interact with adaptive learning systems. This is positioned as a way to customize and streamline K-12 education to meet the needs of each individual student. For instance, The System [Re] Design for Personalized Learning (2010) narrative compares personalized learning to iTunes and Amazon, advocating for the application of the 'Market of One' principle, often used in the business industry. This principle advocates for 'a level of customization and customer service at which a customer feels that he or she is an exclusive or preferred member of the firm' (Wolf 2010, 12). Big data and learning analytics make such user profiling possible in K-12 education. Rather than making students listen to the same lectures and do the same activities, every student will have his/her own learning map, based on his/her interaction with digital platforms. Importantly, while it is a long standing progressive ideal that students should be able to pursue advanced learning that is relevant to their own lives and personal interests, the reports indicate that learning should be customized according to personal learner profiles at every level, just as businesses customize products based on customer profiles. This is typically justified in the reductive language of efficiency rather than sociocultural agency and intellectual development within the learning process. As the Educational Data Mining Report succinctly states, 'the long-term objective of user profiling is to provide adapted and personalized learning environments for individuals or groups of students to maximize learning effectiveness and efficiency (Bienkowski, Feng, and Means 2012, 32).

Getting under the skin – expanding the role of data from skills to affects

All of the documents frame data as the key to personalizing learning. While they all advocate for using multiple sources of data to drive instruction and assessment, two sub-themes emerged in the analysis: types of data collected and purposes of data collection.

Types of data collected

According to the Data Mining Report, making personalized learning a reality in K-12 education requires a change in the educational culture to accept more frequent use of data to make decisions (Bienkowski, Feng, and Means 2012, ix). Over the last decade, the potential for data collection and analysis has increased dramatically. Comprehensive databases have made it possible to store massive quantities of personal student information including student identification numbers, dates of birth, race, socioeconomic status, standardized test scores, attendance records, disciplinary records, health records, learning disabilities, homework completion, as well as student goals and interests all in one system. As all of these data points are interoperable, they can be used to create an adaptive learning profile for every student in the United States, much like a movie profile created by Netflix, or a music profile created by Pandora.

All three types of documents promote the idea of measuring and collecting data on student learning outcomes, test scores, and other cognitive measures of student performance. However, one of the most interesting aspects of the personalized learning documents is the enthusiasm over collecting and utilizing data on noncognitive factors, and inter and intrapersonal skills, or affective dispositions (Verbert et al. 2012; Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013; Shechtman et al. 2013; DiCerbo and Behrens 2014). The Grit Report (2013), for instance, indicates that the test-based accountability movement has focused too narrowly on the intellectual aspects of educational success. The report outlines how new biometric technologies can be used to enhance the efficacy of personalized learning through the measurement of noncognitive factors and student dispositions such as grit, tenacity, and perseverance that involve measuring physiological processes. For example, the report discusses an online tutoring system called Wayang Outpost where researchers use *four biometric sensor systems* on students to measure and collect data on dispositions and engagement such as levels of frustration, motivation, confidence, boredom, and fatigue. First, the Mood Meter sensor purports to measures emotions. It uses a camera to capture students' facial expressions and software to measure the distance between the corners of the students' lips to their eyes in order to provide a Smile Intensity Score. Second, a sensor called the Posture Analysis Seat is proposed as a means to detect boredom and fatigue by measuring student movement. Third, a hand-held Pressure Mouse is given as a measure of frustration. Fourth, a wireless skin conductance sensor is used to assess levels of stress and arousal. For each student, researchers combined data from these sensors with various types of data from an adaptive tutoring system, such as time spent on each problem or exercise, number of hints requested, and correct solutions. Then researchers used machine-learning techniques to determine how sensor data and online learning behaviors relate to student attitudes toward math. Researchers then used the information to create a predictive model to be tested on a new set of students (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013; Shechtman et al. 2013).

The Grit Report (2013) states that measures of behavioral task performance 'hold strong promise' for deepening the interaction between the cognitive and affective processes underlying grit (Shechtman et al. 2013, 45). Learning analytics research similarly advocates for the use of behavioral data. Blikstein (2011) discussed how new data collection, sensing, and data-mining technologies make capturing and analyzing large amounts of data possible in all fields of human activity and can be used to evaluate cognitive and noncognitive strategies and abilities. 'These techniques include logs of email and web servers, computer activity capture, wearable cameras, wearable sensors, biosensors (e.g. skin conductivity, heartbeat, brainwaves) and eye-tracking, using techniques such as machine learning and text mining' (Blikstein 2011, 110).

Purpose of data collection

Not only has the type of data collected expanded, the purposes of data collection have also expanded. As described in the research monographs, the objectives of learning analytics research is to use data to predict learning performance, suggest relevant learning resources, detect undesirable learning behavior, detect the affect of learners (Verbert et al. 2012), to personalize and adapt content (Siemens 2013), and to detect at-risk learners (Macfadyen and Dawson 2010). In addition to these objectives, another reported aim of using big data and learning analytics is to help students set goals for themselves and track their progress, by giving them access to their data. For instance, the NETP states that, 'From the point of high school entry, every student could have a learning dashboard indicating whether or not his or her course enrollments and performance are on track for high school graduation and qualification for college entry' (Atkins et al. 2010, 72). The report further explains that based on the information from each student's data, 'Such a system could make 'smart' suggestions about options for fulfilling requirements, including the possibility of earning credits for courses taken during the summer, in alternative programs, at community colleges, or online' (72). Another important purpose of collecting various types of data is tracking student progress with the intent of improving instruction, as well as for accountability purposes. According to documents, particularly the USDE reports and advocacy papers, personalized learning will prepare students for the demands of working in a global economy. The reports claim that these demands are reflected in the Common Core State Standards (CCSS) (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013; Frame, 2012). Tracking student progress on the CCSS using technology-based interventions and resources is identified as central in the documents (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013). Since these standards are said to measure career and college readiness, tracking student progress on the tests aligned to them is also portrayed as crucial in the USDE reports. Tracking student progress for the purpose of determining growth and developing twenty-first century skills is also discussed in the documents. For instance, the Grit Report (2013) encourages both parents and educators to praise effort over ability to encourage students to persevere and develop a 'growth mindset' (Shechtman et al. 2013, 78). The reports explain that new sources of data and technology can document growth throughout the year instead of waiting for end of the year summative assessments (Bienkowski, Feng, and Means 2012; DiCerbo and Behrens 2014).

All power to the algorithm: reconceptualizing teaching

All three types of documents position personalized learning as a superior form of classroom authority, rendering both non-educators and computer algorithms as more credible than teachers. This is evident in two sub-themes that have emerged from the analysis: teachers as coaches or guides, and teachers as data-collectors.

Teachers as coaches or guides

Pathways to Personalized Learning (2013) explicitly discusses the role of the teacher stating, 'no longer are they expected to be all-knowing providers of information, but instead are needed as coaches and guides, leading students to actively find their own knowledge' (Frame 2013, 20). Teachers are portrayed as largely ancillary to the decision-making process. The NETP discusses a 'team activity' called 'connected teaching.'

> Individual educators build online learning communities consisting of their students and their students' peers; fellow educators in their schools, libraries, and after school programs; professional experts in various disciplines around the world; members of community organizations that serve students the hours they are not in school; and parents that desire greater participation in their children's education. (Atkins et al. 2010, p. xii)

While connecting the classroom to the broader community could serve progressive aims and therefore should be encouraged, we find it troubling how the personalized learning documents we analyzed de-emphasize the professional knowledge and experience of teachers in relation to noneducators and to technology. For instance, System [Re] Design for Personalized Learning (2010) acknowledges that

the role of the teacher dramatically changes with personalized learning, as it 'emphasizes a shift from a single teacher delivering knowledge to a classroom of students to teachers as facilitators of learning, often as a part of a team of teachers with differentiated roles' (Wolf 2010, 14). The role of the teacher is here said to be 'expanded' and indeed it is expanded to include individuals without teaching degrees or professional certification, such as, 'mentors and informal learning providers, including boys and girls clubs, museums, businesses, social workers, health providers, scientists, and other experts' (Wolf 2010, 14). Similarly, the Evidence Report discusses how 'new players' are bringing 'new perspectives,' changing the nature of learning resources and who develops them (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013, 3). As the role of the K-12 teacher is diminished in decisions over curriculum and pedagogy, 'new players' are emerging to fill the gap. The report states that 'technology developers from noneducation fields, such as gaming, mobile, and social technologies, are imagining and developing new digital resources that are intended to compete with print-based textbooks and other learning materials' (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013, 3). The NETP takes noneducators' involvement one step further to include assessing student work. The plan explains that, 'for many academic efforts, the free-for-all of the Internet would not provide a meaningful assessment of student work, but technology can support connections with online communities of individuals who do have the expertise and interest to be judges of students' work' (Atkins et al. 2010). Even though the plan admits that noneducators lack expertise, it gives examples of involving them in the evaluation of students. For instance, practicing scientists can respond to student projects in online science fairs, or readers of online literary magazines can review student writing.

Teachers as data-collectors

The use of big data and learning analytics are changing the nature of educational decisions. Curriculum decisions, as well as instructional practices, are reduced to algorithms and determined by adaptive computer-based systems that create 'personalized learning,' thereby allowing decision-making to take place externally to the classroom. Teachers no longer have to make pedagogical decisions, but rather manage the technology that will make instructional decisions for them. For instance, in the Early Warning System monograph, Macfadyen and Dawson (2009) describe data collection via Learning Management Systems (LMS) as non-intrusive because they 'require no faculty or staff intervention' (590). According to Siemens (2011), an adaptive learning management system can provide personalized content and learning activities based on an evaluation of a learner's knowledge. One example discussed in the System [Re] Design for Personalized Learning, is New York City Department of Education's School of One math program. The School of One, which operates in six middle schools in New York City, reports that its mission is to 'provide students with personalized, effective, and dynamic classroom instruction customized to their particular needs, interests, and learning preferences' (School of One, 2012). System [Re] Design for Personalized Learning suggests this math program is a model of successful personalized learning, stating it 'utilizes computer-based assessments to power the algorithms critical for the real-time development of the daily playlist at the center of personalization for each student' (Wolf 2010, 19). The teacher oversees individual student playlists that are determined by the algorithm. The technology, via learning analytics, decides each step for each student. This reduces the role of the teacher to data collector, data analyst, and technology facilitator as opposed to a professional with specialized knowledge and independent judgment. Extending this theme, the Evidence Report (2013) states that technology is surpassing educators – 'advances in technology have heightened the possibility that digital learning systems can replicate dynamic adaptations used successfully by human tutors or even implement those and other methods more effectively than humans' (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013, 28).

Learning as skill acquisition and behavior modification

The documents render learning as development of discrete skills. Even complex concepts such as critical thinking and innovation, as well as noncogntive attributes such as grit and tenacity are rendered

as skills. Personalized learning through big data and adaptive learning technologies is viewed as a mechanism for making the transmission of skills more efficient and effective. Thus, two overlapping sub-themes emerged in this analysis: disregard for/redefinition of social learning and the rendering of everything as a skill.

Disregard for context/redefinition of social learning

Personalized learning is rooted in the assumption that maximization of 'efficiency' and 'effectiveness' is the overarching purpose of learning. For instance the Evidence Report states that an advantage of digital learning systems is that they can be revised repeatedly, quickly, and economically. With the Internet as the hosting system, there is very little cost to distributing updates and enhancement to users (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013, 13). Similarly, the Grit Report discusses how teachers lack time to personalize learning and give feedback to students without technology (Shechtman et al. 2013, 84). The technology makes giving feedback more 'efficient' because it is done immediately, and the algorithms make decision-making more 'effective'. The NETP discusses efficiency in terms of productivity stating, 'education has not incorporated many of the practices other sectors regularly use to measure outcomes, manage costs, and improve productivity, a number of which are enabled or enhanced by technology' (Atkins et al. 2010, 73).

The research monographs reflect the same idea that learning via technology is much more efficient than traditional forms of learning. This includes the initial implementation stages of learning management and intelligent tutoring systems. Verbert et al. (2012) contend that the rate of technological innovation in validating the prototypes of such intelligent tools is more efficient than the time needed by social scientists to do the same tasks. MacFayden and Dawson (2009) also question how teachers can effectively assess teaching strategies and track the progress of so many students without the vast datasets captured by learning management systems. What emerges in the documents is that social context and human interaction are largely irrelevant and that 'learning' can be reduced to a set of prescriptive skills and behavioral attributes removed from questions and debate over meaning and values. What is considered 'social' in learning is simply interaction with and through technology.

Everything is a skill

The documents render everything as a skill so that it can be quantified and entered into a database. Visible behaviors serve as evidence of skills for both simple and complex concepts. Personalized learning, which claims to adjust the path and pace to optimize learning for students intends to make learning more efficient, while reducing the process to the acquisition of discrete skills that students must master before moving on to the next skill. With this narrow conception of learning, complex qualities such as innovation, creative thinking, and perseverance are rendered as skills that can be measured and adapted in algorithms. For example the Grit Report (2013) claims that, 'if perseverance is conceptualized as a set of *processes*, measurement may focus on sequences of behaviors, emotions, physiological reactions, and/or thoughts that unfold over time during learning, extracting indicators of persistence and giving up' (Shechtman et al. 2013, ix). In the documents, qualities such as perseverance, grit, and innovation are defined by the data, in this case, behaviors that measure them. Complex concepts and behaviors are therefore operationally defined, allowing them to be identified as skills.

The rendering of complex qualities as skills requires the collection and analysis of new types of data. All of the documents highlight the importance of this and suggest that a change in thinking is required to include studying twenty-first century skills such as innovation (Blikstein 2011), creativity, critical thinking, problem solving (Atkins et al. 2010), collaboration, and leadership (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013). The Digital Ocean says that a change in thinking is required because, 'our categories of thinking and acting have often been based on the limits and artifacts of the pre-digital era' (DiCerbo and Behrens 2014, iii). Whether it is data collected during each step of learning, behavioral data, noncogntive data, or biometric data, the

documents insist that more data points make a more complete learning profile and increase learning efficiency. The NETP explains:

> As the students work, the system can capture their inputs and collect evidence of their problem-solving sequences, knowledge and strategy use, as reflected by the information each student selects or inputs, the number of attempts the student makes, the number of hints and type of feedback given, and the time allocation across parts of the problem. (Atkins et al. 2010)

The Evidence report reflects a similar view:

> As educational systems assess student achievement, big data and new evidence models can shift measurements to focus more on what is really important and to provide more timely information to educators and students. As demands shift in the twenty-first century, new outcomes such as collaboration, problem-solving, and critical thinking become even more important than the past. (Cator, Adams, and U.S. Department of Education, Office of Educational Technology 2013, x)

The documents reflect the view that current assessment instruments lack reliable ways to assess twenty-first century skills and that technology has made documenting complex behaviors possible. Moreover, according to the Grit Report, behavioral task performance can be elicited in digital learning environments. The report explains that, 'student data collected in online learning systems can be used to develop models about processes associated with grit, which then can be used, for example, to design interventions or adaptations to a learning system to promote desirable behaviors' (Shechtman et al. 2013, 41). Similarly, the Data Mining Report claims data can be used for 'sensing' student learning and can even pinpoint the 'moment of learning' (Bienkowski, Feng, and Means 2012, 6). Since teaching and learning in the personalized learning model does not require a traditional teacher, classroom, or social interaction, the documents advocate for using constant data streams and algorithms to assess student learning. What this means is that technology enables testing of skill development and behavioral modification to be embedded within all learning activities, thus making assessment the immanent foundation of personalized learning. This renders external testing as largely obsolete. The NETP summarizes:

> When teaching and learning are mediated through technology, it is possible to reduce the number of external assessments needed to audit the education system's quality. Data streams captured by an online learning system can provide the information needed to make judgments about students' competencies (Atkins et al. 2010).

Similarly, The Digital Ocean discusses Shute's (2011) conception of 'stealth assessment,' which uses information from student interaction with digital tools to make inferences about their knowledge, skills, and attributes. The report explains, 'in contrast to intrusive assessments, which are usually not connected to the learning environment, stealth assessment unobtrusively gathers data from learners' everyday interaction within the teaching and learning environment' (DiCerbo and Behrens 2014, 21). To translate, stealth assessment is a form of perpetual behavioral modification and examination. Teachers will no longer teach to the test per se, but to the algorithm as testing machine.

Discussion: personalized learning as customized privatization

According to the documents analyzed above, the explicit aim of personalized learning technology is to increasingly move curricular, pedagogical, and assessment decisions away from public school settings to private providers of commercial technology and digital learning platforms. This reconfiguration of authority and decision-making denies the social and political context as well as the dialogical features of teaching and learning. The role of the teacher – as public employee and citizen – is minimized. Her autonomy is dramatically reduced, as her experience, expertise and deliberations are deemed less relevant, less accurate, and less efficient than algorithmic learning software. In our view, the notion of personalization reflected in the documents represents a limiting and demoralizing *standardized customization*, properly understood as an advanced form of digital Taylorism. This 'standardized customization' not only reframes education as a narrow private good oriented primarily toward efficiently preparing students for twenty-first century global economy, it also serves to re-render complex characteristics of human beings into discrete 'skills' that are transformed into data points subject to

the authority of a computer algorithm outside the control of the individual student, the school, or the community. Just as Netflix owns the data mined from user preferences, so too learning data become owned by corporate entities with a strong incentive to market that data and distribute it to third parties for profit. Learning, which is broken down into discrete skills, is tracked, stored, and manipulated via impersonal commercial technology.

While the use of multiple data points may provide more information about a student than private companies have ever had access to before, none of the reports offered concrete proof that personalized learning technology delivers a more complete, robust and nuanced understanding of students than those held by experienced teachers. Many of the reported benefits of big data are well-known functions that teachers already perform daily in their classrooms through human interaction. These include modifying curriculum and activities when necessary to meet the students' needs, determining when a student needs extra help or is ready to move on, and choosing appropriate content for the students based on their unique interests. The solution to any demonstrated need for personalized learning is obvious and simple: hire more teachers. But such a solution does not benefit or empower personalized learning technology advocates and their corporate partners. Moreover, as a solution, hiring more teachers and investing in their professional status and development directly challenges the neoliberal assault on public employees and privatization of public services and institutions. The narrow focus on economic ends in these documents in fact buttresses an obsession with efficiency and mechanization, and clearly aligns with the general characteristics of corporate school reform, including the de-professionalization of teaching and the marketization of public education. This transformation is most evident in the way in which the purpose of education is framed in the documents as a commercial service, while schools and students are imagined as producers, consumers, and products. While there is a long history of public schools serving economic ends, and while students and their families have often been described as 'customers', the move to render students themselves as 'products' to be tracked and consumed by educational corporations and educational technology is something new.

The main justification offered for personalized learning is to better prepare a diverse population of students for success in the twenty-first century workforce. While this mantra sounds familiar and can be found in earlier reform movements, this preparation functions by tracking student progress on corporate established goals through a privately managed personal learner profile that will follow the student from kindergarten through high school and possibly college and beyond. 'Data-driven' is thus really *data managed*. Data manages teachers as workers, by making decisions for them and manages the students through prescriptive and decontextualized learning. No need to worry about the interfering teacher, parent or school board member. Personalized learning does not really render, or even recognize education as an individual private good. Rather, it transforms persons, reconstructs the personal characteristics of students into the assets – private property – of database creators and education technology vendors. This moves us from the model of students and their families as 'consumers' to students and their data as the 'products' of the 'education industry'. Products have no claims, or rights, and with this assertion, the notion of the person as citizen, both private and public, is threatened with erasure. This hints at what is perhaps most interesting about the claims and rationalities highlighted in the documents as far as they reveal in stark detail the fundamental contradictions at the core of the corporate school reform movement. For instance, it is very difficult to imagine how personalized learning technology, as it is rendered in the documents, will actually contribute to generating the high-end human capital and creative entrepreneurial workers said to be necessary to stimulate economic growth and invent the jobs of the future. Rather, personalized learning technology favors reductionist, mechanistic, linear, anti-intellectual, anti-relational, and prescriptive approaches to teaching and learning. Such an instrumental approach to knowledge, teaching and learning makes little practical sense for training advanced knowledge workers endowed with the high-end cognitive, analytic and creative capacities that corporate school reformers claim are essential for the twenty-first century economy and workplace. Moreover, while there is zero scientific evidence that personalized learning systems enhance educational efficacy, there is a growing body of research that suggests exposure to screen technologies is harmful for the cognitive, physical, and affective development of children and

adolescents. For instance, the American Academy of Pediatrics and the Canadian Society of Pediatrics have detailed that prolonged exposure to TV, video games, tablets, smart phones, and laptops is associated with childhood cognitive impairment, learning disabilities, obesity, mental illness, aggression, and sleep deprivation (Rowan 2014).

In our view, the explicit goals of the corporate school reform movement would actually be better served through adherence to progressive principles and critical pedagogies. The way to support critical thinking, creativity, innovation, perseverance, tenacity, and other advanced cognitive and non-cognitive capacities is simply to invest in schools, communities and young people in order to create the social conditions in which these capacities can develop and flourish. Even if one does subscribe to the inherently reductive notion of education as purely about advanced human capital development, privatized and standardized customization through personalized learning technology does not appear to effectively support this goal. The cognitive dissonance here raises serious questions about the aims and motives of the personalized learning movement, particularly in a time of growing class stratification and proliferation of low-skill, low-wage precarious employment. What is required today is a profound shift in dominant values and assumptions concerning the relationship between education, technology, and society. The core issue is not how new digital technology should be used to transform education (particularly for narrow economic purposes that serve powerful corporations and corporate interests), but how can our educational institutions and practices be supported and transformed in order to effectively mobilize technology and generate technological literacies in line with progressive, democratic, and sustainable communities and futures. We believe new digital technologies do contain fascinating possibilities for education and society. However, without a clear ethical commitment to fostering the necessary conditions for human flourishing, cooperation, autonomy, equity, and democracy in schools and communities, personalized technologies combined with narrow neoliberal market imperatives in education are likely to do far more harm than good.

Notes

1. For a variety of research reports that show the shortcomings of the corporate reform movement in the United States, see the studies conducted by CREDO at Stanford University (http://credo.stanford.edu/), the National Center for Education Policy at the University of Colorado (http://nepc.colorado.edu/), and the Economic Policy Institute (*www.epi.org*).
2. While business interests have always had a hand in shaping educational policy in the United States, the economic goals of education now tend to overshadow progressive goals historically linked to public education, such as the development of democratic citizens (Katznelson and Weir 1985). This narrowing of educational purpose emphasizes the private domain and private gain, shifting control from public to private interests by transferring decision-making about public matters to corporations largely through federal and state policy-making, which is increasingly bought and paid for by private corporate actors (for instance by the right-wing American Legislative Exchange Council, or ALEC, funded by the Koch brothers). Furthermore, within the corporate reform perspective, structural conditions such as class and racial segregation, child poverty, educational funding inequities, and declining economic opportunities for young people and communities are typically viewed as irrelevant, or they are said to derive directly from supposedly failing public schools and their teachers (Fabricant and Fine 2013; Means 2013).

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Heather Roberts-Mahoney received her doctorate in Educational Leadership from D'Youville College in Buffalo, New York in the spring of 2015. She has been teaching French and Spanish for 18 years at Lackawanna High School in Lackawanna, New York. She earned an MS in Teaching English to Speakers of Other Languages (TESOL) from the University at Buffalo and has been teaching in the TESOL program at Canisius College since 2014. Her areas of interest include education policy and reform.

Alexander J. Means is an assistant professor in the Department of Social and Psychological Foundations of Education at SUNY Buffalo State. He is the author of Schooling in the Age of Austerity: Urban Education and the struggle for Democratic Life (Palgrave, 2013), which won a 2014 Society of the Professors of Education Book Award, and Toward a New Common School Movement (Paradigm, 2014) with Noah De Lissovoy and Kenneth Saltman. His work examines educational policy in relation to political, economic, cultural, and social change.

Mark J. Garrison is a professor of Education Policy & Research in the Educational Leadership Doctoral Program at D'Youville College, Buffalo, NY. His work examines the restructuring of public education and its relationship to larger social change. His scholarship has won him national acclaim, including the 2011 American Education Studies Association Critic's Choice Award and the 2010 CHOICE Outstanding Academic Title for his book, A Measure of Failure: The Political Origins of Standardized Testing (SUNY Press, 2009).

References

Apple, M. 2006. *Educating the "Right" Way: Markets, Standards, God, and Inequality*. 2nd ed. New York: Routledge.

Atkins, D., J. Bennett, J. Brown, A. Chopra, C. Dede, B. Fishman, L. Gomez, et al. 2010. *National Education Technology Plan (ED-04-CO-0040,)*. Alexandria, VA: SRI International.

Ball, S. 2012. *Global Education Inc: New Policy Networks and the Neoliberal Imaginary*. New York: Routledge.

Benkler, Y. 2003. *The Wealth of Networks*. New Haven, CT: Yale University Press.

Berliner, D. 2013. "Effects of Inequality and Poverty vs. Teachers and America's Schools." *Teachers College Record* 115 (12): 1–26.

Berliner, D., and G. Glass. 2014. *50 Myths and Lies That Threaten America's Schools: The Real Crisis in Education*. New York: Teachers college Record Press.

Bienkowski, M., M. Feng, and B. Means US Department of Education, Office of Technology. 2012. *Enhancing Teaching and Learning through Educational Data Mining and Learning Analytics (ED-04-CO-0040)*. Washington, D.C.: SRI International.

Blikstein, P. 2011. *Using Learning Analytics to Assess Students' Behavior in Open-Ended Programming Tasks*. doi:10.1145/2090116.2090132 Lak'11 1st international conference on learning analytics and knowledge, Banff, Alberta.

Burch, P. 2009. *Hidden Markets: The New Education Privatization*. New York: Routledge.

Callahan, R. 1964. *Education and the Cult of Efficiency: A Study of the Social Forces That Have Shaped the Administration of the Public Schools*. Chicago, IL: University of Chicago Press.

Castells, M. 2009. *The Rise of the Network Society*. New York: Wiley-Blackwell.

Cator, K., and B. Adams U.S. Department of Education, Office of Educational Technology. 2013. *Expanding Evidence Approaches for Learning in a Digital World* (ED-04-CO-0040). SRI International website: http://www.ed.gov/technology.

Dean, M. 2007. *Governing Societies: Political Perspectives on Domestic and International Rule*. New York: Open University Press.

Dewey, J. 1944. *Democracy and Education*. New York: The Free Press.

DiCerbo, K. E. and J. T. Behrens 2014. *Impacts of the Digital Ocean on Education*. Pearson.

Dijk, T. A. 1985. *Handbook of Discourse Analysis*. New York: Academic Press.

Fabricant, M., and M. Fine. 2013. *The Changing Politics of Education: Privatization and the Dispossessed Lives Left behind*. Boulder: Paradigm Publishers.

Foucault, M. 2007. *Security, Territory, Population*. New York: Palgrave Macmillan.

Frame, K. 2012. *Pathways to Personalized Learning: Tapping the Potential, Realizing the Benefits*, Center for Digital Education.

Freire, P. 2003. *Pedagogy of the Oppressed*. New York: Continuum.

Garrison, M. J. 2009. *A Measure of Failure: The Political Significance of Standardized Testing*. Albany: State University of New York Press.

Garrison, M., and H. Bromley. 2004. "Social Contexts, Defensive Pedagogies, and the (Mis)Uses of Educational Technology." *Educational Policy* 18: 589–613.

Haraway, D. 1991. *Simians, Cyborgs and Women*. New York: Routledge.

Hursh, D. 2015. *The End of Public Schools*. New York: Routledge.

Katznelson, I., and M. Weir. 1985. *Schooling for All: Class, Race, and the Decline of the Democratic Ideal*. New York: Basic Books.

Krippendorff, K. 2012. *Content Analysis: An Introduction to Its Methodology*. New York: Sage.

Latour, B. 1987. *Science in Action: How to Follow Science and Engineers through Society*. Cambridge, MA: Harvard university Press.

Lemke, C. 2013. "Intelligent Adaptive Learning: An Essential Element of 21st Century Teaching and Learning." *Dreambox Learning Inc.*

Macfadyen, L., and S. Dawson. 2010. "Mining LMS Data to Develop an "Early Warning System" for Educators: A Proof of Concept." *Computers & Education* 54: 588–599.

McRae, P. 2013, June 3. "Rebirth of the Teaching Machine through the Seduction of Data Analytics". *Alberta Teachers Association*, 93(4), 1–9.

Means, A. J. 2013. *Schooling in the Age of Austerity*. New York: Palgrave Macmillan.

Peters, M., and E. Bult, eds. 2011. *Cognitive Capitalism, Education, and Digital Labor*. New York: Peter Lang.

Ravitch, D. 2013. *Reign of Error*. New York: Alfred A. Knopf.

Rowan, C. 2014. 10 reasons why handheld devices should be banned for children under the age 12. *Huffington Post*. Available at: http://www.huffingtonpost.com/crisrowan/10-reasons-why-handheld-devices-should-be-banned_b_4899218.html

Saltman, K. 2010. *The Gift of Education*. New York: Palgrave Macmillan.

Saltman, K. 2012. *The Failure of Corporate School Reform*. Boulder, CO: Paradigm Publishers.

School of One. 2012, January 1. http://izonenyc.org/?project=school-of-one

Selwyn, N. 2015. "Minding Our Language: Why Education and Technology is Full of Bullshit … and What We Can Do about It". Paper to be presented to the "Digital Innovation, Creativity & Knowledge in Education" conference – Qatar. http://www.academia.edu/9792417/Minding_Our_Language_-_why_education_and_technology_is_full_of_bullshit_…_and_what_might_be_done_about_it

Selwyn, N., and K. Facer, eds. 2013. *The Politics of Education and Technology Conflicts, Controversies, and Connections*. Palgrave Macmillan: New York.

Shechtman, N., A. H. DeBarger, C. Dornsife, S. Rosier, and L. Yarnall U.S. Department of Education, Office of Educational Technology. 2013. *Promoting Grit, Tenacity, and Perseverance: Critical Factors for Success in the 21st Century*. SRI International website: http://www.ed.gov/edblogs/technology/files/2013/02/OET-Draft-Grit-Report-2-17-13.pdf

Siemens, G. 2011. Learning Analytics: Envisioning a Research Discipline and a Domain of Practice. Paper presented at 2nd International Conference on Learning Analytics and Knowledge (LAK12), http://learninganalytics.net/LAK_12_Siemens.pdf

Siemens, G. 2013. "Learning Analytics: The Emergence of a Discipline." *American Behavioral Scientist* 57 (10): 1380–1400.

Verbert, K., N. Manouselis, H. Drachsler, and E. Duval. 2012. "Dataset-Driven Research to Support Learning and Knowledge Analytics." *Educational Technology & Society* 15 (3): 133–148.

West, D. M. 2012, September. Big Data for Education: Data Mining, Data Analytics, and Web Dashboards. Governance studies at Brookings, p. 1–12.

Wolf, M. 2010. *Innovate to Educate: System [Re]Design for Personalized Learning*. Washington, DC: Software & Information Association.