UNCONNECTED

RESULTS AND RECOMMENDATIONS FROM A SURVEY OF WIFI INTERNET IN MANHATTAN PUBLIC SCHOOLS

MANHATTAN BOROUGH PRESIDENT
GALE A. BREWER

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OFFICE OF THE PRESIDENT
BOROUGH OF MANHATTAN
THE CITY OF NEW YORK

1 Centre Street, 19th floor, New York, NY 10007
(212) 669-8300 p (212) 669-4306 f

431 West 125th Street, New York, NY 10027
(212) 531-1609 p (212) 531-4615 f

www.manhattanbp.nyc.gov

Gale A. Brewer, Borough President

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Dear Friend,

Internet technology is omnipresent in our world—except, all too often, in Manhattan public schools.

Our survey of wifi internet access in scores of Manhattan public schools shows that slow, erratic, and inadequate wireless internet is commonplace.

This needs to change.

Better connectivity is only the first step. We must also equip more of our classrooms with the devices students need—whether to access one-off lectures on the web, participate in massive open online courses, or learn programming.

I hope the data reported here is the first step on that path.

Sincerely,

Gale A. Brewer

Gale A. Brewer
Manhattan Borough President

Introduction

Twenty years ago, schools were making a huge step forward merely by being connected to the internet. And today, almost every K-12 public school in the nation has some connectivity to the internet.

That's largely thanks to the federal "E-rate" program, which was established in 1996 to help schools and libraries get affordable broadband (E-Rate - Schools & Libraries USF Program).

But school connectivity is not distributed equally. Lower-income schools have a lower chance of having high-speed internet than higher-income schools. Children from low-income families also have a higher chance of being "digitally illiterate" than their wealthier counterparts (Bridging the digital divide, from the front lines, 2013; Ross, 2015).

Reducing the digital divide requires equitable internet access across entire school systems.

Today, schools need high-speed internet access to stream videos for lessons and use web-based applications. And high-speed internet access is vital not only for educational purposes, but also to allow students the opportunity to understand technology and prepare for jobs that demand it. New York City public school students need access to high-speed wireless internet to compete with their peers regionally, nationally, and globally.

According to the New York State Comptroller, New York had the third-largest tech employment of any state in 2016, and employment in the sector grew 57% between 2010 and 2016 (three times faster than the rest of the private sector). Total wages in the sector also doubled during that period—raising the estimated average salary to $147,300 (DiNapoli & Bleiwas, 2017). Nearly half of those job gains were rooted in companies engaged in internet-related activities, whether they themselves were tech companies or not (DiNapoli & Bleiwas, 2017).

To learn more about the status of wireless internet access in schools, my office surveyed wireless internet speeds at multi-school campuses (known as "co-located" campuses) across Manhattan. Our findings and recommendations for improvement are summarized in this report.

Methods

In spring of 2018, we collaborated with 79 schools from a pool of 28 randomly selected co-located school campuses in Manhattan to collect data at specific points throughout the school day, which allowed us to construct a data-based understanding of the wireless connections that our students and teachers rely on.

Recognizing the fickle nature of wireless connections and the sensitivity of wireless networks to user numbers, we anticipated increasingly slower download speeds as the school day progressed and the number of users on the network increased.

Using a random sample of co-located schools, we controlled for geographic district to ensure that all six of Manhattan's school districts were represented.

We measured download speed at three points during the school day at each of the schools in the sample. Download speed is the measure of data in megabits per second from server to device.

Understanding that wireless internet speeds fluctuate with the number of users on the connection, as well as the strength of the signal and responsiveness of the server, we took measurements throughout the school day in order to capture an approximation of real-world use at each school.

Measurement #1: Taken 20 minutes before the school day began for students;
Measurement #2: Taken 20 minutes into the first class period; and
Measurement #3: Taken 20 minutes into the third class period.

Network use is low before classes start, so Measurement #1 provided our baseline for data. We anticipated that speeds and connectivity would slow as more users accessed the network.

All measurements were taken with the free *speedtest.net* application on smartphones and the local *speedtest.net* server was used at all sites. A server is a computer that "serves" information to other computers, or "clients." The use of localized servers increases the accuracy of captured data.

The measurements were taken in the hallway or main office of each school unless the school's classrooms were located on a different floor; in that case, the measurement was taken in the hallway outside of the school's classrooms.

Limitations. All three measurements were collected from 72 of the 79 schools, but researchers were unable to collect measurement #1 at seven schools. On 12 of the 28 campuses, different schools relied on different networks for their wireless connection. Even though all schools appeared to have access to the Department of Education's newest

wireless network, NCPSP, 12 campuses housed schools which were using older networks that were in the process of being phased out. We often found that these older networks had a stronger signal and more reliable connectivity than the NCPSP network. For this study, we used the network preferred by most staff and students.

Results

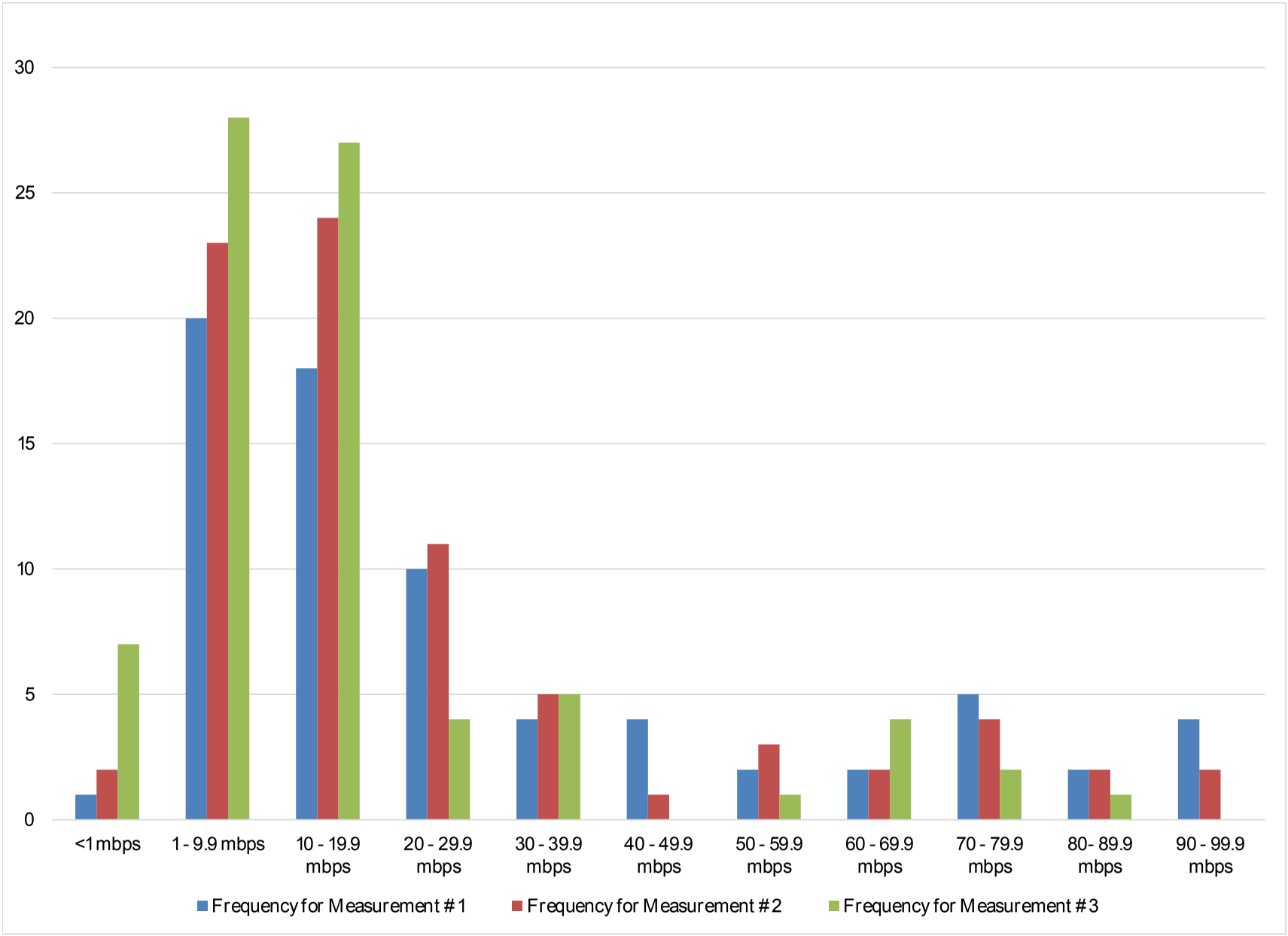
As we suspected, download speeds decreased as the school day progressed. Figure 1 (see page 6) shows the distribution for download speeds across all schools in the sample. For the first measurement, the average download speed of the sample was 28.726 mbps. Thirty-nine schools had wireless connections with download speeds under 20 mbps and 21 schools had download speeds under 10 mbps. Notably, one school had a download speed slower than 1 mbps. The remaining schools had download speeds exceeding 20 mbps. One school had a download speed between 90 and 99.9 mbps (see Table 1). For context, streaming HD videos requires at least 5 mbps, while sharing cloud-based documents requires speeds of at least 50 mbps.

When we got to the second measurement, while classes were underway, the average download speed of the sample decreased by approximately 4 mbps to 24.346. Ten more schools had their download speeds dip below 20 mbps (see Figure 1). The number of schools with download speeds under 10 mbps increased from 21 to 25 and two schools had speeds under 1 mbps. The remaining schools had speeds over 20 mbps. Two schools had wireless connections with a download speed between 90 and 99.9 mbps and no schools achieved a speed over 99.9 mbps. (see Table 1).

For the third measurement, the average download speed of the sample was 17.178 mbps and an even greater number of schools within the <1 mbps to 20 mbps range (see Figure 1). Thirty-five schools had a download speed under 10 mbps and 7 schools had a download speed under 1 mbps. Just 17 schools in the sample had download speeds over 20 mbps. One school had a download speed between 80 and 89.9 mbps (see Table 1).

Co-located campuses. The data suggests that wide gaps exist between the average internet speeds of schools on co-located campuses. Eighteen of the 28 campuses in the sample had a difference of at least 5 mbps between schools with the fastest and schools with the slowest download speeds (see Table 2). Five campuses had a download speed difference greater than 28 mbps, while only ten campuses had a download speed difference under 5 mbps. Campus AA had the smallest download speed difference between schools at just 0.08 mbps. Campus K had the greatest download speed difference between schools at 69.30 mbps.

Figure 1 *Frequency distribution of download speeds for all schools in sample*



Note. Frequency is the number of schools with download speeds in the mbps range listed on the x-axis. Mbps ranges with fewer than 3 columns of data represent a frequency of zero for excluded measurements.

Table 1 ***Maximum and minimum internet speed averages for all campuses in sample.***
School names and locations are not included as several schools requested anonymity.

Campus	Maximum Average Download Speed (mbps)	Minimum Average Download Speed (mbps)	Difference (mbps)
A	15.30	11.47	3.83
B	43.03	16.70	26.33
C	22.70	20.30	2.40
*D	20.10	17.95	2.15
E	69.20	16.80	52.40
F	60.02	11.20	48.82
G	16.03	11.59	4.44
H	53.46	38.23	15.23
I	4.81	1.19	3.62
J	64.33	7.14	57.19
K	88.95	19.65	69.30
*L	12.80	5.51	7.29
M	73.40	57.56	15.84
N	44.10	32.36	11.74
O	9.27	3.36	5.91
P	18.43	5.54	12.89
Q	40.76	27.43	13.33
R	13.36	5.94	7.42
S	13.25	11.96	1.29
T	11.43	2.52	8.91
U	21.73	12.95	8.78
V	16.46	13.97	2.49
W	87.97	20.58	67.39
X	19.53	12.37	7.16
*Y	34.65	25.3	9.35
Z	34.76	32.63	2.13
AA	2.63	2.55	0.08
BB	49.60	47.86	1.74

Note. Maximum school average download speed values are determined by averaging all three measurements for the school with the fastest connection on a campus. Minimum school average download speed values are determined by averaging all three measurements for the school with the slowest connection on a campus. Values in the difference column are determined by calculating the difference between the max average and min average for each campus. Campuses that were not measured 20 minutes before the first class period have an asterisk.

Table 2 ***Complete listing of all measurements for all schools in the sample.***
School names and locations are not included as several schools requested anonymity.

Campus	School	Student Population	Measurement #1: download speed (mbps)	Measurement #2: download speed (mbps)	Measurement #3: download speed (mbps)
A	A3	315	4.62	15.3	14.5
A	A2	318	9.76	14.5	12.4
A	A1	408	12.8	17.9	15.3
AA	AA2	229	3	1.5	3.4
AA	AA1	586	5	1	1.65
B	B2	241	21.2	17	11.8
B	B1	203	60.2	56.7	12.2
BB	BB2	376	47	77.2	24.6
BB	BB3	201	74.8	33.5	35.5
BB	BB1	267	75.2	32	36.4
C	C2	203	24.6	31.5	12
C	C1	171	28.5	25.7	6.67
D	D2	355	N/A	18	19.4
D	D1	245	N/A	18.8	17.1
D	D3	373	N/A	19.1	21.1
E	E1	340	79.5	76.4	16.8
E	E2	200	91.2	38.9	69.2
F	F3	554	17.5	12.9	3.2
F	F4	498	28.4	17.7	7.8
F	F1	827	90.5	81.81	7.75
F	F2	408	90.5	81.81	7.75
G	G2	329	12.1	18.4	17.6
G	G3	427	17.7	17.4	9.67
G	G4	396	19	9.82	5.95
G	G1	307	19.5	11	14.5
H	H2	283	51.3	54.7	8.7
H	H1	433	70.2	74.5	15.7
I	I5	476	0.83	1.04	1.99
I	I1	258	1.02	0.97	1.81
I	I4	586	1.43	2.33	2.5
I	I2	423	1.51	1.32	0.74

Campus	School	Student Population	Measurement #1: download speed (mbps)	Measurement #2: download speed (mbps)	Measurement #3: download speed (mbps)
I	I6	235	2.93	0.61	1.81
I	I3	348	11.9	1.13	1.41
J	J2	494	3.95	9.29	8.18
J	J1	232	8.75	6.49	9.2
J	J3	385	59.19	67.97	65.83
K	K2	174	20.5	20.13	18.33
K	K1	627	95.32	91.73	79.81
L	L2	463	5.95	8.4	2.18
L	L3	391	N/A	6.89	5.28
L	L1	492	N/A	12.1	13.5
M	M2	565	71.2	28.1	73.4
M	M1	366	89.2	69.6	63.1
N	N2	430	40.2	45.3	11.6
N	N1	457	47.7	70.4	14.2
O	O2	391	6.66	5.7	1.35
O	O1	378	8.29	1.65	0.16
O	O5	517	9.61	1.55	0.56
O	O3	356	12.1	1.89	0.57
O	O4	382	16	11.2	0.62
P	P1	197	9.37	2.28	4.99
P	P2	197	16.8	17.8	20.7
Q	Q1	383	34.7	18.7	68.9
Q	Q2	436	48.5	21.8	12
Q	Q3	537	61.3	25.3	33.2
R	R5	160	4.88	13.1	13.3
R	R4	478	7.67	4.37	5.78
R	R1	320	10	3.41	13.42
R	R3	337	11.9	27.2	0.98
R	R2	446	30.7	1.78	0.83
S	S1	318	8.77	18	9.13
S	S2	386	10.1	9.57	20.1
T	T2	1447	3.88	28.6	1.83
T	T1	614	4.34	1.85	1.37

Campus	School	Student Population	Measurement #1: download speed (mbps)	Measurement #2: download speed (mbps)	Measurement #3: download speed (mbps)
U	U1	269	15.76	18.1	5
U	U2	317	22.6	19.7	1.6
U	U3	255	25.4	28.2	11.6
V	V1	400	13.91	20.6	12
V	V2	619	15.76	19.44	14.2
V	V3	198	17.32	18.45	6.16
W	W2	354	21.4	22.9	17.44
W	W1	278	83.7	90.4	89.83
X	X2	223	18.3	21	19.3
X	X3	753	20.3	3.41	13.42
X	X1	138	21.8	6.73	11.7
Y	Y1	203	N/A	13.6	37
Y	Y2	275	N/A	18.9	50.4
Z	Z1	1625	30.4	30.2	37.3
Z	Z2	192	30.4	57.1	16.8

Discussion

To contextualize the results from this study, we compared our findings with standards set by the State Educational Technology Directors Association (SETDA) and the Federal Communications Commission (FCC).

SETDA is a nonprofit representing U.S. state and territorial educational technology leadership, which advocates for improvements in connectivity (Roscorla, 2016). In 2012, SETDA released a broadband-imperative report with short- and long-term high-speed internet goals for schools. They recommended schools reach a bandwidth allocation of at least 100 mbps per 1,000 users by 2014 and at least 1 gbps per 1,000 users by 2017 (Fox et al., 2012; Roscorla, 2016). SETDA then updated its recommendations in 2016, suggesting that large school districts (more than 10,000 students) provide at least 2 gbps per 1,000 students by 2020 (Fox & Jones, 2016).

The New York City school system is still struggling to meet the 2014 SETDA goal. During a City Council hearing in early 2018, NYCDOE Chief Information Officer Peter Quinn, said that New York City schools will meet the 100 mbps/1,000 student goal by June of 2019. Given the results of our data collection and the underwhelming wireless connection

goals set by NYCDOE, it is clear that New York City schools are far from meeting 21st century standards for connectivity.

Streaming HD videos requires at least 5 mbps, while sharing cloud-based documents requires speeds of at least 50 mbps. By the time of our third measurement, 21 schools in the sample had speeds too slow to stream HD videos and only 8 schools had speeds high enough to take advantage of modern cloud-based technologies like Google Apps (see Figure 1).

The speeds we recorded are even more problematic in comparison to the user experience at home. In 2015, the FCC defined a high-speed internet connection for households as 25 mbps. Sixty-nine percent of homes in New York City have high-speed internet and home broadband in New York State typically hits that speed, so students who have high-speed internet at home can see the noticeable difference at school (Brodkin, 2018).

Recommendations

Schools in Manhattan require drastic improvements to their wireless networks to provide a 21st-century education. We recommend the following steps to reduce the disparities between schools and raise their digital capacity to a modern standard.

The City of New York should...

■ ***Ensure all schools meet the SETDA and FCC standards for high-speed internet in schools.*** The goal of 100 mbps per 1,000 students is already outdated. The Department of Education, Department of Information Technology and Telecommunications, and the Mayor's office should immediately invest in making sure that all schools have the recommended bandwidth of 2 gbps per 1,000 users. All students and school personnel on a campus should have access to their wireless network at speeds that allow for full utilization of web-based technologies.

■ ***Implement a progressive bandwidth allocation system that ties allocations to improvements in web-based technologies.*** The standards set by SETDA and the FCC for high-speed internet will soon be outdated. As web-based educational tools improve in quality and substance, the need for more bandwidth increases (i.e. watching or downloading a 4K video requires more bandwidth than a 1080p video). New York City should move beyond providing the minimum allocations for schools and become a leader in providing the highest speeds and most-equitable internet access in the country.

■ ***Incorporate goals for NYC schools into the OneNYC Vision 1 Goal for Broadband.*** OneNYC is an effort to address New York City's long-term challenges: growing population, global warming, aging infrastructure, and changes in the economy. With those goals in mind, the OneNYC plan recognizes the internet is a "prerequisite for full

participation in the city's economic and civic life" and offers LinkNYC kiosks as an innovative way to help close the digital divide (The Plan for a Strong and Just City). Those kiosks provide free wi-fi to those in range; however, young people spend much of their time in schools where LinkNYC is unavailable. The OneNYC plan should leverage interagency collaboration to create ambitious and achievable goals for upgrading the school system's wireless network so that the digital divide is closed where more than 1 million New Yorkers go everyday—schools.

■ ***Facilitate easier access to internet-based education programs by allowing schools to purchase Google Chromebooks and Apple iPads with capital funds.*** Smartphones are all around us, but laptops and tablets make far better instructional tools. A growing educational technology industry is designing classroom tools specifically for computers and tablets. Our schools need to be able to take advantage of the latest, most innovative tools for web-based, digital learning, but right now capital funds can't be used to buy tablets and Chromebooks.

■ ***Provide comprehensive, ongoing training for teachers and administrators.*** Equitable access to high-speed internet is only a first step in closing the digital divide. Teachers and administrators will also need enhanced training to provide the latest digital tools to their students and incorporate web-based learning platforms into their pedagogy.

References

Asimov, N. (2015, January 19). Evan Marwell: Visionary brings Internet access to schools. SF Gate. Retrieved from www.sfgate.com/visionsf/article/Evan-Marwell-Visionary-brings-Internet-access-to-6024299.php

Bleiberg, J. (2016, July 15). Are school internet connections fast enough to support personalized learning? Brookings. Retrieved from www.brookings.edu/blog/brown-center-chalkboard/2016/06/15/are-school-internet-connections-fast-enough-to-support-personalized-learning/

Bode, K. (2018, January 23). More Than 750 American Communities Have Built Their Own Internet Networks. Motherboard Vice. Retrieved from motherboard.vice.com/en_us/article/a3np4a/new-municipal-broadband-map

Bridging the digital divide, from the front lines. (2013, November 13). Retrieved from www.washingtonpost.com/postlive/bridging-the-digital-divide-from-the-front-lines/2013/11/12/95c14966-4b28-11e3-be6b-d3d28122e6d4_story.html?utm_term=.2cfa773304a8

Brodkin, J. (2018, April 20). NYC blasts broadband competition shortage as it pursues suit against Verizon. Retrieved from https://arstechnica.com/information-technology/2018/04/nyc-blasts-broadband-competition-shortage-as-it-pursues-suit-against-verizon/?comments=1&post=35197779

Brownstone, S. (2013, August 26). New York City Has An Internet Inequality Problem. FastCompany. Retrieved from www.fastcompany.com/3016264/new-york-city-has-an-internet-inequality-problem

Brunner, H. (2013, January 29). Equal Internet Access Is a K-12 Must-Have. Edweek. Retrieved from www.edweek.org/ew/articles/2013/01/30/19brunner.h32.html

Burns, M. (2014, November 10). The Bandwidth Schools Have and the Bandwidth They Need. eLearning Industry. Retrieved from: elearningindustry.com/bandwidth-schools-bandwidth-need

Camera, L. (2017, September 19). Federal E-Rate Program Dramatically Expands High-Speed Internet Access for Schools. US News. Retrieved from: www.usnews.com/news/education-news/articles/2017-09-19/federal-e-rate-program-dramatically-expands-high-speed-internet-access-for-schools

City Council Hearing Transcript. March 26, 2018. New York City Council Budget and

Oversight Hearings on The Fiscal Year 2019 Preliminary Budget, The Preliminary Capital Plan for Fiscal Years 2019-2022 and The Fiscal 2018 Preliminary Mayor's Management Report 10:00 a.m. School Construction Authority and Department of Education (Capital) 12:00 p.m. Public. Retrieved from: https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3458029&GUID=2507203F-F7A5-4A4B-811C-B58F976CCF8C&Options=&Search=

Cohen, P., Livingston, J., & Quartz. (2013, November 13). More Than Half of U.S. Public Schools Don't Have Adequate Wireless Access. The Atlantic. Retrieved from: www.theatlantic.com/education/archive/2013/11/more-than-half-of-us-public-schools-dont-have-adequate-wireless-access/281410/

Dilley, J. (2018, March 28). How Much Should I Be Paying for High-Speed Internet? Retrieved from: www.highspeedinternet.com/resources/how-much-should-i-be-paying-for-high-speed-internet-resource

DiNapoli, T.P., & Bleiwas, K. B. (2017, September). The technology sector in New York City. Office of the New York State Comptroller. Retrieved from: www.osc.state.ny.us/osdc/rpt4-2018.pdf

Dotterer, A. (2017, January 19). Wyoming labeled as a leader in providing internet to schools. The Casper Star Tribune. Retrieved from: trib.com/news/local/education/wyoming-labeled-as-a-leader-in-providing-internet-to-schools/article_d9dc1b5f-107e-511a-b4d9-c577501ff677.html

Douglas, T. (2017, December 21). New York City Broadband RFI Generates Strong Response. GovTech. Retrieved June 1, 2018, from www.govtech.com/network/New-York-City-Broadband-RFI-Generates-Strong-Response.html

EducationSuperHighway. (n.d.). Retrieved from www.educationsuperhighway.org/

E-Rate - Schools & Libraries USF Program. (2018, May 31). Retrieved from https://www.fcc.gov/general/e-rate-schools-libraries-usf-program

Faster Internet: FCC Sets New Definition for Broadband Speeds. (n.d.). Retrieved from www.nbcnews.com/tech/internet/faster-internet-fcc-sets-new-definition-broadband-speeds-n296276

Find Internet Providers in NYC. (n.d.). Retrieved from: www.allconnect.com/ny/new-york-city-internet

Fox, C., Jones, R. (2016). The Broadband Imperative II: Equitable Access for Learning. Washington, DC: State Educational Technology Directors Association (SETDA). Retrieved from: http://www.setda.org/wp-content/uploads/2016/09/SETDA-Broadband-ImperativeII-Full-Document-Sept-8-2016.pdf

Fox, C., Waters, J., Fletcher, G., & Levin D. (2012). The Broadband Imperative Recommendations to Address k-12 Education Infrastructure Needs. Washington, DC: State Educational Technology Directors Association (SETDA). Retrieved from http://www.setda.org/wp-content/uploads/2013/09/SETDA_BroadbandImperative_May20Final.pdf

Gomes, L. (2012, September 25). Solving the Problem of School Bandwidth. Stanford Graduate School of Business. Retrieved

from: www.gsb.stanford.edu/insights/solving-problem-school-bandwidth

Governor Cuomo Announces Round III of Nation-Leading New NY Broadband Program to Bring High-Speed Internet Access to All New Yorkers. (2018, February 15). Retrieved from: www.governor.ny.gov/news/governor-cuomo-announces-round-iii-nation-leading-new-ny-broadband-program-bring-high-speed

Hawaii DOE | Hawaii ranked No. 1 in nation in school Internet connectivity. (2017, February 15). Retrieved from: www.hawaiipublicschools.org/ConnectWithUs/MediaRoom/PressReleases/Pages/Hawaii-Schools-Internet-Connectivity.aspx

Hazlett, T. (2016, August 23). Obama's misguided plan to connect schools to the Internet. Retrieved from: www.politico.com/agenda/story/2016/08/stop-spending-money-connecting-schools-to-the-internet-000191

Herold, B. (2017, September 19). Analysis: 94 Percent of School Districts Nationwide Meet Federal High-Speed Internet Access Targets. Government Technology. Retrieved from: www.govtech.com/network/Analysis-94-Percent-of-School-Districts-Nationwide-Meet-Federal-High-Speed-Internet-Access-Targets.html

How much internet speed do I need? (n.d.). Retrieved from: www.highspeedinternet.com/how-much-internet-speed-do-i-need

Johnson, S. (2017, January 17). 34.9M US Students-88 Percent of School Districts-Now Connected Online. EdSurge News. Retrieved from: www.edsurge.com/news/2017-01-17-34-9-million-us-students-up-10-4-million-since-2015-now-connected-online

Landa, M. (2017, May 21) Audit Report on the Department of Education's Implementation of High Speed Internet Connectivity in New York City Public Middle Schools. Retrieved from: comptroller.nyc.gov/reports/audit-report-on-the-department-of-educations-implementation-of-high-speed-internet-connectivity-in-new-york-city-public-middle-schools/

Layton, L. (2013, November 13). Most U.S. schools not up to broadband speed. Washington Post. Retrieved from: www.washingtonpost.com/local/education/most-us-schools-not-up-to-broadband-speed/2013/11/12/5941b504-4658-11e3-a196-3544a03c2351_story.html

McAuliffe, K. (2017, June 23). The false promise of 'municipal broadband' networks. The Hill. Retrieved from: thehill.com/blogs/pundits-blog/technology/339232-the-false-promise-of-municipal-broadband-networks

Moynihan, E., & Blau, R. (2017, May 21). NYC Education Dept. can't account for how $347M was spent on internet upgrades, controller says. NY Daily News. Retrieved May 31, 2018, from National Broadband Map. (n.d.). Retrieved from www.broadbandmap.gov/

National Education Association. E-Rate Program. (n.d.). Retrieved from http://www.nea.org/home/16338.htm

Roscorla, T. (2016, September 09). 4 Broadband Recommendations for Education Technology Leaders. Retrieved from http://www.govtech.com/education/k-12/4-Broadband-Recommendations-for-Education-Technology-Leaders.html

Ross, T. F. (2015, March 13). When Students Can't Go Online. The Atlantic. Retrieved from: www.theatlantic.com/education/archive/2015/03/the-schools-where-kids-cant-go-online/387589/

Scott, D. (2012, May 21). K-12 Education's Broadband Internet Needs Continue to Grow. Governing. Retrieved from: www.governing.com/blogs/view/gov-k-12-educations-broadband-internet-needs-continue-to-grow.html

Sisson, P. (2017, December 27). In wake of net neutrality decision, should cities build internet networks? Curbed. Retrieved from: www.curbed.com/2017/12/27/16822140/internet-broadband-net-neutrality-high-speed-access

Staff. (2017, May 24). Slow Internet Speeds Still a Problem at NYC Public Middle Schools, Audit Finds. The Journal. Retrieved from: thejournal.com/articles/2017/05/24/slow-internet-speeds-still-a-problem-at-nyc-public-middle-schools-audit-finds.aspx

Thompson, G. (2014, March 27). Bandwidth for All. The Journal. Retrieved from https://thejournal.com/Articles/2014/03/27/Bandwidth-for-All.aspx?Page=1

The Plan for a Strong and Just City. (n.d.). Retrieved from onenyc.cityofnewyork.us/goals/broadband/

Wagenen, J. V. (2017, March 20). Getting Up to Speed: States, Schools Partner to Roll Out Increased Broadband. EdTech Magazine. Retrieved from: edtechmagazine.com/k12/article/2017/03/getting-speed-states-schools-partner-roll-out-increased-broadband

Willcox, J. K. (2017, June 20). Are City-Owned Municipal Broadband Networks Better? Consumer Reports. Retrieved from: www.consumerreports.org/municipal-broadband/are-city-owned-municipal-broadband-networks-better/

Yi, H. (2015, April 26). This is how Internet speed and price in the U.S. compares to the rest of the world. PBS.org. Retrieved from: https://www.pbs.org/newshour/world/internet-u-s-compare-globally-hint-slower-expensive

Zimmer, A. (2017, October 01). 30K High School Students Get Free Wireless Devices to Fill 'Homework Gap'. DNAInfo. Retrieved from: www.dnainfo.com/new-york/20170929/lower-east-side/nyc-community-schools-sprint-1-million-project/

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Gale A. Brewer

MANHATTAN BOROUGH PRESIDENT

1 Centre Street, 19th Floor South
New York, NY 10007
(212) 669-8300

431 West 125th Street
New York, NY 10027
(212) 531-1609

www.manhattanbp.nyc.gov

galeabrewer

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