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Examining Technologies Used in K-12 School Districts: A Proposed Framework for Classifying Educational Technologies

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Abstract

K-12 schools utilize a growing number of technologies to operate effectively, ranging from technologies for learning to technologies that manage student and personnel data. We share findings from an analysis of 23 school district websites for technologies used in a number of K-12 school districts surrounding a public, research university in a southeast region of the United States. In addition, we also share findings on technologies used in K-12 school districts from interviews with 12 technology directors. We propose a technology classification framework including educational technologies, management technologies, support technologies, networking technologies, and security technologies in addition to identifying various technologies that are currently used by school districts based on this framework. This framework has implications for K-12 technology adoption and clarifying the roles of school technology personnel.

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As one walks through the exhibit floor of most large educational technology conferences—like the International Society of Technology in Education—a person can quickly become overwhelmed with the myriad of technologies and applications marketed for K-12 schools. The exhibit floor is packed wall to wall with the promises of game-changing and revolutionizing educational technologies. The National Educational Technology Plan (U.S. Department of Education, 2017) posits that one of the goals of educational technology in schools is to connect educators and students with "data, content, resources, expertise, and learning experiences to empower and provide more effective teaching for all learners" (p. 28). The National Educational Technology Plan has many worthwhile goals like the aforementioned one, but how are educators supported and equipped to choose from the almost infinite number of educational technologies available? In this paper, we argue that there needs to be a framework for organizing the types of education technologies in order to categorize the ways to use those technologies. Additionally, not only is there a need for indexing educational technology but also such an educational framework needs to include the applications for securing educational technologies. Indeed, there is a lack of knowledge about cybersecurity-related educational technology in K-12 schools (Rahman, et al., 2020). The inclusion of cybersecurity-related educational technology is a provision for safe, secure, and effective teaching with technology. A more inclusive educational technology framework helps reflect the changing role of technology in education and the range of technology expertise needed to support K-12 schools.

We organize this paper into four sections. First, we examine and review the literature related to educational technology uses, frameworks for supporting instruction in K-12 schools, and the role of school technology support staff. Next, we describe the research design and methodology of our study. Third, we report on the findings to our study's research questions. Last, we discuss the categorization framework that emerged from the findings of our research to support educators in classifying and securing their educational technology and school data in the classroom and school building and discuss implications for K-12 districts.

Literature Review

K-12 education spends a significant amount of capital on a range of educational technologies to create meaningful teaching and learning opportunities (Altavilla, 2020). Investment in educational applications in K-12 schools continues to increase as technology is viewed as a means to support student-centered learning and promote growth on standardized tests (Ross, 2020). Additionally, schools rapidly adopted new

technologies to help support emergency remote teaching at the onset of the COVID-19 pandemic (Hodges et al., 2020). A range of technologies is included under the umbrella of *educational technologies*, including digital learning games, virtual reality systems, robotics, and massive online open courses and simulations (Baker, 2021). Much of the existing research on technologies used in K-12 schools focuses on instructional technology and related learning outcomes (Martin et al., 2021). Yet as a growing number of computer science experts identify increasing cybersecurity risks in K-12 schools (Chang, 2017; Levin, 2019; Whitney, 2021), more attention needs to be directed at network and security technologies, as well. With such a range of technologies working together, there is a need to organize and synthesize educational technologies into a framework that can be used to better understand the technologies used in K-12 schools. Additionally, this range in educational technology creates a need to reevaluate the roles of technology support staff in schools as teams now require a wider range of specialized skills.

Technology Frameworks in K-12 Education

There are a number of technology frameworks used within K-12 education. The SABER ICT framework (Trucano, 2016) is designed to support education policymakers to make decisions about how to use information and communication technology (ICT). The PISA ICT framework focuses on access and use of technology and related learning outcomes (OECD, 2019). The widely used TPACK framework (Mishra, 2019) represents the kinds of teacher knowledge necessary for the successful integration of technology into instructional practice. Based on latent analysis of technology-using teachers across the United States, Graves and Bowers (2018) developed four categories to identify technology-using teacher typologies: dextrous, evaders, assessors, and presenters. The T3 framework (Magana, 2020) outlines the stages of educational technology use from translational to transcendent to help facilitate educators' self-reflection about their use of technology and guide teachers toward higher levels of mastery with technology. However, there is still a need for a classification of the various technologies used in K-12 school districts and continuous examination of the various technologies used in schools for each of these categories. Based on the findings from this study, we propose a technology classification framework that can be used to better understand the technologies currently used in K-12 schools.

Data Management in Schools

With increased technology, the use in K-12 schools also comes a wealth of data that is collected and stored about each of the system's users, including students. Although there are some concerns about data privacy associated with the wealth of data collected by educational technology (Schlosser et al., 2022), when harnessed appropriately, data analytics can provide students, educators, and parents with a wealth of useful

information (Baker, 2021; Bowers, 2021; Nyland, 2018). Data processing methods can provide teachers and students with valuable formative assessment data based on student activity and performance that can guide future instruction (Nyland, 2018). According to Bowers (2021), data analytics can identify patterns in student data to provide early warning predictors of students' risk of dropping out of school. A better understanding of the technologies used by school districts can support district leaders in adopting practices to manage and secure data while also harnessing the potential of data analytics to inform instructional and administrative practice.

Technology Support Staff and Their Roles

K-12 school districts in most states have technology support personnel to support teachers and students. In this study, we interviewed district technology leaders with various role titles, including technology director and chief technology officer (CTO). In most cases, these technology leaders collaborated with a team of other technology support staff including school-level instructional technology facilitators (ITFs). Technology directors, ITFs, and other technology personnel are responsible for supporting the various technologies used in K-12 schools, though these roles can vary greatly from district to district (Haines, 2018) and often call on a single staff member to serve a variety of roles (Karlin et al., 2018; Murphy et al., 2018; Zhong & Wang, 2019).

Although some standardization exists within certification programs for ITFs, there is a lack of standardization for other technology personnel (Adams, 2015). Murphy and colleagues (2018) identified eight role categories of educational technology professionals including teaching/training, instructional support, technological, administrative communication, administrative coordination, planning, professional development, and public relations. Although not every education technology professional is meant to fill all eight role categories, this categorization highlights the range of technology support needed within education. Even when K-12 technology leaders' roles are more clearly defined, such as with ITFs and technology coaches, these leaders struggle to implement their roles based on users' needs in a sustainable manner (Karlin et al., 2018). The technology classification framework we propose in this paper can help better represent the various technology needs in K-12 schools to help better define the roles of technology professionals.

Purpose of the Study and Research Questions

The purpose of this study is to identify the various technologies that are commonly used by K-12 school districts in an effort to develop a comprehensive framework to organize the different technology categories. Based on the findings, this study proposes a school technology classification (STC) framework including educational technologies, management technologies, support technologies, networking technologies, and

security technologies. Additionally, the STC framework helps to provide a comprehensive representation of the range of technologies used in K-12 schools to support the changing role of educational technology personnel at both the district and school levels. The following research questions are answered in this study:

1. What technologies are commonly used in K-12 schools?
2. What are the various categories of technologies used by school districts?

Methods

This research study was conducted in five phases. Data collection occurred during the first three phases through district website analysis and qualitative interviews with district technology directors. In the final two phases, data collected from website analysis and interviews was analyzed and categorized into a framework based on technology type.

Phase I. Identification of School Districts. School districts from a southeastern state in the United States were used in this study for technology analysis. In order to capture data from various sized districts, school districts were grouped into six categories based on student enrollment numbers: 1) less than 2,000 students, 2) 2,000–5,000 students, 3) 5,000–10,000 students, 4) 11,000–30,000 students, 5) 30,000–75,000 students, and 6) above 75,000 students. Out of 100 school districts in this southeastern state, 23 school districts were identified for analysis representing all six enrollment categories described above. Charter schools and other independent districts were not included in this portion of the data collection. Table 1 identifies the approximate size of each school district based on student enrollment during the 2019–2020 school years. The annual school technology fund for each school district is also included, when available.

Phase II. Identification of Websites and List of Technologies. Beginning in Spring 2022, district websites for each of the 23 districts selected in Phase I were identified and examined for various technologies used across the district. A list of technologies was compiled in a document prior to classification. The a priori list of technologies used for data extraction included seven categories: student information system (SIS), communication tools, learning management systems, instructional tools, assessment tools, synchronous technologies, and mobile applications. These categories were identified through relevant literature (McKnight et al., 2016; Vega & Robb, 2019) and sample analysis of seven school district websites previously conducted by members of the team. Identified technologies ranged from learning applications for student use to technologies used by faculty for administrative purposes. Overall, website analysis served as the primary source of data to answer the first research question.

Phase III. Interviews with Technology Directors. As part of the needs assessment, technology directors from across the state, including those working in charter schools, were invited to participate in one-on-one, qualitative interviews related to technology use and security practices in their district. A total of 12 district technology administrators were interviewed via Zoom. Table 2 provides some background information about

Table 1. School Districts: Website Analysis.

District	Student enrollment size (2019–2020)	Annual School Technology Fund (2019–2020)
A	>100,000	4,326,325
B	>100,000	1,452,362
C	30,000–75,000	402,857
D	30,000–75,000	449,754
E	30,000–75,000	379,044
F	30,000–75,000	1,925,003
G	30,000–75,000	778,581
H	30,000–75,000	769,325
I	30,000–75,000	252,240
J	11,000–29,999	142,054
K	11,000–29,999	522,156
L	11,000–29,999	491,612
M	5,000–10,999	169,619
N	5,000–10,999	65,619
O	5,000–10,999	64,045
P	5,000–10,999	109,151
Q	5,000–10,999	257,491
R	2,000–4,999	114,010
S	2,000–4,999	70,229
T	2,000–4,999	18,300
U	2,000–4,999	61,179
V	<2,000	15,814
W	<2,000	Not reported

each participant and the district or charter they serve. Each interview lasted approximately 30 min. Although phase II data collection helped us identify *which* technologies are used in K-12 school districts, interviews helped clarify *how* these technologies are used to help refine the categorization in the proposed framework. A basic qualitative design (Merriam, 1998) was used for this portion of the study in order to describe, interpret, and understand the types of technologies used in K-12 schools in a categorical manner. The semistructured interview protocol developed for these interviews is provided in Appendix A. It should be noted that this protocol was designed to address other needs beyond the purpose of this study alone. Interview questions that yielded data most pertinent to this study are included in bold text. Interview transcriptions were coded by two members of the research team. Descriptive coding (Saldaña, 2016) was used to identify technologies used, including both hardware and software. Identified technologies were initially coded using the same a priori codes listed in Phase II with additional codes added for hardware, single sign-on (SSO) systems, social media, file management technologies, and security technologies. Participants'

Table 2. Technology Administrators Interview Participants.

Participant identifier	Job title	District/ Charter	Size of district/charter (based on enrollment)	Years in education	Years in current role
A	Chief Information Officer	K-12 school district	Medium-large (over 12,000)	28	8
B	Information Technology Director	9-12 charter school	Small (approx. 400 students)	<1	<1
C	Director of Technology	K-12 school district	Large (approx. 19,000)	>30	5
D	Technology Director	K-12 school district	Small (approx. 1600)	16	6
E	Chief Technology Officer	K-12 school district	Medium-large (about 16,000)	22	7
F	Chief Technology Officer	K-12 school district	Large (over 30,000)	20	3
G	Chief Technology Officer	K-12 school district	Small (less than 3,000)	28	3
H	Technology Facilitator	K-12 school district	Large (over 50,000)	8	2
I	Director of Technology	K-8 Charter school	(approx 400 students)	8	4
J	Director of Technology	K-12 school district	Medium-small(Approx. 7,000 students)	40	1
K	Technology Director	6-12 Charter school	small (approx. 700 students)	13	5
L	Director of Technology	K-12 school district	Medium-small (Approx. 6,000 students)	17	2

descriptions of how these technologies are used supported the final two phases of this study as technology classifications were identified and refined.

Phase IV. Initial Classification of Technologies. Technologies from the website analysis and interviews were compiled. With data from the first phases of analysis, we developed an initial framework based on the seven categories outlined in the middle section of Figure 1. However, this initial classification did not capture the various technologies used to support network security or information management. Furthermore, we found that some categories from our initial framework could be merged to create a more concise framework.

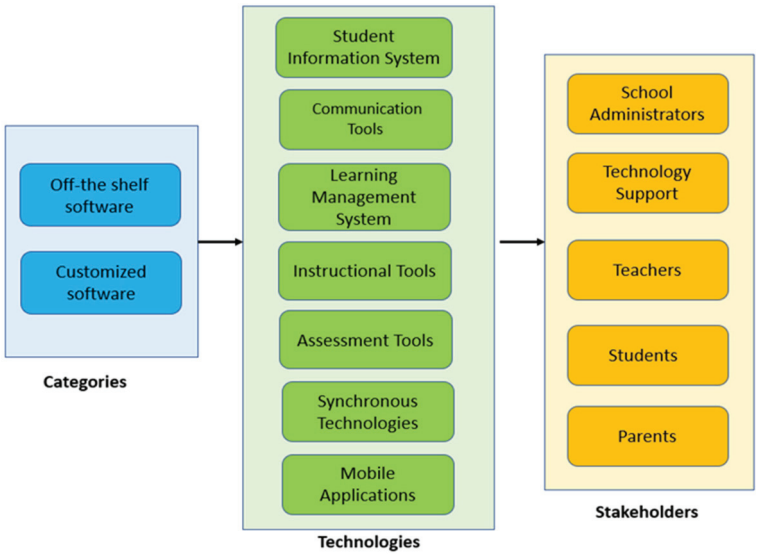

Figure 1. School Technology Classification (STC) Framework (Initial).

Phase V. Final Classification of Technologies. A final framework was developed to categorize technologies in a more comprehensive yet concise way with only four categories rather than the initial seven. The four categories include 1) educational technologies, 2) network and security technologies, 3) support technologies, and 4) management technologies. This framework was used to categorize the various technologies identified through website analysis and interviews. This resulted in the framework shown in Figure 2. Within each category, there are subcategories that were inductively created as technologies were being coded. We elaborate on the categories in this proposed framework in the following section.

Findings

First, we present the findings from Phases II, III, and IV of our data collection and analysis. In Phases II and III, we collected data to identify the technologies used in K-12 schools, as demonstrated in the first research question. In Phase IV, these data were organized using our initial framework. Ultimately, the categories we used in our Phase IV analysis serve as subcategories in our final framework. Finally, we present our findings for our second research question as we share our proposed STC framework that resulted from the analysis in Phase V.

Technologies Used in K-12 Schools

To answer the first research question, we conducted a school district website analysis of 23 school districts of various enrollment sizes. Additional technologies were

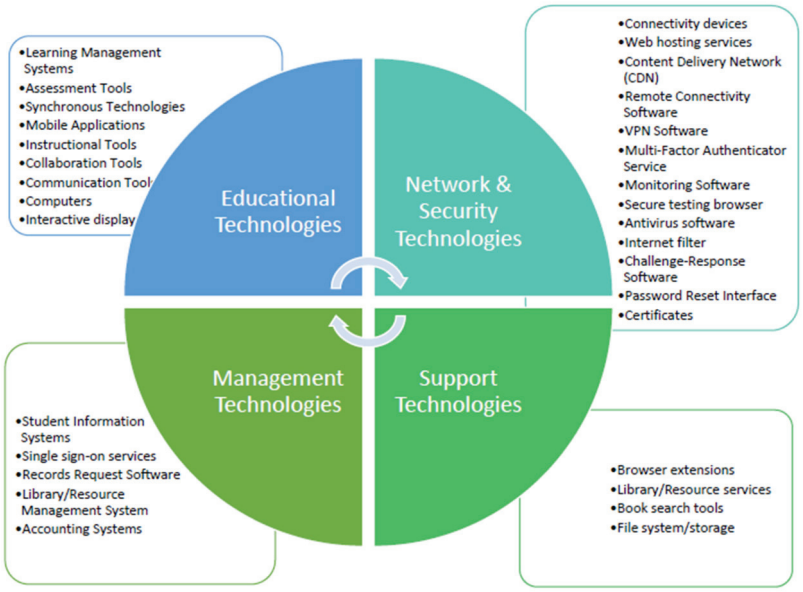

Figure 2. School Technology Classification (STC) Framework.

identified in qualitative interviews with district technology leaders. Table 3 presents our findings as organized by the categories from the STC framework developed in Phase V, and the subcategories used to categorize technologies in Phase IV.

Most of the technologies identified fall into the category of *educational technology*, specifically in the subcategory of *instructional technology*. Within the educational technology category, Chromebooks and Mac devices were most commonly used by students. As interview participants shared, these devices are commonly adopted because of their innate security features. Several of the technologies within the *management technology* category are provided to schools and districts by the state. These technologies commonly access and store a district's most sensitive data, including student health records and financial accounts. Network and security technologies represent a growing category of technologies used in schools that were not represented in our initial framework. In response to the increased threat of cyberattacks on schools, interview participants described efforts to invest more district manpower and financial resources into more advanced security technologies. Participant H shared how his technology team used an allotment of money provided by the state for technology needs, "We used [the money] to get Microsoft Defender for a year. It's about to expire. Having the resources to continue using something like that would be tremendously valuable." Other participants shared similar ways they invested in this one-time allotment from the state, but continued funding remains a concern.

Table 3. Technologies Used in K-12 Schools.

School Technology Classification	Subcategory	Technology
Educational Technology	Learning Management Systems	Canvas, WebAssign, Seesaw, Schoology, Google Classroom, GradPoint, PowerSchool Learning, HMH Ed, Edmodo
	Assessment Tools	MasteryConnect, Pivot, Schoolnet, Albert, Panorama Education Student Survey, Kahoot!, Verso, Turnitin, Google Forms, Kami, PowerSchool PowerTeacher Pro Gradebook, Microsoft Forms, Nearpod, Socrative, Vizia, Poll Everywhere, Plickers, aimswebPlus, ThatQuiz, Listenwise, NC ELI, mCLASS, Exact Path, Study Island, Lexile & Quantile Hub, easyCBM, iReady, Go Formative, Read180
	Synchronous Technologies	Microsoft Teams, Google Meet, Zoom, Cisco WebEx
	Mobile Applications	PowerSchool Mobile App, Canvas Parent, Say Something, Bloomz, Purposity, Canvas Student, ClassDojo, Here Comes the Bus, "GCS Mobile", "UCPS", Curiscope Virtuali-Tee, NWEA Secure Testing app, Socrative Teacher, Socrative Student, Edulog Parent Portal app, E-Hall Pass, Flextime Manager
	Instructional Tools	Raz-Kids, DreamBox, Edgenuity, Starfall.com, Sheppard Software, Sora, Discovery Education, i-Ready, EVERFI, ALEKS, Neptune Navigate, Khan Academy, Pear Deck, BrainPOP, IXL, Gizmos, myON, Funbrain, Math Playground, Ellevation, Desmos, annotate.net, Google Workspace for Education, Book Creator, Canva, Edpuzzle, loom, Screencastify, Raz-Plus, SMART notebook, CS First, Wixie, ThingLink, Boardworks, Big Universe, Planbook, Amplify Reading, Apex Tutorials, ARC Adventures, ARC Bookshelf, Eureka Math, Newsela, Open Up Resources, Savvas Realize, Waterford Reading Academy, Zearn, LearnEd Notebooks,

(continued)

Table 3. (continued)

School Technology Classification	Subcategory	Technology
		Number Worlds, STEMscopes, Swivl, Actively Learn, Flippity, Rewordify.com, Storyboard That, Timeline JS, information is beautiful, HyperDocs, simpleshow video maker, PlayPosit, Deck. Toys, Symbaloo, Blendspace, Gooru Navigator, Animoto, EasyBib, Quizlet, Scratch, Grammarly, Glogster, Zaption, yourdictionary.com, SpanishDict, PBS LearningMedia, Fast ForWord, Headsprout, TeachTown, MimioConnect, MobyMax, AdaptedMind, First In Math, Be Smart Kids, Tools4NCTeachers, Virtual Implementation Kit, Wit & Wisdom in Sync, Lexia, Letter Land, Quizizz, Ed Puzzle, English Grammar One-on-One, Digital Theater Plus, EduSpire, ActivInspire, AutoCad, System 44
	Collaboration Tools	Padlet, Google for Education, Google Docs, Google Sheets, Google Jamboard, OrbitNote, Google Slides, Flipgrid
	Communication Tools	Microsoft Stream, Blackboard Reach, Gmail, Calendly, Peachjar, ParentSquare, Outlook, Microsoft Sway, Remind, smore, Piktochart, Prezi Video, Teachers.net, Canvas Studio, Education Logistics Inc.'s "School Assistant", Twitter, Facebook, Instagram, TikTok, YouTube, Wakelet, Fanschool, ePals, Cult of Pedagogy, BOXLIGHT
	Computers/Devices	iPad, Chromebook, MacBook, Dell Latitude, AS400, Lenovo 300e Chromebook 2nd Generation, Apple TV
	Interactive Displays	SMART Board, Promethean ActivePanel Titanium, RV Sonic
Management Technologies	Student Information Systems	PowerSchool SIS, NC WISE, Ident-A-Kid
	Single sign-on (SSO) services	NCEdCloud IAM, Clever, Microsoft ADFS, ClassLink's LaunchPad, Discovery Education SSO

(continued)

Table 3. (continued)

School Technology Classification	Subcategory	Technology
	Records Request Software	ScribOrder, NCDPI Online Licensure System, NextRequest, NeedMyTranscript
	Library/Resource Management Systems	EBSCO Host, Follet Destiny Resource Manager
	Accounting Systems	SchoolsFunds Online
Support Technologies	Browser Extensions	Read&Write for Google Chrome, Read Aloud, MagicScroll Web Reader, Move It, WriQ, EquatIO - Math made digital, Screenshot reader
	Library/Resource Services	NC LIVE, NCWiseOwl, North Carolina Digital Library, Goodreads
	Book Search Tools	AR BookFinder, Book Expert Online, Follet Destiny Discover
	File Systems/Storage	SharePoint, Google Drive, OneDrive, LiveBinders, ScribEnroll, DropBox, Active Directory, Kronos
Network and Security Technologies	Connectivity Devices	Franklin T9 Hotspot (T-Mobile), R850 Mobile Hotspot (Sprint), ZTE Warp Connect Mobile Hotspot (Sprint), Nighthawk LTE Mobile Hotspot (AT&T), AirCard 797S Mobile Hotspot (AT&T), Kajeet SmartSpot 900 4G LTE
	Web Hosting Services	Blackboard, Google Sites, edlio, ISITE Software's "School Nutrition Network", Finalsite, SchoolMessenger Presence, Cyberschool, WordPress, Symbiotic Networks
	Content Delivery Network (CDN)	Amazon CloudFront, Akamai
	Remote Connectivity Software	TeamViewer, BeyondTrust Remote Support, GenControl, Apple Remote Desktop (ARD)
	VPN Software	FortiClient VPN, "My CMS" intranet
	Multi-Factor Authentication service	Azure AD
	Monitoring software	Gaggle, Downdetector, Bark for Schools, 8e6 Threat Analysis Reporter (for internet traffic), EducatorsHandbook.com Incidents +, DyKnow, Sophos, Managed Methods

(continued)

Table 3. (continued)

School Technology Classification	Subcategory	Technology
	Secure testing browser	NWEA Secure Browser, SafeExamBrowser
	Antivirus software	Panda Antivirus, Microsoft Defender, Malware Bytes
	Internet filter	Zscaler, Barracuda
	Challenge-Response software	reCAPTCHA
	Password Reset interface	Tools4ever's SSRPM
	Certificates	GoDaddy.com Web Server Certificate, Zscaler Root certificate

School Technology Classification Framework

Next, we share the proposed STC framework we used to categorize the K-12 technologies identified through website analysis and interviews with district technology leaders. We initially began the study with seven subcategories of technologies including SIS, Communication Tools, Learning Management System, Instructional Tools, Assessment Tools, Synchronous Tools, and Mobile Applications. However, during research and coding, this resulted in 31 subcategories. The 31 subcategories were further grouped into four main categories: *educational technologies*, *management technologies*, *support technologies*, and *network and security technologies*.

The first category is *educational technologies*. Educational technologies refer to both hardware and software used primarily for teaching and learning purposes. This includes technologies, such as adaptive tools and learning applications, used to meet diverse learner needs and provide access to information. This also includes synchronous technologies, such as Zoom and Microsoft Teams, which facilitate opportunities for students and teachers to collaborate.

The second category is *management technologies***.** Management technologies are used to manage student information and educational resources. For administrative purposes, this includes technologies like SISs used to manage directory information, contact information, and student schedules. For student use, this category includes technologies such as SSO services that facilitate secure access to all learning technologies.

The next category is *support technologies*. Support technologies help facilitate the effective use of other technologies. For example, K-12 school libraries use support technologies to help students access books and other resources they need. Many district websites included such support technologies for not only the school district library but also local public library resources. More common support technologies include technologies used for file storage and management, such as Dropbox and Google Drive.

The last category is *network and security technologies*, a category that was not clearly defined in our initial framework. These technologies are used in schools and school district offices to maintain safe access to and use of technologies and network devices. Common technologies in this category include internet filters and monitoring software. As schools are increasingly facing the threat of cyberattacks (Chang, 2017), this category represents a rapidly growing and evolving set of technologies.

Discussion

The proposed STC framework provides a classification system to organize the vast array of school technologies currently in use in K-12 schools. This comprehensive framework is designed to represent all technologies, not just instructional technologies. We believe this framework benefits K-12 school districts and technology personnel by informing technology needs and representing the changing role of school technology professionals.

Informing Technology Needs

The STC framework benefits various schools and school districts to make sure they have all the different technologies needed. The findings also support various administrators and educators to know the various technologies that are being used by other districts that they can also adopt as needed. Previous research suggests that the primary reasons for digital technology adoption are ease of use and benefits to student learning (Buchanan et al., 2013; Cheung & Vogel, 2013; Schoonenboom, 2014). As Participant A shared, "technology does not drive instruction. Instruction drives our technology," demonstrating that districts are making technology decisions based first and foremost on how these technologies support instruction and student learning. In a systematic review of research in K-12 online teaching and learning, Martin and colleagues (2021) found that course technologies represented the most common research topic across two decades of research. Although the *educational technologies* represented in our STC framework are well represented in both research and practice, findings from this study highlight the range of technologies used in K-12 schools that fall outside of this category. A better understanding of the technologies that fall within this category can also help better understand the data collected from these technologies that can be harnessed through data analytics to inform decision-making in K-12 schools (Bowers, 2021; Nyland, 2018).

As previously mentioned, our initial framework did not include a distinct category for *network and security technologies.* However, both website analysis and interviews with district technology leaders indicated a growing number of crucial technologies in this category. As cyberthreats increasingly target K-12 schools (Chang, 2017; FBI 2020; Levin, 2019), district leaders need to stay informed about the latest network and security technologies available. The STC framework can help inform the adoption of network and security technologies in other schools and districts. Interviews with

technology leaders in smaller districts and charter schools confirmed the need for such findings to be shared in a comprehensive and organized manner as these leaders do not have the benefit of working with larger technology teams that help them stay on top of the most up-to-date technologies.

Changing Role of School Technology Professionals

In addition to informing various technology needs in K-12 schools, we believe that the STC framework also helps present a synthesized representation of the various technologies that K-12 technology professionals must be prepared to manage and support. Interviews with technology leaders from across the state highlight the complexity of technology support roles in K-12 schools. District technology teams composed of technology administrators, ITFs, and technicians must be prepared to address a range of technology needs from instructional support with technology to more specialized cybersecurity needs. The roles of technology leaders are often unclear (Haines, 2018), and the STC framework helps to present a more comprehensive view of the skills and expertise needed on a district technology team.

When specifically speaking about cybersecurity needs, district technology leaders we interviewed expressed the need to update job descriptions for K-12 technology personnel to help recruit and retain those with the specialized skills to implement cybersecurity best practices and investigate potential cybersecurity threats detected by existing network and security technologies. Participant F, a CTO from a large public school district serving over 30,000 students, described the need for district leaders to change their view of the role of technology personnel:

> It's made the job way more stressful. And getting the school system and the state to understand that it's not a typical support position anymore. Even my Tech 1s are required to do a lot more with data and security than they ever had to in the past. And I need to be able to pay them accordingly. They still see technology people as a support [position]. But there's a lot less of, 'I'm going to take apart this computer and replace a card.' I'm now sitting down with teachers and helping them with their data and their security and things of that nature. That's what my techs are doing now.

As this quote indicates, an increased need for cybersecurity in K-12 schools has technology personnel working with new technologies that were not required before. Although the primary role of ITFs in schools is to deliver effective, ongoing professional development for teachers related to effective technology integration (Adams, 2015), as the need for awareness of cybersecurity grows and educational technology in the *network and security technology* category increases, the role of ITFs may similarly need to evolve. Larger school districts might have the ability to build specialized technology teams that can address this range of technology needs, but interviews revealed that technology leaders in charter schools often make up their own "team,"

trying to take on all the roles that a team of technology and instructional technology staff carry out collaboratively. As Participant I, the Director of Technology at a K-8 charter school, shared, "I'm a one-woman show. I have some support, but I don't have as much pull as a larger school district. And the time to really dedicate to getting [new technologies] set up is really hard for me." Additionally, technology personnel who have expertise in data analytics can support educators and administrators to maximize the potential of the data collected by educational technologies to improve learning outcomes (Nyland, 2018). Having the STC framework as a tool to represent the range of technology expertise needed can support technology personnel in advocating for the specialized training needed to effectively fulfill K-12 technology needs.

Limitations

Data collection for this study was limited to school districts in one southeastern state in the United States. As described in Phase I, when selecting districts to include in the website analysis portion of this study, student enrollment size was considered in order to capture a range of districts. However, other considerations, such as the rurality of districts, were not considered when selecting districts for inclusion. Another limitation was that we did not analyze the technologies specific to the districts but compiled the list of technologies for all the districts together as our intention was not to do any comparative analysis between districts. However, including averages of technologies across the districts in each category might be helpful for research and practice. Charter schools and other independent districts were not included in the website analysis though they were included in the interviews. In addition, while we invited technology leaders from all districts in the state to participate in this study, interviews were limited to volunteers who were available during the data collection timeframe. As a result, participants largely represented school districts in the central part of the state.

Conclusion

Technology is now an omnipresent part of K-12 teaching and learning. With an array of educational technologies to choose from, administrators and educators can benefit from a framework that indexes and organizes these technologies to support decisions about future technology adoptions. Additionally, district technology leaders can benefit from having a comprehensive representation of the range of technologies used within a single district to support needs from learning to data privacy in order to advocate for more skilled technology personnel. We believe the proposed STC framework presented in this paper helps support these needs. As educational technologies continue to evolve, we must continue to reevaluate

the categories used in the STC framework to ensure it is still representative of technologies used in K-12 schools.

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APPENDIX

A: Semistructured Interview Protocol

These first few questions will help us better understand your role and responsibilities in your current position to help give us better context for your response to questions.

Introductory Questions:

- I have identified your title as <insert title> based on your district's website. Is that an accurate title for you?
  - On our Form, you said you have been in this role for <insert #> years and in education for <insert #>. Is that correct?
  - Briefly describe your role in education prior to taking on this role.
- Describe your role in the school district, especially as it relates to educational technology use and information security.
  - What are some of your main responsibilities?

These next several questions will focus on technologies used in your district and the types of information collected from these technologies.

Data and Technologies:

- What are some of the different security technologies used in your school/district?
- What are some different educational technologies used in your school/school district?
- What type of data is collected using these educational technologies?
- Who has access to the data that is collected (per technology)?
- Is this technology (list each) customized or off-the-shelf?
- Describe the process and structures you use to secure the data you collect?
- Does your district currently have a process in place to vet educational technology before use with teachers and students? If so, describe this process.

Now, the next several questions will focus on your concerns related to cybersecurity and privacy, including your experience with any cybersecurity attacks since you have been in this position.

Cybersecurity and Privacy:

- What are the challenges that you have experienced related to cybersecurity and privacy issues in your district?
- What are common cybersecurity attacks that you have noticed during your time in your position?
- What is one thing you wish users in your district would change to in order to maintain cybersecurity?
- What keeps you up at night when it comes to cybersecurity in your school/district?
- In your perception, what are the most effective measures related to cybersecurity in your district?
- If you had unlimited resources, what types of hardware or software would you integrate into your existing system to enhance cybersecurity?

As we reach the end of this interview, these last several questions ask for your insight into the design of our intended professional development for educators.

Professional Development:

- What kind of professional development or training is provided to the administrators, technology facilitators, teachers, students?
- If our team offers a professional development course on cybersecurity for K-12 professionals, is there anything specific you would like to see in it?
- Is there anything else you would like to tell us about that was not addressed in any of the previous questions?