DATA COLLABORATIVE
A Practical Exploration of Big Data in Course Wikis

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Wikis continue to be used within technology environments of K–12 and higher education because they offer a collaborative environment for students to produce and receive content in concert with each other or on an individual basis (Kirkham, 2014). These online spaces are typically used as a course management system where students can both receive content from the instructor, as well as generate unique content on their own. Additionally, as wikis are digitally based platforms, that can generate a great amount of data that can be collected, collated, and analyzed. This article seeks to explore the practicality of the use of such big data sets arising from within course wikis from an instructional standpoint, and explores the data that practitioners may wish to capitalize upon so that big data and its associated learning analytics may inform instructional practices.

INTRODUCTION

In one scene from the science-fiction action movie *The Matrix* (Silver, Wachowski, & Wachowski, 1999), the main character, Neo, approaches Cipher, a team member aboard the futuristic ship the *Nebuchadnezzar*, who is monitoring a screen of individual green digits of information streaming down a black background. Neo has recently been "awakened" from the matrix, his formerly perceived reality, which he is now discovering is in actuality a computer-generated program that exists merely as the cascading green icons across Cipher's monitor.

"Is that it?" Neo asks him.

"The Matrix?" Cipher responds, "Yeah."

"Do you always look at it in coding?" Neo inquires of the seemingly illegible green icons.

"You get used to it," Cipher replies. "I don't even see the code; all I see is: blonde, brunette, redhead."

Cipher is making a joke regarding how commonplace the constant stream of data has become for him, so much so that he can easily spot identifiable personal features of individual persons from amongst the seemingly indecipherable scrawling green rain.

Meanwhile, here in our present-day reality, as we advance further within the 21st century and into the heart of the digital age of information, we have a similar, but reversed, problem.

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Our prolific use of technology tools to access digital information or interact with social media, particularly by mobile technologies such as laptop computers, tablet devices and smart phones (connected to cellular data services or Wi-Fi access ports), continues to simultaneously generate a massive digital data stream, just as unyielding and just as unintelligible to the common eye. In fact, with every connected step we take, with every online social connection we make, we leave a trail of digital data in our wake, and we are oftentimes "none the wiser" as we happily carry on our seemingly ordinary daily activities. Efforts to capture and interpret this stream of data are ongoing and, often, problematic.

Recently, experts and leaders in every arena from medicine, consumer economics, the military, and higher education have all marshaled efforts to capture this data and analyze it to identify patterns and glean some sort of insight into human behavior (Smolan & Erwitt, 2012). This ability to harness, store, and analyze this data for some useful purpose has become known simply as "big data" (Picciano, 2012). This article seeks to question whether big data can be used to inform instruction at the classroom level, and to explore the use of wikis as a viable tool to house such information.

MY OWN EXPLORATION: WRITING TO LEARN

Paul Ugor was quoted as saying that "Writing is not a process of saying what is known, but rather, writing is a *process of learning*" (new faculty panel, March 24, 2016, emphasis, mine). In my exploration of big data and its relationship to collaborative course management systems—specifically, wikis—no other description could be more apt. Despite my experience as an instructor in both the secondary classroom and higher education, and as an educational technology specialist, my association with big data was previously limited to a passing generality and familiarity of the concept. This work has forced me to "drill down" and consider the depths to which data are being generated, collected, and tracked, and, subsequently, to consider the various ways in which big data might inform my instruction in meaningful ways. The extent to which my courses were generating data that were either being lost, sitting stagnant on some remote server, or just rotting from my own inability to optimally analyze the data that I had at my disposal has become increasingly evident to me.

Perhaps all data-driven decisions originate at such a juncture, where necessary problems arise and the answer is in data that is either unanalyzed, or not even collected at all. For the purposes of this article, the influence of big data on individual practitioners within the classroom, particularly within collaborative course management systems (such as wikis) will be presented and examined to present a clear representation of this tool. I will explore the use of wikis in postsecondary education—digital spaces that are modifiable by multiple users—and the affordances of big data to shed light on student interactions in the hope of providing ideas for instructors to maximize the effectiveness of their instruction. This exploration has also led me to some conclusions and open questions, which are presented at the end of the article.

Guiding Questions

As I began this work, I employed the following questions to frame my experience in analyzing big data and their affordance within wikis:

1. What type of data are being collected by wikis?
2. How can this data inform instructional practices of teachers?
3. Are there data that are not being collected—or being lost—within wikis that could benefit teachers' instruction, were that data be collected and analyzed?

Definition of Terms

To speak concisely about broader concepts that may embody accompanying connotations, I have defined some of the frequently used terms within this article.

Big data is understood to be the confluence of huge data sets pertaining to a certain field or realm, be it medical, corporate, or educational. Simultaneously, big data encompasses an ability or attempt to harness, store, and analyze this data for some useful purpose based on computer generated algorithms (Picciano, 2012). According to Niemi and Gitin (2012), big data holds the potential to assist the field of education by identifying the best learning paths for students, recommending instructional approaches for students, and enabling researchers to test learning principles in authentic educational settings.

Course management systems (CMS) are used synonymously with learning management systems, and though there are many variations of CMS currently in use, this article focuses exclusively on *wikis* as a collaborative learning space that is also a CMS.

Wikis are considered to be any digitally based tool that allows multiple users to modify content on pages and create links by using simplified markup language, or "wiki markup," usually with the assistance of a rich-text editor (Leuf & Cunningham, 2001). Whereas other digital course management tools have a host of permission-limiting options, wikis are very open in nature, and free as well, as any user is able to modify and/or generate content at will.

Educational data mining (EDM) is a process of combing through vast educational datasets to identify patterns and characteristics from within the educational context (Bienkowski, Feng, & Means, 2012). EDM is particularly suited to identify patterns within educational data that can be targeted and manipulated by computer software programs and other technologies.

Learning analytics are defined as the measurement, collection, analysis, and reporting of big educational data sets from instructional contexts for the purposes of understanding and optimizing learning opportunities for students (Siemens & Long, 2011). Learning analytics synthesizes several research areas, including EDM, academic analytics, and action research. Whereas EDM holds more of a technological focus within its analysis, learning analytics maintains a more pedagogical focus and seeks to bring a more practical element to data use for improving teaching and learning (Chatti et al., 2014).

Instructional practices are any type of pedagogical strategy employed by teachers or instructors within their classrooms. Instructional practices may contain (but are not limited to) direct instruction, student-centered instruction, formative or summative assessment, curriculum development and goals, as well as monitoring and reporting procedures.

A BRIEF EXPLANATION OF BIG DATA

Big data is transforming the way that we live our lives. Regardless of whether we are aware of its constant stream of information, big data is connecting us to other people, organizations, and locations, continually indicating where we have been and what we have seen. Big data is manifesting itself as a vitally important element in data-driven decision making in the business world, the medical field, and education. Corporations are using big data to track the spending habits of individuals. Whenever an electronic purchase is made, companies obtain a data log of exactly what consumers have purchased and when, allowing them to track individuals' spending habits. Online, individuals' behaviors are even easier to track, as every click and every website visited is recorded and stored. Google, for instance, has taken much criticism for the data tracking it employs among its users, many of whom, we must remember, are students using the Google educational suite of products (Peterson, 2015). These systems track online activity, monitor purchases and spending habits, and even track physical locations to more effectively market products consumers will likely want to purchase.

As alarming as this continual surveillance can be, it is simultaneously true that the wealth of information that big data affords is ripe with enormous possibility to positively impact our civilization. By providing us with evidential data regarding a myriad of behavioral patterns and tendencies, we have a concrete model that can be analyzed and used to make changes for the betterment of society and the world in general. For instance, reliance upon big data has led to advancements in improved civic engineering and road conditions; improved monitoring of individual physical activity by tracking number of steps taken, heart rate, weight gain, body mass index, and sleeping patterns; as well as long-term predictive health measures based on the mapping of the entire human genome (Smolan & Erwitt, 2012). Within the field of education, researchers have been able to track student activity in academic settings, generate predictive algorithms regarding student dropout rates and success in specific classes or entire courses of study. At younger ages, researchers are even utilizing big data to map emergent literacy in children documenting "word births" and examining the context for how we create meaning and label it (Roy, 2009).

BIG DATA IN EDUCATION: THE INFORMATION AGE IN THE CLASSROOM

Our increasingly mobilized and technologized culture continues to generate an overwhelming amount of data regarding our habitual patterns of behaviors, both online and physical. In the same way that society is examining this data to improve the ways in which we conduct our lives, education is and has been attempting to capitalize on big data to inform instructional data-driven decision making. What do the online activities of our students tell us about their interests, their goals, and how they perceive themselves? How can we tailor our instruction to meet our students' needs? Can we capitalize on the digital traces our students are leaving as clues to spur their motivation to create some truly unique and rewarding learning opportunities? We now turn our attention to some of the ways this is being accomplished.

Educational Data Mining

EDM is a process of combing through large educational datasets in order to identify patterns and characteristics from within the educational context (Bienkowski et al., 2012). Data from teachers, students, grades, communications, and other digital artifacts may be tracked, but EDM essentially seeks to reduce evidence of learning to the smallest component that can be analyzed, and then target those components via computer software algorithms.

Prior to the digital revolution, such large-scale data sets in the field of education were manifest as generalizable points of information, typically gleaned from standardized test scores, or some other uniform measurement that was largely impersonal, and only a momentary snapshot of students' abilities (such as the day a test was taken). The validity and reliability of such measurements that are solely based on student performance have been called into question regarding their appropriateness to represent classifying entire schools, districts, and the weight they are given in teacher evaluations (Popham, 1993).

Collecting student data for educational purposes through standardized tests has been in effect since the 1970s (Popham, 2014), yet the amount of testing and the frenzy to capture data to be analyzed has increased over the past decade, especially with the mandates of the No Child Left Behind Act of 2002. Critics of this initiative disagreed not only with the application of performance labels to schools and districts based upon student test scores, but also to mandated escalating performance requirements, which caused enormous levels of stress to trickle down from school administrators to teachers, and finally, to the students themselves.

The succeeding administration of President Obama initiated the Race to the Top as an overhaul to No Child Left Behind, in conjunction with the creation and widespread adoption of the Common Core Standards. While this initiative provided a measure of relief from previous performance mandates, it required accepting more stringent policies regarding the amount of testing to be done to generate the largest amount of data possible. Ideally, analyzing vast stores of educational data can theoretically shed light on various patterns and identify characteristics to inform teaching and learning practices, but critics of this administration's educational agenda often cite an overreliance on data mining techniques without results translating to classroom instruction (Hohmann, 2014).

Regardless, the widespread acceptance of Common Core Standards have quickly become normalized within statewide curricula, teachers' lesson plans, and textbooks and resource materials, and this proliferation has moved American education closer to becoming a more centralized entity than we have previously known (Cummins, Johnson, & Adams, 2012). The strict rule of standardized testing has been successful in generating a vast amount of student data, but notions of accountability and evaluation have clouded the purpose of such data. This use of data confounded the curricular aims of some individual schools and teachers, forcing them to prioritize whether to teach their course curricula or whether to simply teach to the test (Phelps, 2011).

Such decisions usually entail sacrificing "depth" of knowledge for "breadth" of material covered, an approach that is never ideally suited to teaching and learning environments. Rather, in efforts to make collected data useful for the purposes of teaching and learning, data must be mined and analyzed using processes geared more toward developing pedagogy and instruction through learning analytics.

Learning Analytics

Learning analytics is a growing field that synthesizes several areas of research including academic analytics, action research and educational data mining. Learning analytics seeks to analyze elements of big data that can inform decisions at the local level to optimize student learning (Chatti, Dyckhoff, Schroeder, & Thüs, 2012). According to Siemens and Long (2011), learning analytics focuses exclusively on the learning process itself and stands to benefit faculty at the *department* level, as well as students within the course and classroom. Learning analytics are also housed internally within many CMS's, including wikis, where they manifest as real-time statistics that track individual student usage in the CMS. The data being tabulated typically surrounds student activity and includes factors such as page views, page edits, message posts, time logged viewing pages, posts within the wiki, and clickstream data. Although not necessarily a marker of genuine learning, this information can be analyzed and reviewed to provide instructors a clearer picture of student action and engagement throughout the CMS.

Using EDM techniques and the application of custom algorithms to such data, learning analytics within CMS have shown to be predictive of potential student dropouts and/or students' overall success in classes and specific coursework (Niemi & Gitin, 2012; Romero & Ventura, 2012). In the hands of course instructors or department chairs, this can certainly be powerful information. However, as Romero, Ventura, and Garcia (2007) point out, instructors often lack the skills to be able to apply such sophisticated algorithmic techniques on their own. Rather, classroom instructors must rely on the data mining of statisticians to glean the information that is useful to their instructional practices. This is where a true harmony between collaborative CMS, like wikis, and big data can be forged. *Can instructors seamlessly capitalize on big educational data filtered through learning analytics to* *hone instruction to students' interests, goals, and needs?*

Siemens and Long (2011) outline nine specific benefits that learning analytics can provide higher education, namely:

1. to assist in administrative decision-making,
2. to provide intervention to assist learners,
3. to create shared understandings of institutions' successes and challenges,
4. to innovate and transform academic models of instruction,
5. to assist in making sense of complex topics across social and instructional networks,
6. to help leaders transition to holistic decision-making,
7. to increase organizational productivity,
8. to help institutional leaders determine the hard and soft value generated by faculty, and
9. to provide students insight into their own learning (p. 36). If they can make data readily interpretable, learning analytics can theoretically offer robust potential within teachers' instructional practices.

However, when housed within a CMS, researchers have also identified a gap of physicality that learning analytics cannot account for—activities, for example, such as library visits, or time spent with individual tutors (Siemens & Wolf, 2011). Thanks to the data streaming from smartphones and other mobile devices, it is now evident that some researchers' hypothesis of *mobility* serving as a bridge between the digital and the physical may hold much promise. The data generated through the mobility of geolocation applications can easily map our physical positions and trace specific behavior patterns. With location services activated, students' mobile devises provide information regarding where they go and what they do (Flux, 2014). This type of data could shed much light on student interests and passions, and might be incredibly beneficial for the purposes of classroom instruction. Of course, this level of surveillance can also be unsettling, and issues of student privacy and identity protection cannot be overlooked. However, could it be possible to achieve a balance between protecting individual privacy and utilizing mobility data to benefit instructional practices and pedagogy?

My Stance as an Educator

In my own practice, I have typically trended away from quantifiable measurements when regarding student learning, including assessment and reporting. Given my beliefs that are shaped by Dewey's notion of teaching to the whole child, I have attempted to structure my courses in ways which prioritize the *quality* of student work above notions of *quantity* (e.g., points, scores, and percentages of traditional grades), instead framing projects and assignments as having an *inherent worth* separate from a point value calculated in a grade. Nonetheless, this exploration has caused me to reevaluate how data-driven quantitative measure may benefit my instruction. I continue to grapple with how a newfound reliance upon student generated data—especially data regarding unstructured learning environments—might increase the value of specific course activities to my students.

Moreover, my commitment to digital literacy has prompted me to model 21st century instructional practices such as student-centered collaboration and teacher facilitation within the classroom, and to challenge my students to familiarize themselves with digital tools they oftentimes have not encountered previously. To this end, I have typically employed wikis to deliver my course content in digital spaces in lieu of other CMS's that are more individualized and less inherently collaborative. While some students are initially leery of the openness of a wiki platform, through the course and their own experience learning to use wikis as an instructional tool, they typically come to value the shared benefit that wikis provide. Many either continue using content from our course wikis long into the future, or else create new wikis for their own instructional purposes.

WIKIS IN EDUCATION: SOME PROS AND CONS

Wikis have been prevalent in education for several years. According to the Horizon Report (Cummins et al., 2012), in order to foster teamwork and group communication "silos both in the workplace and at school are being abandoned in favor of collective intelligence" (p. 4). This emphasis upon collaboration as a necessary skill is instrumental to 21st century learning. In my own practice, I have found wikis to be a valuable tool in meeting that need, not only in transmitting course information and providing students a platform to submit their work, but also by propelling students to gain new technology literacy skills. Students in my classes each create and consistently manage their own pages within our course wiki, using their pages as platforms for submission of assignments, which is almost entirely either embedded digital content or links to outside digital presentations and projects utilizing other technology tools (e.g., digital flyers, digital timelines, digital storytelling, etc.).

Wikis lend themselves naturally to project-based learning, where teams of students can independently create content and post it to shared spaces. Construction and coconstruction of course content not only empowers students in self-driven ways but also lends itself to more authentic learning and exploration that can be beneficial in real-world settings and the lives students will lead in the future. For instance, informed by big data, students may be able to collectively meet challenges indicated through statistical societal needs or trends within a community.

Ultimately, wikis are just tools—collaborative tools—that students or team members can use to store, present, and coauthor work. Considering the importance of Web 2.0 competencies in the 21st century: Pifarré, Marti, and Guijosa (2014) cited that most knowledge creation is conducted by "teams working with and around technology" (p. 55). Wikis, by nature, do just that—provide students the freedom to construct their own spaces to house and store products that are viewable to both their instructor, their classmates and/or team members within their group.

However, despite these affordances of wikis within the confines of a classroom setting, they may also present some drawbacks for teachers and students in K–12 or higher education settings. Wikis, by their collaborative nature, are almost totally public. The submission of any student work or product is viewable by anyone else who has the appropriate access to the site or page. This potential intrusion into the presumed and assumed privacy of assignments that students submit can be somewhat unsettling, especially if students do not want their work displayed for others in or outside of the classroom setting. Teachers, as well, may prefer students' work to be submitted along more private channels, particularly if there are ongoing concerns regarding the quality of content and ideas, or the potential for plagiarism.

Additionally, the idea of ownership can also be problematic, especially when used in higher education settings. When using a wiki, all content is digitally based, and while wikis usually employ a closed group or password protected setting, it is feasible that any user could share certain content with individuals outside of the wiki. If there is content or data that should remain private, such as specific course content and syllabi, for example, student-generated work or projects, or personal information can potentially be shared in a public, digital space.

MARRYING THE TWO: WIKIS AND BIG DATA

The use of wikis as CMS offers many benefits to engendering collaborative digital learning spaces within our classrooms. Coupled with learning analytics, wikis or other digital CMS may be able to harness the affordances of big data to inform classroom decisions regarding personalized learning and student engagement. In their work with collaborative assessment, particularly within wikis, Fidalgo-Blanco, Sein-Echaluce, García-Peñalvo, and Conde (2015) found that learning analytics are helpful for determining individual interactions and learning among team members in collaborative spaces.

Mobility also offers instructors the freedom to digitize their content in ways that expand the limits of the classroom. No longer are teaching and learning activities that necessarily take place on the board at the front of the room or within the four walls of the classroom. Rather, teachers can introduce content in any physical environment; students may travel to whichever location best suits their needs, instructional or otherwise, to receive course content or to produce coursework. This openness is not only emblematic of 21st century skills, but it can also capitalize on the value of students' informal learning to enhance formal classroom instruction.

Moreover, were instructors able to utilize learning analytics within digital CMS's, including as wikis, the patterns of recorded student activity may hold greater promise than simply that of base activity within a CMS. Analyzing student activity in online settings may provide insight into students' interests, student goals for the future, and ultimately, a measure of reliability that could be useful to teachers' instructional practices. Armed with such information, teachers could tailor activities to move students sequentially toward their goals, fueled by students' own passions, into a future that continues to unfold before them.

CONCLUSION

Much progress still needs to be made researching the effects of learning analytics. Advancements need to be made regarding the evaluation and design patterns of learning analytics, as well as how to embed learning analytics within instructional frameworks and CMS's, such as wikis (Chatti et al., 2014). Once readily accessible, learning analytics may have much to offer classroom instructors wishing to improve electronic and summative assessments, and to streamline teacher-student feedback processes.

Employing EDM techniques to identify further patterns within big educational data sets may situate computer software to capitalize upon student interaction in digital and physical environments. Utilizing the information provided by learning analytics embedded within CMS's that is situated around student-generated data may become be a powerful informant for teachers intent on maximizing student learning in class activities and instructional pedagogy. If more accessible tools for nondata mining experts were embedded within CMS's, this could enrich the support for teachers to incorporate the benefit of learning analytics within their daily educational practice (Chatti et al., 2012).

Still, several questions remain. Can learning analytics be streamlined for teachers and instructors who are unfamiliar with such analyses of big data sets? Can issues of privatization and ownership of course content be adequately addressed to allow teachers to utilize the collaborative and open nature of wikis to their greatest extent? Can a balance be reached between capturing online activity and mobility data of students, while still prioritizing student privacy and protecting personal identity?

In the culminating scene of *The Matrix*, Neo has finally realized how to view the Matrix for what it is, essentially a code, and he begins to use his newfound ability to rewrite the reality of his surroundings. In a similar fashion, if practicing teachers can harness the data their students generate—data that is likely indicative of their interests, their passions, and their goals for the future, whether from structured or unstructured learning environments—it could do much to enrich classroom learning activities, increase their relevance and meaningfulness and, ultimately, promote students' success within the classroom and beyond.

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