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The Nationwide Landscape of K–12 School Websites in the United States: Systems, Services, Intended Audiences, and Adoption Patterns

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Abstract

This study sought to collect URLs (web addresses) of all K-12 schools in the United States (N = 98,477) and analyze website home page system and service data for all available U.S. institutional websites (n = 65,899). Building upon previous research related to Web 2.0 educational potentials, this first-of-its-kind study sought (a) to provide descriptive results of system and service adoption and website data for all schools in the United States and (b) to detect theorized differences based upon school demographics and service/system type (e.g., open source vs. proprietary). Results indicated that proprietary and purchased systems were much more common than free and open systems, that adoption patterns were generally not meaningfully influenced by demographic data (except for charter school status), and that K-12 institutional adoption of Web 2.0 seems to be more focused on educational uses of these tools that might not strictly be considered pedagogical (e.g., community outreach).

Keywords: Web 2.0, social media, K-12 education, open source software, community outreach, communication

Introduction

Digital technologies, the Internet and Web 2.0 in particular, have expanded the possibilities available to schools and researchers for improving teaching and learning via new communication, pedagogy, data collection, and data analysis methods. Web 2.0 (or the social Web) is a broad term that refers to Internet applications that allow non-programmers to create, remix, and share content on the Web or, more generally, as "anything that uses the Internet to facilitate conversations" (Solis & Breakenridge, 2009, p. xvii). A few prominent examples include Facebook, YouTube, Twitter, and Google Apps. Web 2.0 alters and enhances the scope and methods available to individual Web users to learn, socialize, self-express, and interact with the world at large. Many research and theoretical pieces have been written on Web 2.0's proper place in K–12, but as a field, we have yet to grasp the breadth of its use and the way it is being used by actual schools. Similarly, though it is expected that most schools in the US have a Web presence and share information with their communities via their school websites, little work has been done to explore how these websites can be mined as open data resources for improving education. For example, a search of the ERIC database for journal articles with the words "school" and "website" in the title yields only 24 results in the past 10 years. As well, these results include studies that are entirely unrelated to this topic or only analyze a very small ($n < 30$) group of websites for specific resources, such as content for counseling support (e.g., Kennedy & Baker, 2015) or the presence of outdoor education programs (Campbell-Price, 2018). Through this study, we seek to address two gaps in the literature. First, we attempt to provide valuable insights regarding the adoption of general website systems and Web 2.0 resources in K–12 schools across the US, and second, we seek to provide a necessary step forward in exploring how mining openly available public school websites can be used to support research that can inform educational policy and practice.

The prospect of integrating the social Web into educational environments (particularly at K–12 levels) is greeted with a wide spectrum of responses. On one hand, the innovative and ever-improving affordances of Web 2.0 are considered beneficial for learners and teachers alike by (a) increasing learners' agency and connectedness; (b) enhancing learners' capacity to develop 21st-century skills; (c) extending boundaries of time, space, and audience that have restricted learning in the past; and (d) supporting the integration of formal and informal learning (Chen & Bryer, 2012; Dabbagh & Kitsantas, 2012; Kim, Jeong, & Lee, 2010). On the other hand, the culture of participation, commitment of resources, and theoretical paradigm shifts associated with Web 2.0 bring with them a host of legitimate concerns about student safety, institutional sustainability, and pedagogical efficacy that must be addressed before advocating for their wholesale adoption (Howard, 2013; Kimmons & Veletsianos, 2015; Weeden, Cooke, & McVey, 2013).

At its heart, Web 2.0 is participatory in nature, which theoretically implies that students, teachers, parents, and leaders in K–12 can use these tools to meaningfully interact with one another in collaborative and enriching ways. Users engaging with others via the social Web may be participating in a variety of activities including social networking, sharing user-generated content, sharing experiences and resources, and collaborating with others in virtual workspaces (Dabbagh & Kitsantas, 2012; Kim et al., 2010). Proponents of Web 2.0 adoption for educational use tend to focus their reasoning on theoretical and observed benefits for the learner. When Web 2.0 tools are used effectively, it is proposed that they can

- increase self-regulation (or self-direction) and agency for the learner (Dabbagh & Kitsantas, 2012; McLoughlin & Lee, 2010);

- empower the development of media literacy (Krutka & Carpenter, 2016);
- support critical thinking (Reich, Murnane, & Willett, 2012);
- facilitate high levels of communication and collaboration, both within and outside the classroom (Howard, 2013; Krutka & Carpenter, 2016; Luckin et al., 2009; Reich et al., 2012);
- foster creativity (Luckin et al., 2009);
- expand boundaries of time and space in which to learn (Krutka & Carpenter, 2016);
- provide professional resources and networks for teachers (Carpenter, Kimmons, Short, Clements, & Staples, 2019; Hunter & Hall, 2018; Kimmons, Carpenter, Veletsianos, & Krutka, 2018; Trust, Carpenter, & Krutka, 2017);
- enable publication to authentic audiences where cost and logistics would have previously prohibited it, thus (potentially) increasing motivation to do quality work (Krutka & Carpenter, 2016); and
- provide the flexibility necessary to allow deeper integration of formal and informal learning modes (Dabbagh & Kitsantas, 2012; McLoughlin & Lee, 2010; Vasbø, Silseth, & Erstad, 2013; Woodward & Kimmons, 2018).

Though such affordances seem promising, the rapidly-changing nature of today's technological environment also presents unique and ever-changing challenges to its adoption in K–12 environments. Educators and policy-makers must constantly balance the advantages of the social Web with the "safety, privacy, and psychological well-being" of students and the danger of damaging the reputations of teachers and administrators (Howard, 2013, p. 51; cf. also Kimmons & Veletsianos, 2015; Kimmons, Veletsianos, & Woodward, 2017; Veletsianos, Kimmons, Shaw, Pasquini, & Woodward, 2017). Furthermore, despite the great potential of Web 2.0, many studies agree that few students are actually engaging with its high-end affordances, even when they are using the technology in their classrooms (Luckin et al, 2009; Reich et al., 2012). Students need guidance in order to avoid the distractions and dangers of social media as well as to put it to its highest communicative, collaborative, transformative, and creative use (Krutka & Carpenter, 2016; Luckin et al., 2009; McLoughlin & Lee, 2010). For students to receive that guidance, teachers often need additional training in areas such as how to (a) minimize the distractions of Web 2.0 (Andersson, Hatakka, Grönlund, & Wiklund, 2013); (b) adjust privacy settings on social networking sites or SNSs (Weeden et al., 2013); and (c) use "thoughtful questions" to guide students to explore the possibilities, affordances, and challenges of the social Web (Krutka & Carpenter, 2016, p. 9).

Although the safety concerns for Web 2.0 adoption are very real, many researchers argue that this is a point in favor of its adoption, not against it. Engaging with social media in schools provides students with a more controlled and safer environment in which to experiment with the capacities of these tools. Furthermore, it may be considered a "deontological . . . responsibility" (Howard, 2013, p. 41) for teachers to help students consume and create with social media in a critical, safe, and responsible way rather than leaving them to navigate these uncertain spaces on their own. Teachers who understand the language and customs of the

cyber world (Howard, 2013) and connect with students via social media (Krutka & Carpenter, 2016) have just such an opportunity, and this scaffolded approach to Web 2.0 may take on additional security measures through the use of alternate, safer, education-specific SNS software, such as Edmodo, Schoology, and Coursesites (Howard, 2013).

While the literature is replete with postulations of the benefits and drawbacks of Web 2.0 adoption, there is no current, reliable, generalizable research that would provide an overall snapshot of how Web 2.0 technologies are being adopted by US schools, and there are no existing studies that explore institutional adoption of these tools on par with those that have been done in higher education (Kimmons et al., 2017; Veletsianos et al., 2017). Individual school and district case studies do exist (Hew & Brush, 2007), and though these provide valuable insights and a deeper look into what is occurring at selected schools, they do not give us a sufficiently broad understanding of the topic to recognize what is happening generally. This study seeks to fill this gap by providing a high level, descriptive overview of K–12 institutional use of Web 2.0 across the entire United States. Beginning by collecting a large and representative sample of public K–12 school website addresses (URLs), we then used data mining techniques explored in previous studies to identify system adoption and service linking, and connected these indicators with school-level demographic data for further analysis (Kimmons, 2015a, 2015b). Our reasons for doing this were manifold, but one specific purpose was to test the hypothesis offered elsewhere that open source and free software will be used more by those who already have access to social capital than by those who are struggling (Chander & Sunder, 2004; Kimmons, 2015b).

Our overarching research goal for this study was to provide educators and decision-makers with a general understanding of how Web 2.0 is being adopted among schools in the US. We used the following two research questions to guide us in these efforts:

1. What types of Web systems and supplemental Web 2.0 services are K–12 schools adopting institutionally?

2. What effect, if any, do factors such as poverty, locale, school size, and grade level exert on institutional adoption patterns?

Methods

This study made use of a variety of website data mining and analysis methods explored in previous studies (Kimmons, 2015a, 2015b) to collect, clean, and analyze K–12 school website data. A brief outline of our research process follows:

1. Collect website lists from Department of Education (DOE) websites of all 50 states.

2. Compile all websites into a MySQL relational database.

3. Compare to National Center for Education Statistics (NCES) data to determine coverage.

4. Use search engines and APIs (e.g., Google Custom Search) to fill in missing data.
5. Manually verify 1% of URLs.
6. Scrape all school homepages using PHP scripting and the CURL data transfer tool.
7. Verify results against NCES data to determine coverage.
8. Analyze HTML for heuristic identifiers of website systems (e.g., Wordpress).
9. Extract all links from homepages and save in the database.
10. Extract domains from links (e.g., bypass URL shorteners) and save in the database.
11. Manually code top domains and website systems based on categories (e.g., open source).
12. Analyze demographic differences in SPSS.

We will now explain each of these steps in detail.

We began by having human data collectors systematically explore state Department of Education websites to determine if lists of schools and accompanying URLs were provided for all 50 states. Data was converted from provided formats (e.g., spreadsheets, Web page lists, PDFs) to a spreadsheet for database entry. Through this process, we discovered that very few states provided such lists, and in all, we were only able to collect 6,152 websites representing 18 states.

To check the coverage of our data, we compared our list to the National Center for Education Statistics public school database because it provided a relatively recent (2013–2015) collection of school information for all US states that could be readily downloaded in Microsoft Excel format. In total, school-identifying information for 98,477 schools was imported from the NCES database, which we treated as a full and complete list of all K–12 schools in the US. We proceeded to fill in missing school URL data through various manual and guided means, depending on the needs and availability of data for each state. We also used various online search tools, databases, and APIs to supplement the process (e.g., Google Custom Search), relying on school name and location information from the NCES database as references. This process took our team of five researchers five months to complete, but the finished dataset provided URL results for 68,106 schools in the US, or 69.2% of the NCES database.

One important step in this process was manual verification that the results returned by our data queries were indeed accurate. After fetching approximately 1% of the URLs for our data set, our team manually verified that each positive result actually linked to the school (or at least the district) website of the institution in question. Part of this process was also a manual examination of each website's HTML code, which we used to create programmatic rules to heuristically determine which primary system was being used to create and host the website (e.g., embedded metadata, included files). We also extracted domain and keyword data from all provided links to identify linked systems (e.g., a link to voicethread.com revealed use of VoiceThread). In total, 1.07 million unique school-domain links were analyzed in this way.

When identifying these systems, we also coded them according to their cost and the license placed upon the source code as either purchased, proprietary/free, or open, as in previous research (Kimmons, 2015b). *Purchased* included any system for which a purchased license would be required for use (and implied closed source code). *Proprietary/free* included systems that required a license but that did not require purchase by a school (e.g., Google Sites). Finally, *open* included systems that were released under an open license, which means they were free, meaning no cost, as well as meaning users had freedom to use the system however they liked (e.g., Drupal).

Using MySQL, PHP, and existing data mining libraries, we then developed a series of persistent scripts running on a Linux Web server to systematically open and store data from all website home pages in the list. When we attempted to fetch website content from these addresses, 65,899 (96.8%) returned valid results, with the remainder returning missing link or permission denied errors. Thus, our final dataset consisted of website homepage content representing 66.9% of the NCES dataset. This sample size was sufficiently large to yield a confidence interval of +/- 0.3% on results at the 99% confidence level, provided that the sample was representative of the entire set and that specific groups of schools were not disproportionately excluded from sampling. In this process, we focused on homepages only. Due to the massive size of our dataset, traversing and scraping all subpages of these websites would have exponentially increased time and data management requirements to an extent that would have made the project infeasible. For example, scraping a single website with a conservative average of 200 subpages would have required about 6.7 minutes (based on a common page latency of 2 seconds with no errors). This seems feasible until it is applied to the entire dataset, which would have required 306 full-time days to scrape with this method and would have yielded over 13 million pages with hundreds of millions of links for analysis. Thus, our approach, though not exhaustive, seemed at least reasonable to provide a snapshot of school use of technologies at a high level without exerting effort comparable to a dedicated search engine provider.

To ensure that sampling was proportional, we compared NCES demographic data between schools for which we were able to collect a homepage versus those that we could not. Results are provided in Table 1 and indicate that sampling slightly favored more urban and poorer schools (Title I and high percentage of free or reduced rate lunches), though these sampling differences were relatively minor (within 5% of the mean). However, charter schools (public schools with less regulation) and magnet schools (public schools focused on a specific curricular theme) were overrepresented in the dataset by 10.2% to 13%. Despite this, we concluded that sampling differences were not sufficiently large between groups to warrant additional analyses, because it seemed dubious that such sampling differences would meaningfully influence other factors (such as open vs. proprietary system adoptions). We then analyzed these data in SPSS using a variety of methods (detailed in the research question subsections in the Results).

Table 1

School Sampling Demographics

	Schools listed in NCES	Homepages collected	Collected %	Sampling difference from overall
All schools	98,477	65,899	66.9%	-
Primary (elementary, middle)	71,308	48,734	68.3%	1.4%
Secondary (high)	17,232	11,404	66.2%	-0.7%
Magnet	3,221	2,485	77.1%	10.2%
Charter	6,751	5,394	79.9%	13.0%
Non-magnet/non-charter	88,573	58,101	65.6%	-1.3%
City	26,041	18,382	70.6%	3.7%
Suburb	30,566	21,229	69.5%	2.5%
Town	13,260	8,473	63.9%	-3.0%
Rural	26,683	16,725	62.7%	-4.2%
Title I	68,476	47,574	69.5%	2.6%
Non-title I	25,288	15,829	62.6%	-4.3%
Very low FRL (< 25%)	18,182	11,979	65.9%	-1.0%
Low FRL (25–50%)	24,663	16,500	66.9%	0.0%
High FRL (50–75%)	26,341	17,933	68.1%	1.2%
Very high FRL (>75%)	24,332	17,154	70.5%	3.6%

Results

The dataset generated for our study revealed that our data collection methods were highly successful in providing a wealth of data for analysis. Next, we provide detailed results for each of our guiding research questions and discuss implications of these results.

Research Question 1: Systems and Services

Of the 65,899 school websites that returned an HTML result, we were able to programmatically identify a primary system for 60.2% of schools by searching for keyword classifiers in the HTML or URL. The remaining 39.8% either used a custom-built website without a discernible system or used a system that was so uncommon that it was not represented in the manually-coded random sample. Schools used a variety of systems, including blog platforms, content management systems (CMS), learning management systems (LMS), student information systems (SIS), and hybrids. As well, 21.1% of these schools used more than one system; in these cases, each system was included in the analysis.

Recognizing the diversity and complexity of systems that were presented in the data, we quickly found it unhelpful to try to disaggregate the data by traditional categories (e.g., CMS vs. LMS) and instead generated descriptions of system use in an inclusive manner. Over two-thirds of the identifiable adoption was shared by the top six systems: SchoolWires, PowerSchool, Wordpress, SharpSchool, SchoolLoop, and SchoolInsites. Table 2 provides details of the top systems with relative frequency. However, some of these labels should be approached tenuously, because many systems are in a constant state of flux and rebranding. For instance, EdLine, SchoolWorld, and SchoolFusion are all now owned by Blackboard, which appears to be consolidating them into its Engage platform. Thus, there is some fluidity to these results, because some systems may be rebranded, merged, forked, and so on, and should not be treated as distinct entities.

Table 2

Homepage Systems and Information

System	N	% of returned websites	Cumulative % of overall market	License cost category	Developer audience
SchoolWires	9,250	14.0%	19.0%	purchased	education
PowerSchool	6,386	9.7%	32.0%	purchased	education
Wordpress	6,180	9.4%	44.7%	open	generic
SharpSchool/SchoolMessenger	4,351	6.6%	53.6%	purchased	education
SchoolLoop	3,841	5.8%	61.5%	purchased	education
SchoolInsites	2,549	3.9%	66.7%	purchased	education
Drupal	2,251	3.4%	71.3%	open	generic
Edline/SchoolWorld	1,731	2.6%	74.9%	purchased	education
SharePoint	1,524	2.3%	78.0%	purchased	generic
Weebly	1,464	2.2%	81.0%	proprietary/free	generic
SchoolFusion	1,450	2.2%	84.0%	purchased	education
SchoolPointe	1,260	1.9%	86.5%	purchased	education
eSchoolView	1,240	1.9%	89.1%	purchased	education
EducationalNetworks	777	1.2%	90.7%	purchased	education
RSchoolToday	745	1.1%	92.2%	purchased	education
CyberSchool	716	1.1%	93.7%	purchased	education
FoxBright	421	0.6%	94.5%	purchased	education
Google Sites	403	0.6%	95.4%	proprietary/free	generic
OnCourseSystems	401	0.6%	96.2%	purchased	education
SquareSpace	382	0.6%	97.0%	purchased	generic
All others	1,481	2.2%	100.0%	mixed	mixed

The identified systems were then categorized according to cost and source code licensing as

- proprietary/purchased—the system is based on proprietary code, and schools must purchase a license or subscription to use it (e.g., SchoolWires);
- proprietary/free— the system is based on proprietary code, but schools do not need to purchase a license or subscription to use it (e.g., Google Sites); or
- open—the system is based on openly licensed technology that may be freely used without additional permissions or subscriptions (e.g., Wordpress).

Results indicated that of the top 20 systems, only 2 were open (Wordpress and Drupal), and only 2 were proprietary/free (Weebly and Google Sites; cf. Table 2). When adoption of these most popular systems was aggregated, proprietary/purchased systems were the most common (56.2%), followed by open systems (12.8%), and then proprietary/free systems (2.8%). Additionally, some of these systems were developed specifically for an education audience (e.g., SchoolWires, PowerSchool, SharpSchool), while others were created for a more general audience, such as blogging or website creation (e.g., Wordpress, Drupal, Google Sites). When compared, adoption of education-specialized systems was much more common (72%) than was adoption of generic systems (25%) at a rate of roughly 3:1.

Categorized system data was then combined with institutional data to determine patterns of adoption based on school type (e.g., magnet, charter), Title I status, locale (e.g., city, rural), student free and reduced lunch percentage, student-teacher ratio, and grade level (i.e., primary, secondary). Table 3 indicates that adoption patterns were generally constant (only varying 1–2 percentage points between groups in each classification category) with a few distinct variations. First, city schools were 8% to 10% more likely (1.6 times the rate) to adopt an open system than were suburban, town, and rural schools. Second, Title I schools were 5% more likely to adopt a proprietary/purchased system than were their non-Title I counterparts, and were 6% less likely to adopt an open system. And third, charter schools were 34% to 38% more likely to adopt an open system (2.8 times the rate) and were 33% to 36% less likely to adopt a proprietary/purchased system (0.6 times the rate) than were their non-charter counterparts.

Table 3

System Category Summary

	Any	Proprietary/purchased		Proprietary/free		Open	
	n	n	%	n	%	n	%
All schools	39,702	31,294	79%	1,658	4%	8,619	22%
Primary (elementary, middle)	29,017	23,214	80%	1,161	4%	5,803	20%
Secondary (high)	6,731	5,317	79%	269	4%	1,481	22%
Magnet	1,652	1,388	84%	50	3%	248	15%
Charter	2,995	1,438	48%	210	7%	1,587	53%
Non-magnet/non-charter	25,395	20,570	81%	1,016	4%	4,825	19%
City	10,947	7,882	72%	438	4%	3,065	28%
Suburb	13,302	10,908	82%	399	3%	2,394	18%
Town	5,049	4,191	83%	202	4%	1,010	20%
Rural	9,799	7,937	81%	588	6%	1,960	20%
Title I	28,486	23,074	81%	1,139	4%	5,697	20%
Non-title I	9,825	7,467	76%	393	4%	2,555	26%
Very low FRL (< 25%)	7,127	5,630	79%	214	3%	1,639	23%
Low FRL (25–50%)	10,067	8,054	80%	503	5%	2,215	22%
High FRL (50–75%)	10,773	8,618	80%	539	5%	2,155	20%
Very high FRL (>75%)	10,085	7,866	78%	403	4%	2,118	21%
Very low s/t ratio (<10)	2,182	1,593	73%	131	6%	633	29%
Low s/t ratio (10-20)	27,588	22,346	81%	1,104	4%	5,518	20%
High s/t ratio (20-30)	7,303	5,623	77%	292	4%	1,680	23%
Very high s/t ratio (>30)	583	431	74%	17	3%	152	26%

In addition to primary Web systems, we also considered the external Web resources that each website linked to, ignoring Department of Education and other state websites, or websites that were no longer active. On average, 15.7 unique external links were detected on every school homepage that included at least one external link, and when aggregated, these external links represented 113,197 unique domains. Given the sheer size of the resulting dataset, we decided to focus analysis on only the most commonly used external links across school sites. Table 4 provides details on the top sites with relative linking frequency. Of these sites, social networking sites such as Facebook (43.7%) and Twitter (39.7%) were the most popular, but other popular sites also included search engines (e.g., Google Search), image sharing sites (e.g., Instagram, Flickr), video sharing sites (e.g., YouTube, Vimeo), Web publishing platforms (e.g., Google Sites), email

providers (e.g., Google Mail, Microsoft Online), office applications, (e.g., Google Docs / Drive, Microsoft Office 365), administrative tools (My School Bucks, Aesop Online), and various others.

Table 4

Linked External Sites and Services

Name	Frequency	% Likelihood on returned websites	Service category	Ed-specific/ generic	Free/paid
Facebook	26,073	43.7%	SNS	Generic	Free
Twitter	23,702	39.7%	SNS	Generic	Free
Google Search	12,233	20.5%	Search	Generic	Free
Google Docs/Drive	10,426	17.5%	Office applications	Generic	Free
YouTube	10,387	17.4%	Video sharing	Generic	Free
Google Sites	8,751	14.7%	Website creation	Generic	Free
Google Maps	4,255	7.1%	Maps	Generic	Free
Instagram	4,179	7.0%	SNS	Generic	Free
My School Bucks	3,357	5.6%	Administrative	Ed-Specific	Paid
Aesop Online	3,349	5.6%	Administrative	Ed-Specific	Paid
Google Mail	2,853	4.8%	Email	Generic	Free
LinkedIn	2,514	4.2%	SNS	Generic	Free
Peach Jar	2,361	4.0%	Administrative	Ed-Specific	Paid
Microsoft Online	2,091	3.5%	Office applications /email	Generic	Paid
Google Translate	2,089	3.5%	Translation	Generic	Free
Vimeo	1,801	3.0%	Video sharing	Generic	Free
School Nutrition Network	1,756	2.9%	Administrative	Ed-Specific	Paid
Google+	1,740	2.9%	SNS	Generic	Free
Google Accounts	1,739	2.9%	Administrative	Generic	Free
Frontline Education	1,562	2.6%	Administrative	Ed-Specific	Paid
Pinterest	1,540	2.6%	SNS	Generic	Free
Board Docs	1,392	2.3%	Office applications	Generic	Paid
Flickr	1,296	2.2%	Image sharing	Generic	Free
Naviance	1,268	2.1%	Academic planning	Ed-Specific	Paid
My School Building	1,266	2.1%	Building management	Ed-Specific	Paid
iTunes	1,246	2.1%	App library	Generic	Free
Accelerated Reader Book Finder	1,176	2.0%	Reading helper	Ed-Specific	Paid
Survey Monkey	1,120	1.9%	Survey creation	Generic	Free
Google Play	1,111	1.9%	App library	Generic	Free
Google Support	1,069	1.8%	Technical support	Generic	Free

From this list, a few items deserve attention. First, public (non-educational, non-restricted) social media platforms such as Facebook, Twitter, LinkedIn, Pinterest, and so forth were linked to far more often than were education-oriented services (e.g., My School Bucks). Second, free websites were much more common than paid services. Third, Google as a service provider was prevalent as the owner of almost one-third of all top 30 services. And fourth, many services that are commonly discussed in association with Web 2.0 and schools were noticeably missing from this list (e.g., Edmodo, PBWorks, VoiceThread, Khan Academy). Even though such services were represented in the large dataset, their relative popularity did not merit inclusion in the most popular link tables, as they generally represented a low likelihood of inclusion on school websites (~1.5% or less).

Research Question 2: Adoption Factors

Given the descriptive results provided in Table 3, we chose to conduct a chi square test for association between open or proprietary/purchased system adoption and charter school status. Phi was used to determine the strength of associations (Warner, 2012). Results indicated that charter school status was significantly associated with open system adoption, $\chi(1) = 1{,}857.33$, $p = .00$, with moderate strength, $Phi = .23$, and that charter school status was also significantly associated with proprietary/purchased adoption, $\chi(1) = 1{,}815.01$, $p = .00$, with moderate strength, $Phi = -.22$. Thus, we concluded that charter schools were moderately more likely to adopt open systems and were moderately less likely to adopt proprietary/purchased systems than were their counterparts.

Similarly, we conducted a second chi square test for association between open or proprietary/purchased system adoption and urban school status (collapsing suburban, town, and rural schools into a single non-urban category). Results indicated that urban school status was significantly associated with open system adoption, $\chi(1) = 356.36$, $p = .00$, with weak strength, $Phi = .1$, and that urban school status was also significantly associated with proprietary/purchased adoption, $\chi(1) = 459.78$, $p = .00$, with weak strength, $Phi = -.11$. Thus, we concluded that urban schools were somewhat more likely to adopt open systems and were somewhat less likely to adopt proprietary/purchased systems than were their counterparts.

Finally, we conducted a third chi square test for association between open or proprietary/purchased system adoption and Title I school status. Results indicated that Title I school status was significantly associated with open system adoption, $\chi(1) = 151.47$, $p = .00$, with weak strength, $Phi = -.06$, and that Title I school status was also significantly associated with proprietary/purchased adoption, $\chi(1) = 102.46$, $p = .00$, with weak strength, $Phi = .05$. Thus, we concluded that Title I schools were somewhat less likely to adopt open systems and were somewhat more likely to adopt proprietary/purchased systems than were their counterparts, and though these results were statistically significant, they were not practically significant (given the weak Phi values).

When links to supplemental or external services were then disaggregated according to demographic data, a few items of interest arose (cf. Table 5). First, charter schools linked more frequently to many prominent social media and app management resources like Facebook, YouTube, Instagram, iTunes, and Google Play than did their counterparts (often at almost double the rate), but charter schools also linked less frequently to file sharing and email services like Google Docs/Drive, Board Docs, Google Mail, and Microsoft Office 365. Second, city and suburban schools were more likely to link to image and video sharing services like

YouTube and Instagram. Third, Title I schools were less likely to link to some resources including Facebook, Twitter, Google Docs / Drive, and Aesop Online than were their counterparts.

Table 5

Supplemental Service Adoption and Difference From Mean Based on School Category

	Any	SNS		Image/video sharing		File sharing/email				Administrative	
		Facebook	Twitter	YouTube	Instagram	Google Docs/Drive	Google Mail	Microsoft Online	Board Docs	My School Bucks	Aesop Online
All schools	59,720	43.7%	39.7%	17.4%	7.0%	17.5%	4.8%	3.5%	2.3%	5.6%	5.6%
Primary (elementary, middle)	43,013	-0.9%	-0.5%	-0.7%	-0.4%	-0.8%	-0.2%	-0.2%	0.3%	0.4%	0.2%
Secondary (high)	10,227	1.9%	3.6%	2.0%	1.0%	4.2%	0.6%	1.1%	-0.5%	-0.5%	0.3%
Magnet	2,241	-1.1%	3.4%	2.1%	0.9%	-3.4%	-3.2%	-0.8%	-1.1%	1.0%	-1.8%
Charter	4,807	17.9%	5.3%	7.8%	5.4%	-7.9%	-2.5%	-2.2%	-2.1%	-3.7%	-4.6%
Non-magnet/ non-charter	38,564	-1.9%	-0.6%	-0.3%	-0.2%	-0.1%	-0.3%	-0.7%	0.7%	0.5%	-0.2%
City	17,605	2.6%	4.1%	4.2%	3.3%	-4.5%	-3.3%	-0.5%	-0.8%	-1.1%	7.7%
Suburb	19,313	1.5%	7.1%	2.9%	0.9%	-0.2%	-0.5%	-0.4%	1.4%	1.3%	-0.8%
Town	7,693	0.9%	-6.4%	-4.7%	-2.5%	3.6%	3.0%	0.4%	-0.2%	0.1%	2.2%
Rural	15,109	-5.5%	-10.6%	-6.2%	-3.7%	3.5%	2.9%	0.9%	-0.6%	-0.4%	2.8%
Title I	43,107	-1.2%	-1.8%	-1.0%	-0.2%	-1.1%	0.2%	0.1%	0.0%	-0.1%	-4.1%
Non-title I	14,371	2.4%	4.9%	2.3%	0.0%	3.6%	-0.3%	-0.4%	0.3%	0.5%	0.2%

Discussion

This study has revealed that K–12 institutional homepages generally take the form of purchased, proprietary systems linking to predominantly free Web 2.0 resources. Some important areas of discussion that arise from these results include (a) the undocumented and varied nature of these school websites, (b) the non-pedagogical institutional benefits of Web 2.0 for schools, and (c) adoption differences based on school demographic factors. We will now discuss each of these areas in depth.

Undocumented Nature of School Websites

First, as we proceeded with this study, it was striking to us how difficult it was to collect institutional website data across states or even to gain access to a list of website URLs. Some states provided lists of school websites on a Department of Education or other state-run source, but this was not the norm, and the few lists that were provided were typically out-of-date, incomplete, and difficult to navigate (e.g., showing only a single website URL on a page). Other school-identifying data, such as physical addresses, enrollment, Title I status, and so forth were much more readily available than were Web addresses, which suggests that public school website data seems to be of little interest to those who generally collect, report, and make policy based on school data. This is potentially alarming, because state and federal policy-makers enact policies that could be meaningfully informed by such data (including service licensing, free and open source software adoption policies, professional development opportunities, and so forth). However, at present there does not seem to be a readily available method for states to even collect their own data in this regard, let alone data beyond the state level.

This situation is likely the result of localized control over website and Internet-related decisions among US schools, as few decisions related to system adoption are made in a top-down manner or in a manner informed by what other schools are doing. Thus, principals and other local decision-makers are left to enact Web use policies with limited data and are likely susceptible to vendor-driven marketing strategies, such as purchasing systems based on sales pitches rather than comparative or diffusion data. This result underscores the need for future adoption and landscape studies in this same vein to provide an ongoing understanding of what schools and systems are adopting, so that decision-makers can have a realistic sense for the options available to them and the relative diffusion of those options among peer institutions.

Non-Pedagogical Institutional Benefits

Second, it is clear from this study that Web 2.0 tools serve important functions in K–12 schools that likely extend far outside the realms of pedagogy (e.g., Dunlap & Lowenthal, 2009; Kimmons et al., 2018; Trust et al., 2017), even though it is the pedagogical potential of these tools that is most predominant in the literature. A comparison of the top 30 supplemental Web 2.0 services listed in Table 4 shows that the types of services most commonly adopted were, in order of prevalence, (a) SNSs (42.8%); (b) administrative and office support tools (23.8%); (c) multi-purpose tools (i.e., they can be both academic or administrative) (22.1%); and (d) media sharing tools (9.7%). Of these top 30 tools, only 1.7% were tools that were strictly academic in nature. This may be a reflection of the diversity of choices in academic Web 2.0 tools and the fact that schools may adopt one tool over another even though the tools themselves do similar things. However, nuances of the data also suggest that the stakeholders and those creating school websites cater

their designs to broader educational concerns than pedagogy alone. These concerns may include community and parent outreach initiatives, administrative tasks, marketing, and data archival.

Almost half of all schools had a link to Facebook on their homepage; schools were much more likely to use a generic, popular tool like Facebook, Twitter, or Instagram than they were to use school-specific alternatives like Edmodo and Schoology. There could be a number of reasons for this, but the simplest explanation seems to be that generic tools fill a need that school-specific tools cannot, and in the case of SNSs, these needs might include community outreach and marketing.

For example, consider Facebook (a generic, public SNS) versus Edmodo (an education-specific, more private SNS). On the surface, these two SNSs appear to have much in common, as they both (a) operate by users making individual posts that appear in a news feed and can contain text, images, videos, polls, and events; (b) enable users to create profiles; (c) facilitate the creation of private groups; and (d) have similar design elements and shades of blue in their interfaces.

In many ways, Edmodo and Facebook are similar, but Edmodo is additionally engineered specifically toward meeting requirements valued by educational institutions that would seem to make it a better option for education. From a safety perspective, Edmodo's structure as a private SNS protects student data by default, whereas in Facebook, default sharing settings need to be adjusted in order to make classroom or community groups private. In this way, Edmodo seems to be better suited to protect students from Internet predation, cyber bullying, or identity theft; in addition, Edmodo does not contain ads that might present inappropriate content to students. Further, from a pedagogical perspective, Edmodo was built for education, and its course and assignment-building features enable it to additionally serve the function of a learning management system (LMS), supporting grading, attendance, and so forth. Because it has fewer features than Facebook, it also presents a simpler interface, which would presumably make it easier for teachers and students to adopt and navigate.

In light of these potential benefits, why is Edmodo adopted at such a low rate compared to Facebook? Only 1.3% of our sample adopted Edmodo while 43.7% adopted Facebook. This pattern may be partially explained by the fact that most schools that adopt a school-specific service probably also adopt a generic one (i.e., a school who adopts Edmodo is more likely to adopt Facebook [+8.8%]). However, this factor alone does not seem to merit the drastic difference in relative adoption rates of these disparate systems. A more likely explanation seems to be that schools are using these tools not for their teaching and learning benefits but for their non-pedagogical marketing, communication, and outreach functions.

Another example of this pattern is the comparison between SchoolTube, an education-focused video repository, and YouTube, a public video repository for just about everything (e.g., entertainment, news). While YouTube does have specific policies against some objectionable content, SchoolTube's policies are generally stricter, and the videos there are screened and moderated by volunteers to prevent students from gaining access to inappropriate video content. Similarly, because SchoolTube content is designed to be strictly educational, students using the platform will be less likely to receive suggestions and ads that contain objectionable material than if they were to use YouTube. For these reasons, schools and districts regularly impose bans on YouTube for their students and teachers, making services like SchoolTube a more viable video platform for teachers.

Despite these benefits, many more schools in our sample linked to YouTube (17.4%) than to SchoolTube (0.4%). This is likely due in part to the fact that YouTube is a much more effective community outreach tool than is SchoolTube, so schools that view outreach as a primary purpose of their website are more likely to link to YouTube than to SchoolTube. This may also reflect the commercial platforms' design and usability superiority compared to their education-oriented counterparts. Interestingly, however, schools that adopted SchoolTube were also 22.4% more likely to adopt YouTube than schools that did not. This is roughly twice the rate of YouTube adoption without SchoolTube, and may suggest that many schools value both technologies for different reasons or for different audiences. They may, for example, choose YouTube for their community and parent outreach initiatives and SchoolTube or similar services for more student-centered, pedagogical aims.

Another point along this vein is the fact that charter schools were 47% more likely to adopt both Facebook and YouTube than were their non-charter, non-magnet counterparts. Under our hypothesis, the most likely reason for this is that charter schools, by their nature, are more interested in recruiting students and families to their organization than are regular public schools, which might be considered the educational default for most families. Thus, charter schools are more likely to use SNSs that lend themselves to community outreach and social marketing. In all of these examples, it seems that educational benefits (i.e., benefits that affect any aspect of the educational ecosystem) of Web 2.0 are not synonymous with pedagogical benefits (i.e., benefits that only affect teaching efficacy) but that educational institutions find great value in using these tools in non-pedagogical ways. This may also be a distinction between institutional versus classroom adoption, whereas most current research focuses on the latter while ignoring the former. Ongoing research related to Web 2.0 should build on this realization to more fully consider how these improved communication and collaboration tools are becoming educationally useful in a broader sense (e.g., community outreach, archiving, marketing, scheduling, sharing). To corroborate this finding, it is noteworthy that school website content was found to be written for a standard audience across grade level or demographic differences. This suggests that school websites—and the tools they link to—are primarily intended to support the school's interactions with the public rather than interactions among teachers and students.

Demographics of Adoption

Third and finally, both differences and similarities in Web 2.0 adoption among schools across demographic groups suggest a variety of implications for practice and future research. Building on the theoretical notion of the romance of the public domain (Chander & Sunder, 2004; Kimmons, 2015b), we entered this study expecting to find that wealthier, better-resourced schools (i.e., those with more social capital) would benefit more from open source software. Generally, our results revealed this assumption to be accurate (from a statistical perspective). Title I schools, for instance, adopt open source software less, though this result was not very meaningful (from a practical perspective), because the adoption differences were not drastic. Thus, we were led to conclude that though the romance of the public domain does exist in this regard, and those with greater access to resources will technically benefit more from open resources, any differences will be relatively minor.

However, charter schools were much more likely to adopt open source software than were their non-charter counterparts, and were much less likely to adopt a proprietary/purchased system. The reason for this is

unclear, but it may be due to differences in funding (e.g., money to personnel vs. licenses), expertise of technology support personnel (e.g., corporate vs. education background), or other factors. Future research should explore this issue by interviewing charter school personnel to determine their reasons for adopting open platforms over others.

Differences in service linking also varied in the case of charter schools with their more frequent linking to SNSs and image/video sharing services than did their counterparts. The reason for this is also unclear but may stem from the increased attention charter schools may pay to marketing strategies or community outreach, both to garner student applications and to justify their existence as a respected alternative to their non-charter counterparts. Future research should explore how charter schools in particular use these Web 2.0 tools, and why their status as chartered organizations might influence this.

Some small but potentially interesting differences in adoption might also exist between schools based upon locale or wealth factors (e.g., urban vs. rural, Title I status), but most of these seem fairly intuitive. For instance, urban (+26%) and suburban (+49%) schools were more likely to link to Google Translate than were their rural peers, presumably because their students reflect a greater diversity of home languages being spoken. In any case, these subtle differences might merit additional study in future research to determine how specific Web 2.0 tools meet the contextual needs of specific types of schools.

Limitations

Our methods of data collection provided a variety of benefits over other common methods, such as contacting schools directly or conducting surveys of use, but also introduced some limitations that should be considered when interpreting results. In terms of benefits, this approach prevented errors due to self-reporting bias (e.g., saying that a school uses a technology when it does not), self-selection bias (e.g., schools not responding to requests for information), and lack of institutional self-awareness (e.g., a superintendent not knowing all of the technologies being used in a school). By using public-facing websites as the data source, we were able to exclude human sources of data errors and were able to consider technologies actually in use versus those that are thought or expected to be in use by those who would respond to a survey or questionnaire. Our methods also allowed us to collect data on all schools in the US, not just a small subset, thereby ensuring massive data coverage and scale. The major limitation of this approach, however, is that internal systems (e.g., student information systems used only for intra-institutional bookkeeping) would be excluded from analysis, though such exclusion makes sense given our emphasis on Web 2.0 tools rather than productivity and management tools. Another limitation of this approach was that we were not able to determine extent of use. So, if a school provided links to Google Docs, for instance, we could say for certain that the school used Google Docs but not how much they used them. This is a necessary limitation of other common approaches as well (e.g., self-reports would be unreliable for collecting such data) and would warrant future studies on Web traffic and usage statistics.

Conclusion

The integration of Web 2.0 into K–12 schools is an undertaking fraught with safety concerns, lack of resources, and a good deal of training and guidance necessary for its success. However, it is also an undertaking rich in its potential to (a) increase self-regulated learning; (b) foster the development of communication, collaboration, and creativity; (c) eliminate the barriers of time, space, and community that can restrict both breadth and depth of education; and (d) integrate formal and informal learning in highly productive ways. This study has provided a first step in understanding the landscape of Web 2.0 adoption across K–12 institutions in the US, including demographic factors influencing adoption and different types of systems (e.g., open vs. proprietary), and for determining how public data mining of the open Internet can be used to inform educational practice and policy. For distance education, it is necessary to understand these topics because they inform tool selection and opportunities for both formal and informal learning via Web 2.0 in K–12. In choosing whether, when, and how to adopt elements of the social Web, schools, classrooms, and leaders should carefully consider both the potential and the limitations of such adoption and also have a sense for how other schools are doing this en masse. As others build upon and supplement the methods and results of this study, we hope that decision-makers at all levels will be better informed regarding actual Web 2.0 use in schools so that their decisions will be grounded in meaningful, generalizable data.

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