Systems Thinking as an Approach to Technology Integration at the K-12 School Level

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Abstract

Amid the pedagogical and leadership shifts that the COVID pandemic placed on the K-12 educational landscape, the pandemic itself brought to light the systems that need to be in place for technology to be effectively integrated in classrooms and school buildings. The COVID transition period has produced a technology rebirth in K-12 schools across the country. This article provides a theoretical framework for K-12 leaders to utilize as a guide to establishing a technology integration system in schools that is effective and sustainable. This comparative case study examined two school districts and utilized multiple methods to formulate an actionable framework for technology leaders. Through the combined theoretical lens of Peter Senge's learning organizations and Hargreaves & Fullan's professional capital model, researchers highlight the need and value of current instructional technology measuring and evaluative tools, and how they resourcefully support and guide technology leaders. Findings revealed leadership practices and systems thinking matter, and that they have a prominent impact on technology implementation and adaptation within the fabric of K-12 schooling.

Introduction

There is a new technology era within the K-12 educational arena. The COVID pandemic disrupted education in the United States and the world; first closing schools and then pushing them to pivot to distance learning (Alvarez, 2020; McLeod, 2020). K-12 teachers and leaders have become more resilient to change and equipped and confident to leverage technology within their practices. Leading schools and teaching learners amid a pandemic have taught leaders a great deal. Success and missteps during the COVID transitional period have brought to light the systems and personnel infrastructure that need to be in place for effective technology practices in K-12 schools. As this study highlights, in order to achieve the kinds of instructional technology effectiveness required for 21st-century teaching and learning, a systems thinking approach is needed by leaders.

The International Society for Technology in Education, or ISTE, identified key roles of leaders in effectively leading the integration of instructional technology. The new standards identify essential components of technology leadership and have been adopted by many school districts to guide technology integration initiatives and serve as a technology accountability tool (ISTE, 2018; Christensen et al., 2018). Most recently as a response to the pandemic, Congress has increased funding to the Emergency Connectivity Fund, which provides monetary funds to selected elementary schools, secondary schools, or libraries to purchase equipment or services (e.g., Wi-Fi hotspots, modems, and routers) for use by students and staff at locations other than the schools (Flannery, 2020). The National Education Technology Plan (NETP), released in 2017, laid out the vision of the U.S. Department of Education for the purpose and use of technology in American K-12 education. Nationally, the United States government has spent billions of dollars for technology infrastructure in K-12 schools and has made it clear that technology is at the forefront of educational initiatives.

As technology in education today is evolving and transforming instructional pedagogy, research in the field must also be ongoing and progressing to keep up to date with evolving times. Leaders today must be capable of establishing a system that mobilizes resources to support and build the collective capacity of teachers with instructional technology. This study identifies actionable steps that leaders can take to create supportive and sustainable technology integration opportunities. All the elements identified in this study relied on the technological leadership skills of sitting administrators and their ability to react to change. This study provides a useful framework to facilitate systemic change needed in today's schools, as well as capturing research-based practices that lead to effective technology leadership and integration during a time of change and in preparation for 21st century teaching and learning.

This study's purpose is guided by the following research questions:

1) What leadership practices and approaches influence technology implementation and adaptation efforts at the K-12 level?, and

2) What elements within a system infrastructure are necessary to effectively support and sustain technology integration initiatives at the K-12 level?

Theoretical Framework

The researchers chose to review the research base through the combined theoretical lens of systems thinking (Senge, 2006) and professional capital (Hargreaves & Fullan, 2012). Peter Senge (2006) has identified five disciplines of a learning organization: Systems Thinking, Shared Vision, Mental Models, Personal Mastery, and Team Learning. Systems thinking is the core of the five disciplines. Systems thinking allows us to recognize the interrelationships of the disciplines and how each one is needed to foster the growth of a learning organization (Senge, 2006). Hargreaves & Fullan (2012) express professional capital in a formula, where PC is professional capital, HC is human capital, SC is social capital, and DC is decisional capital. Effective learning and teaching during a change process (e.g., COVID pandemic) can be viewed as a product of these three kinds of capital amplifying each other (Hargreaves & Fullan, 2012).

Merging Theoretical Frameworks

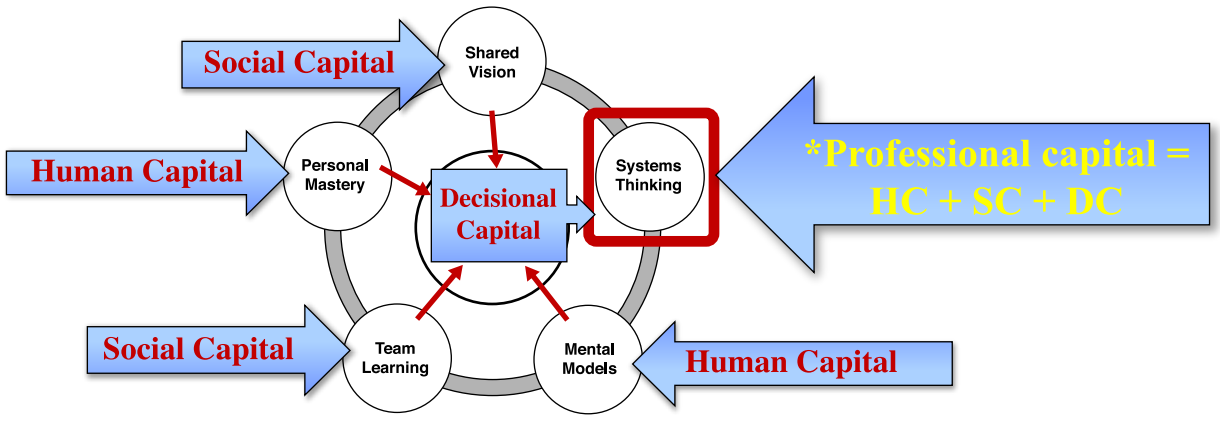
To organize the concepts in a coherent way, the researchers integrated both frameworks and constructed the Systems and Capital Change Model **(See Figure 1)** as a comprehensive framework intended to guide educational leaders during change efforts. Although there are two separate constructs, professional capital can effectively be applied within the five disciplines of learning organizations. As seen in **Figure 1**, three effective interconnections can be made by coupling and integrating both constructs: (a) Human capital corresponds to individuals attaining personal mastery and shifting mental models; (b) Social capital aligns to the disciplines of team learning and shared vision within a learning organization; and (c) Decisions made with a high level of decisional capital can help establish and sustain systems thinking. The human and social element of Fullan's professional capital theory strengthens and reinforces the dynamics of Senge's systems thinking in collaborative and efficient ways. The investment in the progression of people matters (Fullan's model) and can only be attained within a system that cultivates the process (Senge's model). Educational leaders nationwide will benefit from the fusion of both Senge's and Fullan's theoretical frameworks as they attempt to establish a system and culture of learning and collaboration among teachers during a time of change.

Review of the Literature

Following the ISTE standards for educational leaders, and to further synthesize and organize the robust literature, effective technology leadership is sub-categorized into five essential aspects: (1) establishing vision; (2) empowering and collaboration; (3) model & advocacy; (4) connected learner; (5) systems designer; and (6) accountability.

Technology leaders must build on a shared vision by collaboratively creating a plan that articulates how

Figure 1
Systems and Capital Change Model



technology will be used to enhance learning. Creating a shared technology vision during a change process enables leaders to communicate and collaborate with key stakeholders and facilitate conversations regarding technology initiatives or implementation plans (Schrum et al., 2011; Tucker, 2019). The ISTE leader standards recommend that leaders create a culture where teachers and learners are empowered to use technology in innovative ways (ISTE, 2018). To ensure that teachers feel empowered, technology leaders must provide opportunities for them to learn (e.g., professional learning communities, or PLC's) and participate in conversations that drive and support technology initiatives (e.g., technology committees).

Technology leaders must be willing to model change efforts (Afshari et al., 2010). According to the ISTE standards for education leaders, technology leaders need to model digital citizenship by intentionally adopting and demonstrating best practices to teach others (ISTE, n.d.). Further, technology leaders must consistently encourage teachers to enhance their teaching craft, actively introduce new technological resources to teachers, and advocate for their usage and effectiveness in the classroom (Hsieh et al., 2014). To stay current and effectively model and advocate for innovative technologies, technology leaders need to stay connected with other leaders as continuous learners of technology. ISTE recommends for technology leaders to sustain a continuous learning mindset in the field of technology by practicing being connected learners (ISTE, n.d.) and remain current with current research, best practices, and technological trends and advancements (Christensen et al. 2018).

According to the ISTE standards for leaders, technology leaders must assure that systems are in place to effectively implement, sustain, and continuously improve the use of instructional technology to support teaching and learning (ISTE, n.d.; Machado & Chung, 2015). Technology leadership involves designing and establishing a system of interrelated support components that promote and invest in the growth and enhancement of the teachers (Bleakley & Mangin, 2013). Part of that system infrastructure include technology committees, professional learning communities (PLC's), enhancement opportunities (e.g., training, workshops), and support teams (e.g., technology coach/es, IT department). It is necessary for technology leaders to set the path and structure for all the essential components of the system to be established and implemented within the dynamics of a school system. Lastly, ISTE contends that it is important for technology leaders to implement evaluative procedures that allow for the technological growth of teachers (2016). Two current commonly utilized and researched evaluative tools for instructional technology include the Substitution, Augmentation, Modification, Redefinition model (SAMR) and the Technological Pedagogical Content Knowledge model (TPACK). Technology leaders need technology evaluative and reflective tools alongside them to create and sustain a system of technology integration accountability within their building or district. In an evolving educational technology landscape, it is essential that technology leaders approach technology integration in a systematic and reflective way.

Methodology

The researchers conducted a comparative case study to capture the lived experiences of participants as they navigated technology in their diverse school contexts within a real-life, contemporary context (Creswell & Poth, 2018) - K-12 technology integration during a time of change (e.g., COVID). Purposeful sampling was used to select two high-achieving suburban school districts in opposite counties in Long Island, New York (Nassau and Suffolk). Data collection spanned the 2020-2021 school year. Open-ended, semi-structured interview questions were utilized during both individual and focus group interviews. Each case (school district) within the study provided insight from various stakeholder perspectives (administrators and teachers), which facilitated understanding of their district's technology integration system design during a time of change. Participants included elementary and secondary level principals and teachers, and district-level technology directors and building-level leaders for this study. Additionally, district documents, archived documents (e.g., technology integration plans; Smart School Plan; teacher contracts) and district website were analyzed to gain further input on technology initiatives, budgetary allocations, or contractual language regarding technology integration efforts. The researchers triangulated the data by utilizing not only three methods of data collection (individual interviews, focus group interviews, document analysis), but also three sources of data from divergent stakeholder voices (leader perspectives, teacher perspectives, varying grade levels) to confirm this study's findings.

Findings

Three pertinent overarching themes emerged from the study:

a) Technology Leadership;
b) Systems infrastructure; and
c) Accountability.

Technology Leadership

The analysis of the interview data found that technology leadership requires a specific set of interpersonal skills to be able to influence teachers' instructional technology usage. In essence, people skills allow technology leaders to build trust and communicate change efforts more effectively. Across both cases, most teacher and leader participants emphasized that technology leaders need patience. Patience to listen and value their perspectives. Patience to understand and acknowledge that teachers have diverse levels of technology proficiency. Both leader and teacher

participants across both cases also expressed that technology leaders must have humility to accept assistance from others when needed, and humility to not be afraid to learn along with teachers. Among the main practices identified by most leader and teacher participants included, modeling expectations, allocating time for teachers to learn and practice instructional technology along with colleagues, listening to understand, and practicing a continuous learning mindset. As expressed by many teacher participants from both districts, time is also an essential consideration technology leaders must consider if they want teachers to successfully incorporate technology. Lastly, most district leaders expressed the importance of technology leaders consistently practicing being life-long learners by staying current with best practices, collaborating with other leaders, and seeking learning opportunities.

Systems Infrastructure

The analysis of the interview data found that, overall, systems thinking matters with technology leadership. The findings revealed that every aspect or element of instructional technology relates back to the system that has been put in place to support and sustain it, which leaders are charged with establishing. Most leaders across both districts agreed that adequate bandwidth speed and Wi-Fi capabilities are crucial foundational system needs. Without adequate bandwidth or Wi-Fi capabilities, schools and districts will not be able to sustain technology integration initiatives. In addition to foundational needs, the majority of leader and teacher participants across both cases reported that technology leadership must continuously structure enhancement opportunities for teachers with technology more consistently to enhance their craft. Teachers must have support available when it comes to instructional technology. As such, teacher and leader participants across both districts identified specific technology positions and departments within a K-12 district or school system that provide available support. A prominent position that surfaced from all leader and teacher responses across both districts was the notion that having a designated person (e.g., technology coach) responsible for assisting and guiding teachers' technology usage in the classroom is vital to a district's success with technology integration. The information technology (IT) department was also reported as an essential support component alongside technology coaches. The IT department takes care of all network and hardware/software related matters within instructional technology, while technology coaches focus on the instructional aspect of technology in the classrooms.

Accountability

Findings revealed that technological accountability is an important aspect for an effective technology integration system. The 2018-2021 Instructional Technology Plan from both cases communicated and outlined a three-year plan for the district's technology vision, short-term and long-term goals, and action steps. The presence of each district's 2018-2021 Instructional Technology Plan showed alignment with the ISTE standards. Moreover, all leader participants shared that their district utilized Google Forms as surveys to gather information from parents, students, teachers, and administrators to evaluate the needs and progress of their technology initiatives. All leader participants also expressed the importance of establishing technology committees within the district to be able to gather stakeholder input and collaboratively work towards a technology vision. Technology committees develop consensus and create and facilitate buy-in from stakeholders at all levels. Another important finding was that no other guiding framework, such as the SAMR model, or standards, such as ISTE, were being utilized by teachers or leaders within each district. Across both districts, findings revealed that most teacher participants from both districts were not knowledgeable or familiar with either standards or framework. This key finding alludes to the notion that ISTE technology standards and guiding frameworks such as SAMR or TPACK are just touching the surface of awareness by K-12 educators. Lastly, the researchers also discovered that contract language regarding instructional technology expectations were non-existent in both district's teacher contracts.

As the findings reflect across both district cases, a system thinking approach is necessary for technology leaders to establish a system of interrelated support components that are integral to the instructional technology infrastructure of schools and districts.

Discussion and Conclusion

Creating a system that nurtures teacher's growth with technology, and providing a framework for consistent collaboration and communication were found to be vital components for a functional, efficient, and effective instructional technology environment in schools. After interviewing and listening to the stories of leaders and teachers from both participating districts, the researchers identified the following key conclusions: a) technology leaders must establish processes and systems design as foundational aspects of the technology infrastructure within a school; and b) accountability for the effectiveness of instructional technology integration is needed, thus K-12 technology leaders and teachers will benefit from adapting and utilizing models that are guiding, evaluative, and reflective (e.g. ISTE; SAMR; TPACK). Future studies should investigate leader preparation programs and determine if leadership programs are adequately preparing leaders to become technology leaders. The digital divide between

school districts with varying demographics is also an area that merits further study. School districts, educational leaders, and leader preparation programs can utilize the findings from this study to provide a basis to inform and guide 21st century technology leadership.

In a continuously emerging technological age marked with rapid change, it has become imperative and necessary to continue understanding the depth of influence that leadership practices and systems and structures have on technology integration efforts at the K-12 school level. Only then can educational leaders establish and sustain the means to experience success with instructional technology implementation initiatives.

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