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Educational Leadership in the Age of Artificial Intelligence

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ACCEPTANCE

This dissertation, EDUCATIONAL LEADERSHIP IN THE AGE OF ARTIFICIAL INTELLIGENCE, by MATTHEW TYSON, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

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EDUCATIONAL LEADERSHIP IN THE AGE OF ARTIFICIAL INTELLIGENCE

by

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Under the Direction of Nicholas J. Sauers, Ph. D.

ABSTRACT

Programs that utilize artificial intelligence (AI) are becoming more and more prevalent in classrooms throughout the world. As this technology becomes more available and affordable, school administrators are going to have to decide whether or not these types of programs make sense for their schools. It is essential that school administrators educate themselves about the different types of AI programs available to them, as well as the effects they may have on the education of their students. The purpose of this study was to examine the experiences of educational professionals currently employed in positions of school leadership who have implemented AI technology in their schools. A review of literature was completed to provide an overview of educational technology, educational technology leadership, and related applications of AI. This was a qualitative case study where the perceptions of school administrators were viewed through the diffusion of innovations theoretical framework. The data collection consisted of extensive interviews *with seven school leaders who utilized artificial intelligence programs in their schools and the analysis of related artifacts collected from them. The findings of this study help to fill in existing gaps in the literature around the impact of AI on educational technology leadership by providing a better understanding of how school leaders have implemented AI programs in their schools. This should help to build a foundation for further studies on the nature of AI programs as seen through the lens of school leadership.*

INDEX WORDS: Educational Leadership, Artificial Intelligence, Technology Leadership, Innovation

EDUCATIONAL LEADERSHIP IN THE AGE OF ARTIFICIAL INTELLIGENCE

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DEDICATION

I dedicate this to my wonderful wife and daughters, without whose patience none of this would have been possible.

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TABLE OF CONTENTS

1 EDUCATIONAL LEADERSHIP IN THE AGE OF AI

"The average American school lags 25 years behind the best practice" (Mort, 1953).

Introduction

While this statement may have been written over 50 years ago, studies suggest that it remains true today. One of the most important tasks faced by educational leaders today is the struggle to stay ahead of the waves of technology that alter the world we live in on a daily basis. These waves of technology have become increasingly disruptive, each altering society in increasingly significant ways. School and district administrators must become more knowledgeable about each new technology that emerges, particularly the ones that may have the potential to fundamentally alter the profession of teaching. Parents and other stakeholders will hold these leaders accountable for providing their students with the best technology available, and it is the educational leaders' responsibility to research which technological advancements may be beneficial to their students so that implementation can occur in a timely manner. With the pace of technological advancements increasing exponentially, educational leaders would be prescient to create a process governing technological adoptions in their schools and to ensure that ample budget is provided to develop and nurture the usage of new programs and devices.

The realm of artificial intelligence (AI) is increasingly intersecting with traditional educational arenas in new and interesting ways. From virtual tutors to digital classroom assistants, both the quality and availability of AI have increased to the point where AI has become a viable option for many schools across the world. While the depth of the AI integration may vary, the idea that AI may disrupt the very nature of the classroom environment has picked up steam in recent years. Already altering our everyday environment with digital assistants such as Alexa by

Google or Siri by Apple, AI can similarly influence how educational professionals operate in a school setting. While opinions on which method of AI adoption makes the most sense for schools may vary, it is shortsighted to believe that AI will not intersect with education in any meaningful way in the years to come.

The traditional model of a classroom has been challenged in recent years, with many schools and teachers moving to a more individualized type of teaching rather than the "sage on a stage" format of delivering lectures to a classroom of children sitting in neat rows facing the front of the room. While it may seem intuitively beneficial to tailor learning to each individual student's needs, this can increase the demands on classroom teachers substantially. This is one area where artificial intelligence has the potential to make a huge difference. Through functioning as a personal tutor for a student or a diagnostician for a teacher, there are few limits to the ways that AI may alter the classroom environment of schools across all grade levels and content areas.

AI's potential educational applications are not limited to students; however, educational administrators and faculty members may also be impacted (Zawacki-Richter, Marin, Bond, & Gouverneur, 2019). It is important to understand the processes and perceptions of these leaders in order to better understand what drives their adoption of AI programs in their schools. The ways in which leaders are using AI need to be better understood as well.

Purpose

The purpose of this study is to examine the experiences of educational professionals currently employed in positions of school leadership who have implemented AI technology in their schools. While technologies such as artificial intelligence may reduce the number of workers in some fields, they have the potential to alter many more occupations (Manyika, Lund, Chui, Bughin, Woetzel, Batra, Ko, & Sanghvi, 2017). Huang, Rust, & Maksimovic (2019) believe that these advancements in AI have led to the emergence of a new, “feeling economy”, wherein AI takes over many thinking and analysis-based tasks and humans end up doing more tasks having to do with empathy and interpersonal skills.

AI has already been utilized for various classroom purposes but it may also have applications for educational management and administration (Coccoli, Maresca, & Stanganelli, 2016). This makes it all the more important for researchers to gain an understanding of the depth to which school administrators understand and utilize AI programs in their schools. Approximately 60% of jobs now have a minimum of 30% of tasks that can potentially be automated (Manyika et al., 2017). It is doubtful that this slows down in coming years, so determining which aspects of teaching and school leadership can be automated will be paramount for the success of future educational leaders.

It has been suggested that policy makers and business executives need to embrace the benefits of automation while also addressing the transitions that technology will bring to their workforce (Manyika et al., 2017). Through this study, a better understanding of how school leaders are using and plan to use artificial intelligence in their schools, as well as what their perceptions are related to the school-based usage of artificial intelligence (AI), have been revealed. Insights about the adoption and diffusion processes that are informing the spread of educational AI technology also emerged. While there are a great number of studies surrounding school leaders’ implementation of technology as well as educational technology in general, there are few studies that examine the adoption of AI technology in schools from an educational leadership perspective. It is my belief that this study remedies this deficit and in doing so provides a significant addition to the current body of literature surrounding educational leadership and technology adoption.

Guiding Questions

I have created two guiding questions that relate directly to the purpose of this study. This study has provided valuable information related to the experiences educational leaders have had with AI technology, while also providing insight into where this technology is potentially going. The questions are as follows:

- What do educational leaders perceive as factors influencing the diffusion of artificial intelligence in education?
- How do school leaders influence artificial intelligence implementation in their school?

Literature Review

Major developments in educational technology.

The history of technology use in schools is long and winding. From the abacus to virtual reality, enterprising educators have always attempted to integrate the newest technology into their classrooms in order to give their students a leg up on the future. Slide projectors were an early type of technology that was used from the 1950s onward to allow teachers to project their lessons on a board at the front of the class for all the students to observe (Seldon, 2018). Televisions were used in the classroom to show learning videos to students during the 1980s and 1990s, but they had a number of clear drawbacks (Seldon, 2018). The televisions used were often small and difficult for students to see, and the passive observation that students would engage in was not the active learning often sought after in today’s classrooms.

Computers first began to appear in the school setting during the 1960s but it would take until the 1980s for computing in schools to become truly widespread (Seldon, 2018). In 1993, approximately two-thirds of public schools in the United Stated would have internet access available to staff and students (Wells & Lewis, 2006). By 2003, this number had increased to include virtually every public school (Wells & Lewis, 2006). Such quick and widespread adoption of anything in education is rare, but as the internet changed society itself, so it would change the school experience for children. Brady (2012) found that:

> teaching with the Internet and infusing the use of new technologies through the curriculum creates an environment where inquiry learning can be more fully embraced. With the strategic use of computers, students can learn to locate their own resources, access content in flexible ways, and engage with a wide variety of information presented in multiple formats (p. 212).

This can lead students to develop skills in the areas of critical evaluation of resources, creativity, persuasion, and the facilitation of ideas (Brady, 2012). These are skills that can aid students throughout their educational careers and lives.

Smartboards and video projectors first appeared in United States classrooms in the 1990s, and questions began to emerge as to whether the high expense was justified (Seldon, 2018). E-books have begun replacing traditional textbooks in many schools as well. Reasons behind their adoption include their eco-friendliness, access to more books, cost, and more instructional options (Brady, 2012). Some studies have found that increased e-book usage has created more means through which students can foster critical inquiry (Brady, 2012).

The first research of systems that would become known as artificial intelligence dates back to the 1950s, with the term "artificial intelligence" credited to a professor named John

McCarthy (Shubhendu & Vijay, 2013). A mathematician named Alan Turing was the first to suggest the creation of a test that would determine whether a machine could pass as human; this would come to be known as the Turing Test and it is a hurdle that artificial intelligence programs have yet to reach. The goal of AI research is to understand how humans think and create programs that can approximate that thinking (Shubhendu & Vijay, 2013).

Current applications of educational technology.

The convergence between artificial intelligence and education is both natural and inevitable. Humans solve their problems by dividing each problem into smaller sub-problems and devising a plan to conquer each sub-problem by relying on known techniques and existing knowledge bases (Shubhendu & Vijay, 2013). This is exactly how artificial intelligence programs operate; and knowing the ways that AI programs decide to solve problems may help humans to solve the same problem more effectively.

The first precursors to artificial intelligence applications were known as Computer-Aided Instructional (CAI) systems. CAI systems help students work through course material by giving them choices and informing them if they are correct or not, which cannot truly be classified as an artificial intelligence program although they resemble them in many respects (McArthur, Lewis, & Bishay, 2005). Intelligent Tutoring Systems evolved from CAIs around thirty years ago, and these types of systems attempt to mimic the human relationship between tutor and tutee (Shubhendu & Vijay, 2013). Programmers aimed to replicate this type of teaching environment primarily because of the general acceptance and popularity of one-on-one teaching environments, where a high level of individualized instruction can be provided due to the singular nature of the learner involved (McArthur, Lewis, & Bishay, 2005).

Both CAI and ITS programs are very instructor-oriented and teach the student by asking predetermined questions to which the student must provide accurate answers. ITS programs are an improvement on CAI systems primarily because technology has allowed them to have increased intelligence and stores of topical knowledge that were not available for CAI systems (McArthur, Lewis, & Bishay, 2005). They can interact better with students and provide more detailed feedback as well. The biggest difference between ITS and CAI systems lies in ITS programs' focus on individual reasoning, whereas CAI programs focused simply on questions (McArthur, Lewis, & Bishay, 2005).

ITS programs analyze students throughout every step of their problem solving, so that more accurate feedback can be provided that attempts to relay to the student specifically where they went wrong and how it could have been avoided. It is through this scaffolding of new topics and ideas that ITS systems can help students increase their individual knowledge of a topic without personalized intervention from a human instructor (Luckin, Homes, Griffiths, & Forcier, 2016).

There are many limitations to current software programs that can potentially be overcome by the usage of artificial intelligence programs. Current software programs can provide pre- and post-test data on the knowledge that a student has learned, but they cannot provide data as to where in the learning continuum that a student started having trouble. AI programs can be used to determine exactly what topics the students are having difficulty with and at exactly what point in the material their struggles began (Dickson, 2017). AI programs have also proven to be successful at improving students' academic achievement overall (Coccoli, Maresca, & Stanganelli, 2016).

Another difficulty lies in the assessment of a student's learning progression (Dickson, 2017), which cannot be done by basic software programs but can be done quite effectively by artificial intelligence programs. Cognitive Computing is a new form of AI that can emulate human reasoning far better than previous forms of AI. It can be especially well-suited for the task of instructing humans in how to understand new concepts or complete new tasks (Coccoli, Maresca, & Stanganelli, 2016).

As computing power increases, the cost of processing power is decreasing (Aoun, 2017). This has driven the push towards new artificial intelligence programs, with greater capabilities than before. There are a variety of terms to describe the facets of this new technology. Machine learning refers to the capability of some AI programs to learn from data rather than any type of explicit programming (Aoun, 2017). Artificial neural networks are programs that attempt to replicate a human mind. Deep learning refers to the ability of these artificial neural networks to recognize patterns (Aoun, 2017). Many current AI programs utilize some combination of these facets.

New directions in learning.

Several new educational structures that have gained popularity in recent years lend themselves particularly well to the adoption of AI technology. This will include such topics as individualized learning, self-directed learning, personalized learning, and e-learning. One significant way that technology can enhance the academic performance of students is through applications that support heutagogy, or self-directed learning, wherein students must perform mostly autonomously.

A heutagogical learning environment focuses on the improvement of learner capacities in order to produce students that are prepared for the complexities of the jobs that will await them upon graduation (Blaschke, 2012). While it is often applied only to adult learners, the increasing prevalence of open-source materials has allowed for even elementary-level students to participate in self-directed learning (Gerstein, 2014). This does not necessarily devalue the role of teachers entirely, but it would seem to require a change in the practice of teaching.

The new purpose can be seen clearly in the statement that, “As educators, we can create the curiosity to find and explore connections between many sources while using emerging technologies that can lead learners to new knowledge and enhanced learning” (Cook & Gregory, 2018, p. 122). Instead of being arbiters of knowledge, the new educator may function as more of a guide to help steer students through their own personal learning experiences.

New technologies such as virtual reality, augmented reality, and artificial intelligence can be beneficial to self-directed learning due to their focus on making students active participants in their learning (Cook & Gregory, 2018). AI technology in particular would seem to provide a host of opportunities for the differentiation of instruction necessary for adaptive learning (Cook & Gregory, 2018).

Adopting a curriculum that allows students to move through individualized learning paths using traditional teaching methods may seem daunting. This is another area where AIs aim to increase efficiency and limit human work may be beneficial. AI can be a useful tool in the creation and modification of individual learning paths to provide each student with exactly what they need academically (Cook & Gregory, 2018).

Forming an operational definition of AI

AI can be defined as a thinking machine. The difference between simple machines and thinking machines lies in the latters’ ability to learn from data and update their actions and views accordingly (Huang, Rust, & Maksimovic, 2019). New technologies driving AI, such as deep neural networks, have led to groundbreaking advancements in areas such as paralinguistics, audio-visual recognition, speech recognition, object recognition, speaker recognition, and combined problem solving tactics (Tzirakis, Trigeorgis, Nicolaou, Schuller, & Zafeiriou, 2017).

There are three types of AI intelligence, delineated by the ways which they change data inputs into performance outputs (Huang, Rust, & Maksimovic, 2019). These intelligence types are: thinking, feeling, and mechanical, and they are described by Huang, Rust, & Maksimovic (2019) thusly:

> Some AI systems are mechanically intelligent, designed to perform repetitive tasks for consistent and reliable performance; some AI systems are thinking-intelligent, designed to learn and adapt from data autonomously; and some future AI systems may become feeling-intelligent, designed to interact empathetically with people. (p. 45)

Each of these different types of AI tends to lend itself to specific types of situations that may make them more capable of performing some types of educational tasks than others.

AI and the economy

The increasing capabilities of artificial intelligence are altering the global economy in many ways. The shift away from a workforce based on mechanical tasks began with the advent of automation but has continued with AI to the point where most of these types of tasks are now done by machines (Huang, Rust, & Maksimovic, 2019). There is much debate about how the transformation brought about by AI will impact the workforce of the future, with one viewpoint holding that AI will eliminate some jobs but create new ones, whereas the other viewpoint is that AI will eventually replace all human workers entirely (Huang, Rust, & Maksimovic, 2019).

Our current global economy can be seen as consisting of three different economies. These are the mechanical economy, the thinking economy, and the feeling economy (Huang, Rust, & Maksimovic, 2019). Most jobs contain some elements of each of these economies, but the percentages are constantly in flux. In the mechanical economy, employment and salaries tended to be based on simple repetitive tasks such as machine maintenance while in the thinking economy these are based on the ability to complete problem-solving and decision-making tasks, like interpreting and analyzing data (Huang, Rust, & Maksimovic, 2019). In the feeling economy, so-called "soft skills" such as communication, coordination, and the establishment and maintenance of relationships are of primary importance.

The mechanical economy was replaced by the thinking economy decades ago, and the thinking economy is now being overtaken by the feeling economy (Huang, Rust, & Maksimovic, 2019). We will be seen to have transitioned to this type of economy completely when the employment and wages related to feeling tasks exceed those attributable to thinking and mechanical tasks. Huang, Rust, & Maksimovic (2019) see this happening within the next 20 years, based on projections that utilize U.S. government data. These fundamental changes to the economy can be linked to the increasing capabilities of AI.

AI makes certain types of job tasks irrelevant, and the workers displaced by the change must find employment in other sectors or learn to adjust to the changes that AI has wrought. The mastering of mechanical tasks by AI ushered in the thinking economy, which caused may workers to focus on the "thinking" tasks of jobs (Huang, Rust, & Maksimovic, 2019). The current progress of AI in performing "thinking" tasks is now pushing organizations to put more emphasis on obtaining employees more adept at the "feeling" tasks that AI has not yet mastered. Data has shown a notable decline in employment tasks related to the “mechanical economy” and a significant increase in tasks related to the “feeling economy” (Huang, Rust, & Maksimovic, 2019). Workers will need to adapt to this shift by honing their “soft skills” and learning to utilize AI for more analytical tasks rather than relying on their own skills and intuition. Despite this shift, most colleges are still focused on the transmission of knowledge from teachers to students rather than the metacognitive skills that will be needed to obtain employment in our new economy (Aoun, 2017).

While the importance of the “feeling economy” has been established, there is no guarantee that AI will not eventually replace many of these jobs as well. Artificial emotional intelligence has improved in recent years and now some AI is more capable of sensing and responding to human emotions (Krakovsky, 2018) and reading facial expressions (Aoun, 2017).

Creative occupations may be in danger as well, with so-called “computational creativity” allowing AI programs to create intellectual property as varied as clothing, songs, and books. An AI trained to create songs wrote lyrics that were judged to be more emotional and creative than lyrics from famous songs created by humans (TickPick, 2020). There are currently attempts to allow AI programs to obtain patents for ideas that are primarily theirs’ (Chen, 2020).

If this seeming last refuge of human dominance, the feeling economy, becomes subsumed by AI as the economies that came before it have, then a new way forward will need to be found if the human workforce is to remain employed in purposeful occupational endeavors. In is unlikely that education would be spared from such a civilizational change, and steps must be taken now to prepare for what may come.

AI and education.

The usage of artificial intelligence in educational venues is an area in need of further study (Zawacki-Richter, Marin, Bond, & Gouverneur, 2019). There is a debate over what the primary goals of artificial intelligence are, and whether the aim is to mimic humanlike behavior or improve efficiency (Coelho, 2018). The efficiency element can be seen most often in educational arenas, so much of this section will focus on elements of AI relevant to this. Although the full ramifications of AI on education have yet to be fully determined (Cook & Gregory, 2018); researchers have indicated that there are several major areas in which artificial intelligence is utilized in education (Zawacki-Richter, Marin, Bond, & Gouverneur, 2019).

While AI usage in educational technology is rapidly expanding, it does not all look the same. There are a variety of ways in which AI is beginning to have an impact in education, including administrative, teaching, and performing data analysis-based tasks. Zawacki-Richter, Marin, Bond, & Gouverneur (2019) performed a meta-analysis of current research articles that focus on artificial intelligence applications in education. They targeted their analysis on articles published on or after 2007, which was the year that a notable increase in related articles occurred and was also the year that Siri was introduced. While initially they targeted all levels of education, they narrowed their search to only include studies on AI's usage in higher education in particular. Their findings shed some light on the current state of AI usage in education, and it is the most current meta-analysis related to this topic.

Zawacki-Richter, Marin, Bond, and Gouverneur (2019) determined that most AIEd research is done by researchers from the United States, Taiwan, Turkey, and China. They also found that most of the studies that met their criteria were not done by researchers from education departments, rather, 62% were done by researchers belonging to STEM and Computer Science departments (Zawacki-Richter, Marin, Bond, & Gouverneur, 2019). This suggests that more research is needed from scholars in Education departments so that the pedagogical elements of AI in education can be captured more thoroughly.

While many emerging technologies show promise in their potential educational applications, it is artificial intelligence that may have the most wide-ranging impacts. The profession of teaching may be seen by many as a part of the "feeling economy", since many tasks that teachers perform have to do with "soft skills" such as empathy and collaboration. This is not the case, however, as most teachers also perform tasks that are more related to the "thinking economy" or even the "mechanical economy", such as sharpening pencils or analyzing student test data. One way that their job responsibilities may shift is that the processing and evaluating of information may be lessened as the communicative aspects of the job increase, such as relaying said information to peers or supervisors (Huang, Rust, & Maksimovic, 2019). Teachers may soon be counted among other employees who realize that, "Teaming up with AI is not necessarily a job killer, but the nature of the job may need to change" (Huang, Rust, & Maksimovic, 2019, p. 57).

One option for AI usage in regards to education is for AI to become a sophisticated tool in any teacher's toolbox, a digital assistant that can provide valuable real-time data as to where the teacher's efforts should be targeted to help optimize student achievement. The utilization of AI programs in the classroom can help to lessen the teacher's workload by performing management services that would otherwise have to be done by the teacher (Coccoli, Maresca, & Stanganelli, 2016). This view establishes artificial intelligence as a tool to help teachers achieve peak efficiency. It is these types of AI programs, that can easily be dropped into a classroom environment without altering the entirety of instruction, where the most statistically significant increases in student learning outcomes will be found, at least in the near future (McArthur, Lewis, &

Bishay, 2005). AI can assist in the assessment of student learning (Cook & Gregory, 2018. AI programs have been able to accurately grade student essays after being exposed to large numbers of writing samples (Ford, 2015). Watson, a famous AI-driven computer created by IBM, is currently being used to advise teachers on effective strategies and generally improve instruction in New York City's public schools through the usage of data analytics (Aoun, 2017).

AI programs can also function as digital assistants that can perform as tutors and help a student with topics with which they may struggle, without replacing the traditional teacher who remains in charge of the class. These types of Intelligent Tutoring Systems were among the first types of applications utilizing AI in education (McArthur, Lewis, & Bishay, 2005). These rudimentary AI systems work best with simple drills aimed towards well-defined learning goals, primarily in subjects with a strong basis in facts such as mathematics. A paradox to the success of these programs lies in their very nature, since the emergence of new technologies has reduced the importance of rote fact memorization skills such as remembering algebraic formulas and spelling accuracy (McArthur, Lewis, & Bishay, 2005). Schools and teachers have noticed this and begun to shift their teaching to emphasize so-called "higher-order thinking skills", or skills less likely to be aided by the assistance that rudimentary AI can provide.

A course at the Georgia Institute of Technology recently introduced a new teaching assistant that was powered by artificial intelligence, unbeknownst to the students (Maderer, 2016). The class interacted with her online by asking her questions that she would respond to, initially monitored by human teaching assistants. As her efficiency improved, she was allowed to answer questions herself if she was 97% positive that her answer was correct (Maderer, 2016). All students rated her performance very positively, and most had no idea they were interacting with an artificial intelligence until it was revealed at the end of the course (Maderer, 2016). Another AI program dubbed Hubert was created to assist professors in gathering student end-of-semester evaluations (Lieberman, 2018). More than 600 instructors are currently using this program, and it is a great example of AI technology being used to improve efficiency in education.

There is also a real chance that AI programs may eventually replace the role of the teacher entirely. By providing material to a student and then assisting them with their questions, some AI-powered software has the potential to replace human teachers entirely. While early forms of AI were very basic and nonintuitive, the technology has increased by leaps and bounds in recent years. Students utilizing these types of programs tend to enjoy school better and have more positive feelings about their learning (Flogie & Abersek, 2015). Another usage of AI that can assist teachers lies in the parsing and evaluation of educational texts. Artificial intelligence programs can be used to analyze educational texts so that they can be modified to be more beneficial to the reader in terms of knowledge transmission (Horakova, Houska, & Domeova, 2017).

For the first time, select forms of artificial intelligence have begun to outperform their flesh and blood peers. A recent study undertaken in Zhengzhou, China, compared the performance of students taught by traditional teachers against those taught by AI-powered software on the GaoKao standardized college entrance exam (Tao, 2017). The experiment was supervised by the local education bureau and the instructors selected for the experiment had an average of 17 years of experience in teaching. The students taught by the AI increased their scores on the exam by 36.13 points while the students taught by human teachers increased their scores by 26.18 points (Tao, 2017). The next step for the company that developed the AI, Yixue, may be a partnership with Hanson Robotics, the creators of human-looking robots. This could result in the creation of teaching robots who resemble humans and can improve student achievement more than their human peers.

The strongest argument for this type of option is the speed of technological advancement. Technological improvements have increased exponentially in recent years, from the processing power in computer chips to the advances made in smartphone technology. This makes it hard to imagine a future in which the abilities of AI-powered software don't improve exponentially. If this type of software can already outperform human teachers within certain parameters, it is easy to see how AI instructors may eventually replace their human counterparts. The greatest teacher in the world simply cannot keep up with the processing power of an artificial intelligence that can instantly monitor and adjust the individual learning processes of a classroom full of students.

AI has already been shown to work well in online courses as well, whether it be through the reduction of human labor or retention of students (Coelho, 2018). Another area where artificial intelligence has already been proven to be particularly effective is in the arena of mathematics instruction. Since mathematics is by nature very rules-based, it syncs up well with the strengths of current AI systems. Some programs help students to progress by analyzing their performance as they go through the steps to solve a problem, rather than just providing feedback on whether or not the answer itself was correct (Nabiyev, Karal, Arslan, Erumit, & Cebi, 2013). This way the AI can redirect a student when they are missing a key step in the problem rather than just informing them when they answer incorrectly. Typically, after several tries the AI will make an assumption that the problem in question is at a higher ability level than the student is capable of solving, and a new, lower level problem will be provided (Nabiyev, Karal, Arslan, Erumit, & Cebi, 2013).

Students today tend to be far more tech-savvy than previous generations, which could potentially make for an easier transition to an AI-led educational environment. Students in multiple studies have referenced the ease of use they experienced when using AI programs (Nabiyev, Karal, Arslan, Erumit, & Cebi, 2013). There is also a growing acceptance among humans that machines can be trusted to provide knowledge even in sensitive areas like economics or medicine (Coccoli, Maresca, & Stanganelli, 2016).

An oft-cited drawback of educational AI programs are the communication barriers between AI and humans. The rapid advance of AI technology may soon make these worries a thing of the past. Seldon (2018) speaks of educational programs that can study brain waves and human facial expressions in order to provide relevant instruction to students. The increasing power of machine learning and deep neural networks have made this type of emotional identification possible (Coelho, 2018; Tzirakis, Trigeorgis, Nicolaou, Schuller, & Zafeiriou, 2017). This is important because, "Emotion recognition is an essential component towards complete interaction between human and machine, as affective information is fundamental to human communication" (Tzirakis, Trigeorgis, Nicolaou, Schuller, & Zafeiriou, 2017, p. 1301). While previous forms of machine learning AI learned from preexisting datasets, the new trend has been to have AI learn from raw, or unprocessed, data, which should lead to better performance (Tzirakis, Trigeorgis, Nicolaou, Schuller, & Zafeiriou, 2017).

One factor that has the potential to transform AI usage in education is the ability of AI programs to better assess the emotional state of the humans that are utilizing it. Without the ability to understand human emotions, AI would not be able to detect the emotional nuances that play a large part in how human beings converse with each other. For an AI program to be truly successful in it's interactions with humans, it needs to be able to identify and react to human emotions effectively (Krakovsky, 2018).

In just the past few years, major breakthroughs have occurred in AI's emotion detection capabilities (Krakovsky, 2018). This is possible because newer forms of AI neural networks can utilize deep learning algorithms to sift through huge amounts of data and teach themselves to recognize the underlying emotions beneath the raw data they are examining (Krakovsky, 2018).

In order to develop the contextual knowledge necessary to interpret the vagaries of human emotional displays, AI programs must be equipped to recognize nonverbal cues as well. Human beings tend to mask their emotions and AI can better identify emotions when multiple modalities are analyzed (Krakovsky, 2018). These modalities can include factors as varied as heart rate, body language, facial expressions, or voice tonalities. The ability of AI programs to perform this type of multimodal analysis has increased dramatically (Krakovsky, 2018). So-called “microexpressions” are important to communication as well. Lately, there have been advancements in the ability of AI to recognize these microexpressions as well, even though they may be extremely brief in nature (Krakovsky, 2018).

These increased emotional detection abilities can potentially allow AI to be successful in a variety of new venues. Emotionally intelligent AI could be used on helplines to identify callers who may be at increased risk of suicide (Krakovsky, 2018). The possible educational applications of these new and improved AI programs are numerous as well. Socially assistive robots driven by AI have been used to assist children with autism, by assisting them in their identification and expression of emotions (Krakovsky, 2018). Another potential application of this lies in AI programs that can read human cues and provide access to corresponding answers from a database (Coelho, 2018).

While the emotional capabilities of AI were once seen as a weakness, it could now be said that this is becoming an area of strength. The sheer bandwidth that AI has access to could even eventually allow such programs to surpass human beings in the ability to detect emotions (Krakovsky, 2018).

The ability to recognize micro-expressions can be beneficial in the field of teaching (Pool & Qualter, 2012; Xu, Zhang, & Wang, 2017) because it can allow the instructor to better understand the true emotions that their student may be experiencing, rather than just the easily identifiable macro-expressions. This can be a difficult skill to develop, in both humans and machines. The practical applications that could be derived from deciphering these microexpressions have been limited due to this difficulty, which stems primarily from their subtlety and brief duration, from 1/3 to 1/25 of a second (Xu, Zhang, & Wang, 2017). An AI program with the ability to identify human emotions quickly and accurately could help to make it a much more effective teacher. Education is one area in which effective communication is particularly necessary, and these new AI capabilities seem to suggest that meaningful human-AI communication is possible.

AI in Educational Leadership

The advent of a new type of economy will necessarily have an impact on those leading organizations as well as the organizations themselves. A new type of management will be needed to help organizations deal with the changes this AI-driven shift will cause (Huang, Rust, & Maksimovic, 2019). Managers will need to become better at shifting the focus of their employees to tasks related to empathy and relationships while utilizing AI to perform more of the tasks related to thinking. In education, this means that the leaders of schools and districts will need to become more cognizant of how their organizations are utilizing AI, for both high-level organizational tasks and low-level classroom-based initiatives. This would seem to necessitate a new type of preparation for educational leaders, so that they will be better prepared to understand the ways in which AI can be used to impact the educational environment they are managing.

While leadership positions involve both “thinking” skills and “feeling” skills, the “thinking” skills will likely become more emphasized in years to come as leaders become more adept at utilizing AI for the more analytical aspects of their jobs (Huang, Rust, & Maksimovic, 2019). This applies to educational leaders as well, and while they may be slower to adapt to the shift than their peer leaders in business and other industries, the change will happen nevertheless. Educational leaders who position themselves at the forefront of this fundamental shift will help their schools and districts be more competitive with those in other parts of the world. This does not necessitate that educational leaders rapidly adopt every new AI innovation that comes their way. It instead requires leaders, schools, and districts to gain a knowledge of how their schools or districts can best utilize AI to take advantage of existing technological capability, lessen teacher workload, and provide students with an education that takes advantage of the best that AI can offer while also preparing them for the "feeling economy" that will await them upon their graduation.

Educational technology leadership.

As technology continues to embed itself in society in new and ever-changing ways, so has it continued to alter the field of education. These changes have altered how teachers do their jobs, as well as how schools operate. This would seem to necessitate not only a new way of looking at education, but also the educational leaders who make so many of the operational and academic decisions for their organizations. In this section I will discuss the current state of educational technology leadership, different ways that leaders make decisions relating to technology, and the need for the creation of a new technology-oriented paradigm within which to discuss school leadership.

What is an educational technology leader?

While any individual teacher may be proficient at utilizing technology in their classroom, it is school and district leaders who have the power to set the technology agenda for their organizations. Richardson, McLeod, & Sauers (2015) note that, “Good technology leadership is essentially just good leadership for our digital, global era,” (p. 25). Studies have shown that administrators should be deeply involved in the promotion of technological elements within their schools (Hamzah, Juraime, Hamid, Nordin, & Attan, 2014), and should help their teachers find and implement teaching and learning technology (Creighton, 2003).

There are two main approaches to technology decision-making in education which emerge from related parent philosophies, both of which can be located within the broader construct of technological optimism (Webster, 2017). One approach is that technology usage should be driven by curriculum and educational goals. This approach springs from the philosophy that views technology as a means to an end, or simply another tool to be used by educators when applicable (Webster, 2017).

The second approach supports the idea that if someone does not keep up with technology they will be left behind, and this emerges from the technological determinist philosophy that espouses the idea that technological change is an inevitability (Webster, 2017). Webster (2017) found this approach to be more important to school leaders when making decisions about technology adoption, although both approaches were sometimes evident in the same educational leader simultaneously. Webster (2017) suggests that the personal experiences of educational leaders in regards to the advancing pace of technology may be the reason behind the primacy of this approach. However, this pressure to keep up with the pace of technological advancements can sometimes lead to the hasty adoption of technology ill-suited for a particular learning environment.

A study of "tech-savvy" superintendents revealed five core dispositions that were shared amongst all participants (Richardson, McLeod, & Sauers, 2015). The identified dispositions highlighted the importance of collaboration, clear expectations, risk-taking, and vision setting. These dispositions correlate fairly closely with the Standards for Educational Leaders identified by the International Society for Technology in Education, which suggest that school leaders be empowering of their staff, connected learners, systems designers, equity/citizenship advocates, and visionary planners (International Society for Technology in Education, 2020). Educational technology leaders must also be excellent communicators of the academic impact that can come from successfully implemented technological endeavors (Persichitte, 2013).

Any journey to becoming an effective technology leader must begin with an idea of what a school wants to accomplish and why. This must be accompanied by an honest analysis of a school's strengths and weaknesses, and clear markers that will allow school leaders to know when they have reached these goals (Creighton, 2003). Educational leaders have an important part to play in instituting educational change that impacts students, and understanding their actions is important in any effort to determine what good leadership looks like (Richardson, McLeod, & Sauers, 2015).

Integrating technology into schools often requires transformational leadership in order to challenge the practices, skills, and tendencies that already exist in a school (Hamzah et al., 2014). This type of risk-taking is important when challenging the homeostatic nature of many educational environments (Persichitte, 2013), and it is particularly important given the ever-changing nature of technology and our relationship with it. According to Persichitt (2013), "Educational technology tools and research continue to evolve at a rate none of us can fully capture or effectively prepare for, so we must lead with calculated risks" (p. 16).

There are various types of technology that can impact a school setting, and it is oftentimes left up to educational leaders to grapple with which programs make sense for their schools. Some types of programs that have impacted education include e-portfolios, human resource programs, digital performance review systems, and assessment programs (Persichitte, 2013). Regardless of whether the technology pertains to school management, teaching, or anything else, it is important for the school leaders to be knowledgeable and effective in deciding how it will be used in their schools (Hamzah et al., 2014)

Effective technology leaders in education do not operate in a vacuum. While they may be competent themselves, it is their ability to marshal the forces under their command that will determine whether or not they are successful. It is important for school leaders to understand that any introduction of new technology tends to create some form of opposition (Persichitte, 2013). Most schools consist of teachers with varying degrees of technological prowess, and it is up to school leaders to utilize these different types of teachers in ways that maximizes their potential. Persichitte (2013) suggests that educational technology leaders need to manage their resources with as much focus on the human element as there is on the technological elements.

An understanding of the technological history that each of us carry with us is important also. Most educators have a mixed history of seeing technology implementations, with some being successful and some not (Persichitte, 2013). Referring to past technology-related efforts in a school can be helpful, as is setting a clear timeline for implementation with adequate time for piloting and troubleshooting (Persichitte, 2013). These strategies can help to mitigate some of the oppositional elements that may be resistant to change, while forming a cohesive team that is working together towards a common goal.

School administrators have an integral role to play in promoting the use of technology in their organizations (Hamzah et al., 2014). A clear alignment of educational goals with the appropriate technology should lead to the greatest benefit for schools, and it is for this reason that I have included in my interviews the question, "How does the adoption of this AI program align with your school's educational goals?"

Drawbacks to AI in Education and Areas for Further Research

The field of study for AI in education remains remarkably limited, although there has been an increase in recent years (Zawacki-Richter, Marin, Bond, & Gouverneur, 2019). Despite the prevalence of AI in many aspects of our lives, academia has been hesitant in adopting AI technologies (Cook & Gregory, 2018). Cook and Gregory (2018) suggest that this could be due to prohibitive costs or perhaps the idea that the human connection part of education could be lost.

Although some AI programs have improved in their ability to communicate with us, they still lack the cultural agility of humans and the ability to understand the nuances of communication such as subtexts, contexts and inferences (Aoun, 2017). Another difficulty lies in the different types of thinking that would need to be mastered by AI. The concept of divergent and convergent thinking, developed by J.P. Guilford (1967), details how people use these different types of thinking for different types of tasks. Convergent thinking deals with weighing alternatives in an attempt to find the single correct answer, while divergent thinking involves using creativity to find lots of potential answers (Guilford, 1967). While AI programs are quite adept at accomplishing convergent thinking tasks and even tasks that have require a mixture of convergent and divergent thinking, they still are not yet capable of handling fully divergent tasks such as writing a novel (Aoun, 2017).

However, recent advances in technology have made this a distinct possibility, primarily due to the advent of artificial intelligence and it's creeping prevalence in our everyday lives. According to Coelho (2018), artificial intelligence is the one thing that could, in theory, allow machines to function as educators in a real way. Cook & Gregory (2018) also argue that AI could be one of the biggest game changers for education, although they focused mainly on applications for higher education. While much of the current research on AI focuses on higher education, there is no reason to believe that it won't have a similar effect on younger students as well. This also may be because institutions of higher education currently offer more hybrid or online courses than ever before (Cook & Gregory, 2018), and these types of courses lend themselves more naturally to AI integration.

Although there have been many studies that have provided important contributions to the field of educational research in regards to school leaders and technology (Anderson & Dexter, 2005; Richardson, McLeod, & Sauers, 2015; Hamzah et al., 2014), a more specific analysis of how school leaders perceive the advent of AI technology in schools is an area in need of further research. The revolutionary nature of AI, as described above, would seem to necessitate a study that deals directly with the concept of AI, rather than just a consideration of the broad idea of technology usage and adoption, which is the focus of most existing studies. Another issue lies not in the limited number of total studies concerning AI in education but in the narrow scope and similar characteristics of most of the studies that have been done.

Conclusions and Implications

The 2018 Horizon report about educational technology developments predicted that AI in education will grow by 43% between 2018 and 2022 (Educause, 2018). Without further studies that examine AI in education from a more pedagogical perspective, it is likely that this new technology will be implemented haphazardly, potentially to the disadvantage of the students, educators and administrators that will be using it.

As stated by Zawacki-Richter, Marin, Bond, and Gouverneur (2019), "The full consequences of AI development cannot yet be foreseen today, but it seems likely that AI applications will continue to be a top educational technology issue for the next 20 years" (p. 20).

This expectation of future educational applications for AI may be due in part to the versatile nature of AI programming. Zawacki-Richter, Marin, Bond, and Gouverneur (2019) determined that, "AI-based tools and services have a high potential to support students, faculty members and administrators throughout the student lifecycle" (p. 20). When technology is used appropriately, it can lead to increased student academic performance (Creighton, 2003).

It is the responsibility of school leaders to understand the benefits and drawbacks of using various types of artificial intelligence in their schools. Without direction from their administrators, teachers are likely to implement some of these programs themselves, possibly without the proper direction needed to ensure they are used in a way that best bolsters student achievement. Artificial intelligence is not going away, and it is important for all educational professionals to keep abreast of new developments that may benefit their students.

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2 AN ANALYSIS OF EDUCATIONAL LEADERSHIP IN THE AGE OF AI

Methodology

The increased usage of artificial intelligence programs has greatly altered society in recent years. All sectors of the economy have been impacted, as have the personal lives and habits of individuals. “Artificial intelligence (AI) is arguably the driving technology force of the first half of this century” (Holmes, Bialik, & Fadel, 2019, p. 1). Advances in computing power have led to massive increases in the ability of AI programs to handle a wider variety of tasks than ever before. From manufacturing to farming to medicine, almost all industries have embraced AI as a way to streamline or eliminate many tasks that have been performed by humans for centuries. The elimination of many jobs has already begun, although there is still some debate over whether AI will also create new jobs to replace the old ones. The pace of AI program adoption and integration has increased exponentially, which is leading to massive changes in the economy (Holmes, Bialik, & Fadel, 2019). This has altered the landscape of our world, and workers will need to adapt to be able to remain employable as we enter a new, more automated age.

While it has perhaps not yet been impacted as much as other sectors of society, the field of education will doubtlessly be altered in years to come as educational professionals become more informed about AI’s potential applications to their field. Few industries have escaped the reckoning needed to understand how best to integrate existing AI technology while remaining vigilant about potential future applications. It would behoove all educators, but particularly educational leaders, to gain a deeper understanding of how AI can potentially improve the academic fortunes of the students they serve. Educational leaders have a unique responsibility to ensure that they are prepared for this next round of innovation, just as they needed to learn how best to integrate televisions, computers, and other devices into their schools. Leaders who get a head start on this process can potentially provide their students with academic advantages that may benefit them in the future. Children in school today will be facing a vastly altered world than that of their parents upon graduation, and even a small advantage could be useful as they fight for jobs in our increasingly global, interconnected economy.

As the capabilities of AI programs have increased, so have the questions they have raised. The rapidly changing nature of this technology makes adaptability increasingly important, as well as a broader knowledge of the best way to utilize such programs. Which AI programs to use and how best to use them may become vital questions that all school leaders will need to be equipped to answer. Current educational leadership preparation programs often do little to prepare school leaders to answer these types of questions, which could cause leaders to avoid or delay using programs that could be beneficial for their school.

The guiding questions in this study have been crafted to gain a better understanding of how the innovation of AI is diffusing throughout education and how leaders can impact the implementation of this type of educational technology. There are a variety of options to consider when devising a research design in the social sciences. After careful consideration of many factors, it was determined that this study will employ a case study approach to analyze the perceptions of educational leaders towards the utilization of artificial intelligence in their schools. Triangulation will be achieved through the usage of two data collection methods, interviews and artifact collection.

Guiding Questions

There are two primary goals for this study, the first of which is to gain a better understanding of the lived experiences of school leaders as they are confronted with a new technological advancement in their schools, artificial intelligence (AI). The second goal is to learn how adoption and diffusion processes influence the spread of AI technology in educational settings. These goals are what drove the decision to adopt a qualitative approach rather than a quantitative one. Although an analysis of data related to the performance of AI programs in the classroom may be a useful endeavor, this approach would not provide the broader insight into the minds of school leaders that I am searching for. The guiding questions written to achieve these goals are as follows:

- What do educational leaders perceive as factors influencing the diffusion of artificial intelligence in education?
- How do school leaders influence artificial intelligence implementation in their schools?

Significance of the Study

This study will add to the existing literature on the topic of technology implementation by educational leaders. While there have been many studies dealing with the topic of educational technology leadership, few have dealt with how educational leaders utilize artificial intelligence specifically. The significance of this study is that it will attempt to remedy the current lack of research around the adoption and diffusion of AI technology in education, while also providing unique insight into the lived experiences of school leaders who have utilized AI in their schools.

Theoretical Framework

This study examined the interplay between school leadership and technology by examining it through the lens of the innovation diffusion theory developed by E.M. Rogers (Rogers, 2003; Straub, 2009). According to Rogers (2003), "diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 35). Rogers (2013) determined that the adoption of an idea is a process, not a random occurrence, and there are multiple factors that determine whether an individual is likely to embrace it.

He also noted the importance of diffusion networks and adopter categories when looking at how an innovation diffuses (Rogers, 2013).

Innovation diffusion is a social science theory that deals with the spread of ideas among a particular population (Rogers, 2013) and this study contains elements of innovation diffusion theory as a framework through which to analyze the diffusion networks that the participants may belong to as well as their perceptions regarding the adoption. It is also a useful lens through which to examine what characteristics or factors may have led these leaders to adopt AI technology in their schools in the first place. The perceptions of school leaders are of the utmost importance to this study because it is not the objective classification of an innovation's attributes that is important to adoption; rather, it is a person's individual perception of those attributes that really matters (Rogers, 2003).

A unique aspect of educational leadership lies in the autonomy given to school leaders when it comes to making decisions. Many school leaders rely on leadership teams to bounce ideas off of and gain access to different perspectives. Likewise, school leaders are often mandated to adopt and support educational initiatives handed down to them from district, state, and federal sources. While these are some notable exceptions, the vast majority of building-level decisions are made or signed off on by that individual school's leader. This is important in diffusion research because, "The more persons involved in making an innovation-decision, the slower the rate of adoption" (Rogers, 2003, p. 221). Rogers (2003) even recommended lessening the number of individuals involved in decision-making as a way of increasing the speed of adoption of innovations. According to this belief, education should have a high rate of adoption of innovations due to the consistently small number of individuals involved in making decisions at the building-level. This is also why I chose to focus my study on building-level educational administrators rather than district, state, or federal administrators.

By looking at this issue through that lens, more data was gathered about why some leaders are adopting artificial intelligence for their schools while others are not. This helped to reveal how artificial intelligence programs are diffusing through the educational environment in our current time. The following paragraphs will address the background of innovation diffusion research, it's usages in education, and the two primary elements of diffusion in this study: types of adopter and diffusion networks/communication channels.

Background

The diffusion of innovations theory has roots in many other disciplines, but the book, *Diffusion of Innovations*, first published in 1962 by E.M. Rogers, distilled the many disparate elements into one cohesive theory. An early progenitor of diffusion theory is Gabriel Tarde, whose 1903 book, *The Laws of Imitation*, helped establish many aspects of psychology. He viewed repetition as the universe's main feature and thought that it was the job of scientists to determine what caused the repetition to occur (King, 2016). Tarde believed that individuals were governed by patterns just as cell structures and other biological entities, but with the clear distinction that, "Individuals were conscious beings whose actions were necessarily intentional" (King, 2016, p. 49). Tarde determined that it was the act of imitation that drove much of human behavior, and that social imitation is done intentionally (King, 2016). This provided the basis on which much of diffusion theory is based.

Katz, Levin, & Hamilton (1963) determined that good studies in diffusion define the thing that is diffusing over time, to whom it is diffusing, and what communication channels, social structures/values are involved. The thing being defused must be defined both objectively and subjectively, so as to create a common definition of how that thing appears to the researcher and the adopter (Katz, 1999). This has been accomplished by providing a description of what is considered to be AI in education for the purposes of this study in the literature review, and at the beginning of each interview with an educational leader. This is done to minimize any confusion and ensure that we are talking about the same thing.

Diffusion research has suffered in the past from a lack of common labels with which to discuss seemingly disparate scenarios of diffusion across industries (Katz, 1999). There exists a great degree of difference between things that are diffused, making comparison difficult (Katz, 1999). Differences in cultures and social structures can be problematic as well, as can the involuntary nature of some diffusion processes (Katz, 1999). Everett Rogers is one of the few researchers who have worked to combine all of these different cases into a common whole for the purpose of comparison (Katz, 1999), and his work was utilized extensively as a way to frame some elements of this study.

The S-shaped curve has come to be accepted as a way to visually demonstrate how the diffusion of innovations occurs (Katz, 1999; Rogers, 2003). The S-shaped curve starts with the first 2.5% of adopters, known as ‘innovators,’ followed by the next 13.5% of ‘early adopters,’ followed by the next 34% known as the ‘early majority’ (Rogers, 2003). At this point the curve peaks, as approximately half of the relevant population has adopted the innovation. After this, the curve starts to bend downward and the next 34% of adopters are known as the ‘late majority,’ while the last group to adopt, or the ‘laggards,’ represent the final 16% (Rogers, 2003). It only captures the diffusion phenomenon accurately when the diffusion being studied is successful, however, otherwise it may not be S-shaped at all (Rogers, 2003). While we have yet to see if the advent of AI in education will conform to the traditional S-shape curve, it is still valuable to understand it's characteristics in order to pinpoint where we may currently be on the curve. This S-Curve shares similarities with the three ages of invention initially expounded upon by Gabriel Tarde, who is seen by many as a crucial researcher in the study of innovation diffusion. The three ages were an initially slow advance, then a quick but uniform acceleration, then a measured decline that continues until extinction (Tarde, 1962). This generally matches with the shape of the S-shaped curve expounded on by Rogers (2003). Rogers (2003) determined that for successful adoptions of innovations, the key portion of the S-shaped curve is the part covering 10-20% adoption rates, after which it is difficult to stop a diffusion even if it is no longer desirable. Future studies are needed to determine whether the innovation of AI in education has reached that level yet.

Diffusion of innovations theory is comprised of four main elements: what the innovation is, the channels it is communicated through, what social system it is spreading through, and time (Rogers, 2003). For the purposes of this study, the primary emphasis was on the elements of communication channels and social systems. While the innovation itself has been discussed at length, the similarities and differences between artificial intelligence and other types of educational technology are not the focus of this study. Time was not used either because this is not a longitudinal study.

The communication channels utilized by school leaders were of interest, however, because revealing the depth and extent of awareness-knowledge among school leaders about the innovation is a key goal of this study.

Diffusion in Education

There exists a variety of research traditions within diffusion of innovations theory, each with their own methods of data gathering and units of analysis. I have chosen the education research tradition due to the educational nature of this study. This research tradition is not currently one of the more popular traditions, despite their being a large number of total studies completed (Rogers, 2003). The earliest studies in this tradition emerged almost entirely from one school, the Columbia University Teachers College (Rogers, 2003). One important finding to emerge from these studies was that, "the best single predictor of school innovativeness was educational expenditure per student" (Rogers, 2003, p. 61). This idea lent credence to the idea that wealth was necessary for innovation to occur. Similar findings can be seen in other diffusion research traditions as well, with wealth or status a major factor in whether a person initially decides to adopt an innovation that is not currently popular amongst their peers (Rogers, 2003).

Later studies found that there is actually a much broader range of adoption rates for innovations in education (Rogers, 2003). Rogers (2003) highlights the differing rates for the adoption of modern math (five years) and kindergarten (approximately 50 years) as an example. The support of change agents was seen as a possible reason for the disparity. While they may seem very dissimilar, early innovation diffusion research found that the attributes that influence innovation adoption rates for farmers were related to those that influenced teachers and school administrators when adopting educational innovations (Rogers, 2003).

Types of Adopter

Since the research questions have to do with the perceptions and experiences of school leaders who have adopted AI technology, it was important to create a full picture of each interviewee. This helped me to gain an understanding of what caused the leaders to make the decisions they did, and also to recognize aspects of their beliefs or background that may have colored their perceptions. It is for this reason that several 'why' questions were included in the interviews as a way to better understand why the participants decided to approve the adoption decision in the first place. Rogers (2003) suggested including these types of questions because the motivations of adopters are rarely probed sufficiently in diffusion research. The adopters' attributes must be examined, so a researcher can later make valid comparisons between cases (Katz, 1999).

In diffusion research, the likelihood of an individual to adopt a new innovation can be determined in part by their innovativeness. There is more known about innovativeness than any other part of diffusion research (Rogers, 2003), and several of the interview questions were included in an effort to determine which category of adopter the interviewees fit into (see appendix C). Throughout diffusion research there have been a number of ways to identify different categories of adopters, but the most commonly recognized ones developed by E.M. Rogers have been used for the purposes of this study. Rogers (2003) identified several different categories of person in regards to their attitudes about adopting a new innovation: laggards, early majority, late majority, innovators, and early adopters.

'Laggards' are seen as traditionalists, who are the last to adopt a new system while the 'late majority' can be seen as skeptics, who adopt innovations slightly after the average person (Rogers, 2003). The 'early majority' are deliberate in their decision-making; they interact often within their networks but are rarely seen as opinion leaders (Rogers, 2003). This is in contrast to those individuals in the 'early adopter' category, who tend to be respected by their peers and are seen as the greatest opinion leaders in a network (Rogers, 2003). 'Innovators' are the first people to adopt new innovations, and they are marked by their ‘venturesomeness’, which is a thirst for risky or daring behavior (Rogers, 2003). These gatekeepers must be able to cope with uncertainty, due to the propensity for failure of many innovations (Rogers, 2003). They may not be a part of a given network or system, but their outreach to members of a network can begin the innovation diffusion process.

Diffusion Networks and Communication Channels

One of the primary tenets of diffusion of innovations theory is that individuals adopt new innovations as a result of an exchange of information (Rogers, 2003). These exchanges take place in interpersonal networks, which makes them an important topic to include in most diffusion studies. The interpersonal networks that the participants belong to may tell a vital part of the story as well, and they might hold clues as to why some school leaders have adopted this technology while others haven’t. A number of the interview questions were crafted to determine what, if any, interpersonal networks were deemed important by the participants.

Communication channels can be defined as networks of individuals who are connected by flows of information (Rogers, 2003). The communication channels that educational administrators belong to can be quite extensive. Educational leaders typically are exposed to multiple different groups of educators by necessity to gain their position as educational leaders. Most educational leaders began their careers as teachers, which immersed them in communication channels with other teachers through certification programs, degree programs, and professional developments, along with the more informal peer groups that consist of other teachers with whom they work or converse. Educational administrators are then exposed to even more educators through the preparation programs necessary to gain positions of leadership, such as certification or doctoral programs. Additionally, these leaders are often required to participate in on-going professional developments throughout their careers, which bring them into contact with peer groups made up of other educational leaders.

Both early career and late career educational professionals may participate in online chats, professional conferences, unions, and other channels that expose them to even more educational professionals. Late adopters tend to be swayed to adopt an innovation more through their interpersonal channels as opposed to mass media sources (Rogers, 2003). Since educational administrators are often found to be late adopters of new technological innovations, this would lend credence to the notion that they are more persuaded by their interpersonal networks than they are by mass media sources.

Sociometric questions were included in the interviews, as suggested by Rogers (2003), in order to determine the network links important to this study rather than just the individual characteristics. It is important to understand how the networks of my participants operate so that the communication structures to which they are linked can be determined (Rogers, 2003). Communication structures can be incredibly complex and individuals may not even understand that they are part of a structure (Rogers, 2003). While this study is not extensive enough to reveal the participants' communication structures in their entirety, the goal was to obtain some knowledge as to how they operate.

Methods

This is a qualitative case study focused on the experiences of educational leaders who have adopted AI technology. Qualitative interviewing allows the researcher to develop a portrait of a complicated process through the synthesis of descriptions gleaned from separate interviewees (Rubin & Rubin, 2012). Yin (2009) suggested that case studies are an appropriate research method to use when the goal is to understand any type of social phenomena. It also allows for the researcher to preserve the properties and characteristics of real-world events (Yin, 2009). It is for this reason that a case study was used in order to gain a better understanding of how AI is perceived by school leaders. Through the examination of school leaders' experiences, the current state of AI in schools as seen through the eyes of school administrators can be documented. This has helped to reveal a deeper understanding of the phenomena itself.

A case study methodology typically utilizes a small number of detailed examples to draw conclusions about a phenomenon (Blatter, 2008). Strengths of this approach include the ability to study each case selected for study very deeply (Blatter, 2008). Case studies also can be used to produce theoretical innovations and define the specific interplay occurring between effects and causes (Blatter, 2008). Responsive interviews were conducted with each of the participants in this study. Rubin and Rubin (2012) define responsive interviewing as selecting participants who are knowledgeable about the topic being studied, then listening to them carefully and asking follow-up questions when appropriate. Follow-up questions were asked frequently during the interviews in order to get the participants to reveal more about their experiences and add pertinent details. This allowed for a deeper discussion than what would've occurred had the focus been exclusively on the interview questions. A responsive interview also tends to be focused on a single topic (Rubin & Rubin, 2012), which has been achieved by focusing only on the topic of AI in education. This format was intended to provide information related to each participants' innovativeness, which can be defined as, "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system" (Rogers, 2003, p. 280).

A social construction epistemology was chosen for this study, since the goal was to examine participants' perception of their experiences and how they have interpreted them (Rubin & Rubin, 2012). This type of naturalistic approach was chosen because it should best reveal the richness of the participants' experiences (Rubin & Rubin, 2012), which are vital to the goals of this study.

Sample

A purposive selection process was used to select the participants for this study because this type of process is often used in qualitative research when the goal is to tie the sample to the objectives of the research (Palys, 2008). This is based around the idea that a person's identity and role have an important influence on the concept being studied (Palys, 2008). Due to the agency that school leaders have to make decisions that impact their organizations, the distinctiveness of these factors is key. School leaders all have different beliefs and skills sets that make their marks on the schools they lead; this lack of interchangeability necessitates a more purposive type of sample (Palys, 2008). The purposive sample included the following criteria:

- Since the goal of this study was to examine the perceptions of individuals who had utilized an educational AI program, only those individuals were considered. In-depth qualitative interviewing requires that the researcher selects participants who are familiar with the problem being investigated (Rubin & Rubin, 2012). For this reason, only individuals who have utilized a specific AI program (ALEKs) were included, although some participants also utilized additional AI programs.
- Only individuals currently in positions of educational leadership were considered for participation in this study. This study was focused only on educational lead-

ers, due to their perceived agency in decision-making and knowledgeability of educational settings, academic needs, and educational technology program implementation. This type of purposive sampling is used in studies where the participants must share a specific life experience (Palys, 2008). The operational definition of 'educational leader' for this study included Principals, Assistant Principals, Academic Coaches, Lead Teachers, and Instructional Support Specialists.

- This study was focused specifically on one school system located in the Southeastern United States. This was done to ensure that the focus of the study did not become too broad. The information I gathered from the ALEKs company representative informed me that this one school system contained enough administrators familiar with the program to provide a sufficient sample to achieve saturation.
- There was no constraint placed on the type of school, with leaders from elementary, middle, and high schools invited to participate. This was done to provide a sample more representative of the experiences of school leaders of students from all grade levels.

The ALEKs program is a mathematics program driven by AI that is currently being used in many schools across the county to improve mathematics skills in students from all grade levels. It was selected because it is well-established and is primarily based on mathematics, which is a more natural area for AI integration than other content areas. Although there have been some attempts to utilize AI programs in domains such as argumentation and dispute resolution, most programs are focused on physics or mathematics due to their well-defined nature (Holmes, Bialik, & Fadel, 2019). ALEKs works by using artificial intelligence to determine what a student knows and then providing an individualized learning program for each student, based on what a student is most ready to learn at the time (ALEKS, 2020). The course content provided by ALEKs is aligned automatically to state standards based on where the user is purchasing the account, and it can function as an instructional supplement or as a stand-alone curriculum for home-schooled children or other independent users (ALEKS, 2020).

The first step in the sampling process involved contacting the ALEKs company to obtain a list of schools in the identified school system that had current subscriptions for students to use the ALEKs program. This gave me a total of 22 schools to consider, one of which recently ceased to exist. I then did an internet search to find the names and e-mail addresses for the principals of each of the schools that still existed. Each principal received a form e-mail that stated who I was, why I was contacting them, and the focus of my research (included in appendix C). Each of the four principals who responded was used as a participant in this study, and I conducted interviews with each of them. Three of the principals interviewed indicated that one of their assistant principals was pivotal in the decision to adopt the program, and those three were then asked if they would agree to participate, which they all did.

It is important to understand who in each school was involved in the decision to adopt the ALEKs program, so interview questions were included that pertained to what made the administrator choose to adopt the program. This was done so that another person at that school could also be interviewed if they assisted in the selection of the program. Sometimes school principals are not the only ones responsible for program adoptions, and it is in this way that a school could be seen as innovative regardless of the principal's social or personal characteristics (Rogers, 2003). It is for this reason that snowball sampling was included in addition to the initial purposive sampling, so that individuals besides the principal could be interviewed if their importance to the adoption or implementation process was identified during my initial interviews with principals. Snowball sampling describes a type of sampling wherein the participants are asked if they would like to identify another individual to participate in the research (National Science Foundation, 2020). The initial sampling restraints were observed by requesting that only individuals in positions of educational leadership from within the participants' own organization be selected. This would ensure that any additional participants were also at a school that had adopted AI technology. This helped to create a sample that was varied but still constrained by the initial sampling criteria. Snowball sampling is frequently used in studies focused on the diffusion of new technology (National Science Foundation, 2020), making it ideal for the purposes of this study.

Four principals and three assistant principals participated in this study. The participants represented four schools, two of which were Title 1 and two of which were not, with varied student demographics and a mixture of past academic success based on their publicly available data. Leaders One and Five were from the same large urban Title 1 high school. Leaders 2 and 7 were from the same urban Title 1 elementary school with a large student body also. Leaders 3 and 6 were from a mid-size suburban middle school, and Leader 4 was from a small suburban elementary school. Further details about the qualifications and experience of the participants are provided in Table 1: Participant Demographics below.

Table 1

Participant Demographics

Pseudonym	Position	Type of School	Size of School	Qualifications	Experience	Type of Adopter
Leader One	Principal	High (9-12)	L	GD	LC	EM
Leader Two	Principal	Elementary (K-5)	L	DD	LC	EM
Leader Three	Principal	Middle (6-8)	M	GD	MC	EM
Leader Four	Principal	Elementary	S	GD	MC	EM
Leader Five	Assistant Principal	High	L	CD	MC	EM
Leader Six	Assistant Principal	Middle	M	GD	EC	I
Leader Seven	Assistant Principal	Elementary	L	GD	EC	I

Key:

Size of School	S=Small (less than 500 students)	M=Medium (less than 1,000 students)	L=Large (1,000 or more students)
Qualifications	CD=College Degree	GD=Graduate Degree	DD=Doctoral Degree
Experience	EC=Early Career (0-5 years as an administrator)	MC=Mid-Career (5-15 years as an administrator)	LC= Late-Career (15+ years as an administrator)
Type of Adopter	I= Innovator	EM= Early Adopter	EM= Early Majority

Since the purpose of qualitative research is to develop an in-depth understanding of the phenomena being studied, saturation can be used as a guideline for selecting my sample size instead of statistical criteria (Morgan, 2008). Saturation is achieved in qualitative research when a full description of the event being studied is evident (Sandelowski, 2008). The sample size utilized provided the level of description required to answer the research questions chosen for this study and achieve saturation.

Choosing to focus on only a few participants can lead to a more detailed perspective than one with more participants (Creswell & Guetterman, 2019). Rubin and Rubin (2012) suggest that large numbers of participants are not necessary in case studies, and that interviewing two to three people from each vantage point being studied is sufficient. Since this study focused on analyzing the phenomena from the vantage point of educational leaders, this would suggest that the sample size utilized was large enough to reveal the information being sought.

Data Collection

Two data collection methods were utilized in this study, individual interviews and artifact analysis. Detailed interviews were conducted with seven participants, with each interview lasting between 45 minutes and an hour. Prior to conducting each interview, I had a brief informal conversation with each participant to build rapport, as suggested by Moustakas (1994). The interviews all took place over the telephone and were recorded so that a full transcription could be completed at a later time. This would allow for a greater degree of accuracy in the parsing of each participants' specific verbiage as they described their experiences. The interviews consisted of a set of standardized questions (included in Appendix A), although further follow-up questions were used during the course of the interviews if they seemed applicable to the goals of the study. While the questions based around participant experiences specifically referenced the

ALEKs program, questions related to the perceptions of the participants as to how AI is diffusing through education and potential future usages were more general in nature. The questions were developed to frame the interviews around the guiding questions of the study and the research framework in order to generate the data needed to provide a detailed picture of the participants' experiences and perceptions. This type of generative, explorative interview has been used in other studies to ascertain the essences and meanings of participant experiences (Frick, 2017; du Plessis, Carroll, & Gillies, 2017). All participants were given pseudonyms so as to maintain confidentiality, and participants were informed of the recording beforehand so as to gain consent.

An artifact analysis was also performed to provide additional data for the study. The artifacts were all related to how each individual has implemented AI programs in their schools. The artifacts that were collected included schedules and program guidelines that helped to provide a clearer picture of how each participant implemented AI technology in their school. The schedules showed the times during the day that students utilized the ALEKs program, and the program guidelines provided more detail about why the program was being used, which students would utilize it, and when. The schedules depicted the way that some of the leaders had created Extended Learning Times to provide times for their students to access ALEKs outside of the normal school day. The program guidelines helped to illustrate which students would access the programs and when, based on their specific needs. The guidelines also discussed how teachers could help guide students through the usage of ALEKs. These artifacts helped to provide context to the discussions with participants about how the program was used in their schools.

Data Analysis

Since the primary source of data in this study were the words of the interviewees, a comprehensive process was undertaken to ensure that the words and meanings of each participant were recorded and transcribed as accurately as possible. This was vital because the goal of this study was to examine the experiences and perceptions of the participants, and this can only be done if their words were captured with fidelity. Audio recordings of each interview were transcribed and put through a multi-step review process, after which an in-depth analysis was performed. The analysis consisted of four separate phases detailed by Ruona (2005). These phases are data preparation, familiarization, coding, and the generation of meaning. Each of these phases are described in detail in the remainder of this section.

Data preparation.

The first phase of the data analysis was the data preparation phase. The data preparation phase involves organizing data and creating categories (Ruona, 2005). This phase involved taking the recordings and creating transcripts of the interviews by using Temi, a transcription service. The recordings were uploaded to the Temi website and it quickly produced transcriptions of each. The transcripts were then reviewed while listening to the initial audio recordings to check for accuracy. The transcripts were edited and a final draft copy was developed. Copies of the transcripts were then provided to the interviewees to make sure that their words and meanings were documented correctly. The final drafts were uploaded to NVivo for coding. After this was completed, I moved on to the familiarization phase.

Familiarization.

The second phase of the data analysis was familiarization. The familiarization phase described by Ruona (2005) involves reviewing and reflecting on the data, which was accomplished in this study by analyzing each transcript thoroughly and reviewing the notes taken during each interview. Analyzing the transcripts in this way allowed me to gain a greater familiarity with the data. Reviewing the notes helped me to realize some connections and overarching ideas that I noticed during the interviews, such as the unexpectedly frequent references to topics related to generational change. This process revealed some common verbiage between the transcripts as well, such as the usage of the words, 'adaptability,' 'innovation,' and 'generations' by several participants. Several initial themes began to emerge during this phase of the data analysis as well, although they would need to be confirmed by further analysis in later phases. The themes initially recognized at this stage were generational change and diffusion networks, due to related references by several of the participants.

Coding.

Once familiarization was completed, I began the third phase of the data analysis, coding. The process of coding can be described as attaching labels to data and categorizing it (Ruona, 2005). Two coding cycles were used to interpret the data in this study. The usage of two cycles is suggested by Saldana (2016), with the first cycle intended to broadly group the data while the second cycle being used to really analyze the data. The first coding cycle utilized In Vivo coding and the second utilized Pattern coding. This phase of data analysis was aided in this study through the usage of the NVivo qualitative coding software.

Since my research questions are ontological in nature, I chose to use In Vivo coding for the first cycle of data analysis (Saldana, 2016). In Vivo coding can also be referred to as 'literal coding', and it is used to capture the experiences of interviewees by relying on participant-generated words and phrases (Saldana, 2016). Saldana (2016) argues that this type of coding is appropriate when the focus is on data that is based around the perceptions of the participants. This form of coding is also useful when the aim of the study is to establish a new theory around a phenomenon (Saldana, 2016), and this study's emphasis on exploring the perceptions and experiences of individuals grappling with a new technology fit this description. A descriptive coding method was initially considered but eventually rejected because it tends to not give sufficient insight into the perspective of interviewees (Saldana, 2016). This would be counterintuitive given the research questions and the type of data collected.

While In Vivo coding can be used in almost all qualitative studies, it tends to be most useful for studies where it is important to ensure that the voice of the subjects is captured (Saldana, 2016). I have used this form of initial coding to highlight words and phrases that appeared significant while retaining the voices of my participants (Saldana, 2016). This was done by highlighting text segments within the transcripts in the NVivo program that emerged from the participants themselves. The In Vivo codes used the original language used by the participants in order to better depict their actual experiences and perceptions. These codes were identified when the participants said something that could potentially be related to the guiding questions or the goals of the study.

I felt that this type of coding would best reveal where education currently lies on the S-shaped curve (Rogers, 2003), as well as where it is located within the Gartner Hype Cycle (Gartner Hype Cycle, 2020). The S-shaped curve utilized in diffusion of innovations theory is a way to illustrate how widespread the usage of an innovation has become (Rogers, 2003). The Hype Cycle was established as a similar way of depicting the diffusion of technology innovations graphically by sorting it into different stages (Gartner Hype Cycle, 2020). By relying on the participants own words, I hoped to reveal the methods by which the participants first learned of AI technology, which is a key signifier of how widespread an innovation is (Rogers, 2003). Data gleaned from the interviews seemed to point towards AI adoption in schools approaching or reaching the 10-20% threshold of adoption seen by Rogers (2003) as the point at which innovation usage becomes inevitable, particularly the participants' statements that their fellow administrators would be likely to utilize this technology in the near future. This would seem to signify that AI will eventually be present in some form in all schools.

I used Pattern coding as the method for the second cycle of coding. Pattern coding identifies emergent themes by grouping smaller segments of data from the first cycle of coding into related clusters (Saldana, 2016). Since the main goal of second cycle coding is to organize your previously coded data in a more conceptual or thematic way (Saldana, 2016), I needed to select a method that would lead me to capture the underlying ideas gleaned from the interviews. Pattern coding, with its emphasis on drawing meaning from the data units identified in the first cycle (Saldana, 2016), was a good fit for the goals of this study.

Pattern coding was accomplished by creating a cluster analysis and examining the patterns that emerged. The cluster analysis was completed by using the NVivo program to group similar codes together. It does this by analyzing the In Vivo codes identified during the first cycle of coding and grouping them together based on their similarity or difference to each other. This provided me with a detailed cluster analysis diagram that contained all of the 393 codes, grouped together by their similarity. This exposed emergent patterns of similar verbiage and ideas stated by the participants due to their relative nearness in the diagram. For instance, the In Vivo codes 'adaptability,' 'adapts to students,' and 'artificial intelligence helps us kind of adapt,' all appear next to each other in the cluster analysis. This would suggest that adaptation is potentially a theme worth exploring due to the related references by multiple participants. Through this form of Pattern coding I was able to group related codes together based on the similarity of the perceptions and experiences of the participants in order to create a functional theoretical construct from the data (Saldana, 2016).

Generating meaning.

The fourth and final phase of this data analysis was the generation of meaning. Generating meaning requires the researcher to identify recurring themes and provide an interpretation of the data (Ruona, 2005). Several recurring themes and overarching ideas were clearly evident upon this reflection, which sufficiently answered both research questions. The themes that emerged were leadership characteristics, diffusion networks, generational change, and AI adoption considerations. These themes were selected due to the large numbers of related codes that emerged around those ideas. The AI adoption consideration theme was the largest of the four themes, and because of this I added the subthemes of structural factors, benefits to AI adoption, and drawbacks to AI adoption in order to organize the data more clearly. The ultimate purpose of my analysis was to uncover the underlying structure beneath this facet of the human experience (Cresswell, 1998), which was accomplished through the methods chosen to analyze the data uncovered in this study.

The artifacts collected in this study were analyzed as well, with the goal being to determine how they add to the greater picture of AI integration under each separate educational leader. While the specific documents collected differed by school, they could all be analyzed to determine what specific elements of AI integration at the school are present in each document, and whether that data is consistent with the data collected through the interviews. These artifacts were used to provide supplemental data that provided me with more clarity around some participant responses during the interviews. For instance, the particulars of the afterschool program referenced by one participant were revealed fully upon review of the scheduling artifact provided by that participant.

Trustworthiness, Reliability and Validity

Trustworthiness was achieved through a detailed description of all proceedings related to the study, which should also aid in transferability (Curtin & Fossey, 2007). Recording the interviews should also have helped to ensure that the experiences of the participants were accurately reflected and not just recollections of our conversations, which could be tainted by my implicit biases. Because the research methods involve myself, evidence of reflexivity was needed to acknowledge my personal influence on the research process (Curtin & Fossey, 2007). This was accomplished by providing an introductory statement about my personal interests in regards to AI adoption in schools. A notebook of my thought process was kept throughout the study, so that it could be referred to later on to examine whether my own biases may have interfered with the study in any way.

The biggest threat to the internal validity of this study lies in the selection process (Campbell & Stanley, 1966). Although Campbell & Stanley (1966) direct this towards the selection of participants for comparison groups and comparison groups were not utilized in this study, I believe it to still be applicable to the selection of participants for the sample. Selecting only educational leaders that are currently using AI programs in their schools may result in the data being skewed by the personal characteristics that caused them to adopt such a program.

Confirmation triangulation is an acceptable way to enhance the validity and credibility of my findings and can be achieved through the usage of more than one method of data collection (Curtin & Fossey, 2007). The alternate data collection method used in this study was the collection of artifacts. The artifacts collected were all documents relating to the scope and usage of AI technology in each leader's school, as described in the Methodology section of this paper.

Validation of data can also be achieved through the usage of peer reviews of the data collected (Moustakas, 1994). Two other researchers were asked to review the coded data to ensure that it had been clustered accurately prior to the development of any textural descriptions. This type of member checking helped to ensure the accuracy of the findings, while the theoretical saturation provided by the interview data should also enhance the validity of the study (Sandelowski, 2008).

Findings

Several themes emerged through the data analysis process. These themes have been separated into four major themes: leadership characteristics, diffusion networks, generational change, and AI adoption considerations. Within the AI adoption considerations theme are several frequently referenced concepts grouped around the three subthemes of structural factors, benefits to AI adoption, and drawbacks to AI adoption.

Leadership Characteristics

One goal of this study was to determine what factors caused the participants to adopt AI technology in their schools. Personality traits and characteristics emerged as key factors, with several participants mentioning ‘curiosity’, ‘love of learning,’ and ‘competitiveness’ as reasons why they have made their various decisions. Curiosity was cited by four leaders as an important reason why they adopted educational technology programs, while competitiveness and curiosity were each mentioned by three leaders. This led me to believe that personality characteristics and adopter categories were the most important factors in influencing these leaders’ decisions. The factors discussed here may not be the only ones driving the participants’ decisions, but it is evident that they were of importance, which is why the idea of ‘leadership characteristics’ was identified as a key theme.

Leader One spoke about their experiences as an administrator when personal computers were first introduced into schools. No one knew how to use them at the time so they just sat around the school, until Leader One took one home and spent the time needed to learn how to use them. This gave them an advantage over their peers, because, “I was ahead of everyone because I knew how to make it work.” This reflects the ‘venturesomeness’ referred to by Rogers (2003) as a key innovator characteristic.

A ‘love of learning’ was referenced frequently as well, with several participants noting their continued pursuit of new skills and ideas. This may be important because it speaks to a type of person who is willing to put in the time needed to grapple with difficult new ideas and technologies. Leader Three stated that they needed to keep learning in order to stay ahead of their staff: “your teachers look to you for a model, so you can't be struggling along with them.” Several leaders also mentioned the related concept of working smarter, not harder. They felt that AI technology helped to lessen their workload and that of their teachers, with the speed of the data analysis of the ALEKs program being a prime example. Two leaders mentioned how they used to spend hours doing a data analysis that could now be completed almost instantaneously with the push of a button.

Competitiveness was another factor mentioned by several of the participants. Leader One spoke to this dynamic when they said that, “I think principals are pretty competitive and if one group does something, another group has to do something.” This competitiveness pushed the leaders to stay on top of new technology so that they could quickly adopt any new program that could give their school a competitive advantage over others.

Another major theme that emerged around the idea of leadership characteristics was related to Rogers' (2003) construct of 'adopter categories.' These were created to chart the 'innovativeness' of individuals based on the time it takes them to adopt new technologies. One key finding is that only two of the participants interviewed would be considered to be in the earliest innovator category of 'innovators', which means that they function as gatekeepers who help launch new innovations into arenas where they were not previously used (Rogers, 2003). This matches up with Rogers' (2003) notion that innovators are rare in systems themselves and are often outside agents. The other five participants were identified as part of the 'early majority' category based on their responses to certain interview questions, which means they only adopt ideas slightly before most members of a system (Rogers, 2003). Interestingly, all of those five also shared that earlier in their career they probably would have been members of the 'innovator' or 'early adopter' categories. This suggests that although their proclivity for risk-taking may have lessened over the years, their initial 'innovativeness' still remained an important part of their psyches. Several of them stated that they relied mainly on members of their leadership team to inform them about new technology now, although they did not hesitate to embrace any technology seen as beneficial to their students.

Diffusion Networks

The participants in this study all shared the experiences that led them to adopt an artificial intelligence program in the first place. The importance of diffusion networks emerged as a key factor, with every leader sharing how much their social networks impacted their programmatic adoption decisions. Educational conferences were seen as an important mode of communication for several participants, and most participants also believed that their fellow administrators were gradually becoming more open to using artificial intelligence in their schools.

The participants all stated that they gained initial exposure to educational AI technology through their existing social networks rather than any concerted marketing effort, although those did have some impact as well. Leader Six stated that, “the more you are exposed to something the more you learn about it,” and several other leaders also mentioned that hearing about other school leaders’ experiences made them more comfortable with adopting an AI program themselves. “Word of mouth” was mentioned by several participants as an important adoption factor, with Leader Two suggesting that, “You're going to gravitate towards somebody you trust and know in the field that you know is going through what you're going through, and having those interpersonal connections is more important than having random stuff thrown at you through email.”

The importance of interpersonal connections was touched on frequently in the interviews, with most participants identifying this as their primary source of information about new programs. Leader Two mentioned that any information about a new program was seen as more trusted when it came from, “somebody you know already.” This conformed to Rogers’ (2003) notion of the importance of diffusion networks, which he described thusly: “In deciding whether or not to adopt an innovation, individuals depend mainly on the communicated experience of others much like themselves who have already adopted a new idea” (p. 331).

Three participants also mentioned the importance of educational conferences in their adoption decisions, and they felt that these gave them exposure to new programs and ideas that they may not have discovered otherwise. Another participant, however, spoke about how they found educational conferences to be a waste of time, and they preferred to get their information from trusted professionals on Twitter. They felt that everyone at conferences were trying to sell products, while individuals sharing their experience on Twitter or other social media sites come across as more genuine.

Leader Two felt that it was important to establish relationships with the companies themselves that are creating the programs. They stated that, “what happens is they will produce a product, we'll use it, and then they will put out something that is even better. So the connections and the people that I knew from utilizing a previous product will call me back.”

Leader One discussed how although they used to be the one to persuade their principals to adopt innovative new programs, now they typically relied on their leadership team to advise them on programmatic adoptions. This was evidenced when they reported that, “In my younger days I would do all the research and figure it out. But now I don't know, the past 10 years, I guess I just depend on other people to tell me that this is great and look how this works and I just trust people.”

All of the participants felt that using AI technology was still fairly novel, although it has been diffusing more across education more in recent years. Leader Two spoke about how AI technology is now becoming pretty widespread, and that “everybody's on board” with adopting more similar programs. Leader Four spoke about how many administrators probably don’t even know that many of the programs they are using are driven by AI, they just all fall under the broad umbrella of “educational technology”. This lumping together of educational technology and artificial intelligence educational technology is a recurring problem in AI educational research (Holmes, Bialik, & Fadel, 2019), and it must be overcome for any true progress in charting best practices in educational AI to occur.

Whether it be through connections made during their career progression or at a conference, it is clear that the participants’ diffusion networks are the primary mode through which information about best practices with AI education programs is shared. The steady diffusion of educational AI programs through school leaders' existing social networks was a clearly evident theme in this study, and there is no reason to think that it won't continue to be the driving force behind many schools' adoption of AI programs.

Generational Change

The topic of generational change was an unexpected theme that emerged from the data analysis. This refers to the idea that the change to a more AI-driven educational environment has been made more likely by the increasingly tech-savvy younger generations of leaders, teachers, parents, and students. This would seem to suggest that new capabilities are needed in order for educational leaders to keep up with the populations they serve.

The positive side of this change is that students and parents are ready to interact with technology in a way that older generations could not. Students today have grown up with access to technologies that their parents could only dream of, and this has made them better prepared to utilize educational technology than previous generations of students. Leader One described this phenomenon when they stated that, "all these children have been raised with iPhones and everything else, and that's what they live on." Many of the participants spoke about the changing age demographics of the parents they serve as well. Leader Six stated that they were**, "c**oming into contact over time with younger and younger generations of people. So more people grew up with technology than haven't…so they're going to be used to it and they're going to have more familiarity with it." This is changing the firmament on which any discussion of educational technology must occur.

The negative side of this generational change is that leaders can easily encounter stakeholders far more familiar with technology than themselves. The increasing technological aptitude of students holds potential risks for technology programs that do not utilize the latest in technology. Leader Five shared their concerns about such a predicament:

> I think if the kids are so tech savvy as it is, and more tech savvy than us and know so much more about technology and that's how all generations are going to be, that they will see right through a program like that. And I think if the quality isn't there, if the interface is weird or it looks old, or if it looks too generic or if it's not using the new cool technology, there are going to see through that real quick.

The generational divide could be seen in the participants' fellow administrators and teachers as well, and it could be problematic if not managed appropriately. Leader Five addressed this divide when they said, "I think a lot of people are still very stuck in the old school ways. And you do get a lot of, unfortunately administrators tend to be on the older side and they're all, they're very, Oh, well, this is what I did when I was a child. This is what works for me. And I think that mindset is still what's screwing up education." This was similar to a statement made by Leader Seven, who reported that:

> The leaders higher up are generally the older generation and they want to kind of have education be the same as how they were educated. I do believe young leaders are advocating for AI programs, but the older leaders are kind of reluctant to even adopt AI because of the feeling of, 'Hey, they need to learn how we learned.'

The potentially negative ramifications of generational change can be overcome, but it will require educational leaders willing to constantly learn and adapt to the new technologies that emerge into the educational arena. This can help them become more equipped to vet new technology and deal with any questions or problems that may occur during the implementation. It would also allow educational leaders to be more capable of knowing when a program has become redundant or is in need of replacement. It is important to not lose sight of the potentially positive aspects of this generational change as well. This may be the first time that students and their parents are truly well prepared to utilize educational technology, and it is up to school leaders to stay on top of new developments so that their students have access to the best programs available, many of which will be driven by AI technology.

AI Adoption Considerations

Several major considerations came to the forefront during discussions about why these leaders chose to adopt AI technology in the first place. The way in which a school or district implements a program can be incredibly important to that program's overall success. Ensuring alignment with a school's existing goals and needs was a primary factor seen as necessary for success, as was the structure of the initial program rollout. Staff management, cost, and utility were frequently cited as important considerations as well. This section is separated into three major subthemes: structural factors, benefits to AI adoption, and drawbacks to AI adoption. The benefits and drawbacks to AI adoption are also broken down further into the most frequently referenced concepts.

Structural Factors. Whether someone is looking at an individual school or an entire school system, it is important to consider which structural factors will be key to technology implementation. When looking at large-scale things like districtwide program adoption, there are many things to consider. It is easy for districts to fall into the trap of constantly rolling out new innovations, only for fatigue to set in amongst their leaders. All of the participants mentioned the word, ‘fatigue’ when discussing the implementation of new educational technology programs. Leader Six, speaking about their past experience in another district, stated that, “I left that district knowing a little bit about a lot of stuff, but I can't tell you that I learned a lot about one or two things.

Tying a program to the goals of the organization and then also not changing it all the time is important.” Leader One remarked on the difficulty of managing top-down technology adoptions, particularly when dealing with large school systems, stating that, “bigger districts tend to be farther behind and in order to do to move something forward, it it's like moving a whole big shift.” This supports Rogers’ (2003) assertion that, “organizations, like individuals, adopt an innovation in a manner that suggests various degrees of resistance to the new idea” (p. 277). Smaller systems can be more adaptable and principals tend to have more face time with district leaders. Leader One illustrated this dynamic when they said this about their time leading a school in a smaller system, “we had weekly conversations with the superintendent. So the people at the district office were very much in tuned to what was going on at the schools because of that, so it was more, it was more cohesive.”

Educational leaders must be mindful of how any new program will fit into their existing academic infrastructures as well. Several participants spoke about the need to substantially discuss how a program would benefit their students prior to any adoption, and whether it would perform the same general tasks as programs already in place. Leader Four touched on this when they stated that, “We, as administrators, have to be aware of the number of programs that we have. We only have a certain amount of time during the day, right. We still have to teach our core subjects, and face to face direct instruction is very important.”

Access to technology at home is still a problem for some students as well, and it limits the ability of many principals to determine that AI programs will be utilized for homework purposes. Leader Two spoke about how they had to be mindful of that before purchasing programs, knowing that many students would only be able to use them when they are at school. This was also reflected by the artifact they provided, which was a scheduling document that detailed the times of the day in which students were assigned to work with the two AI programs that they utilized.

Leaders One and Four reflected on similar troubles with technology access for their student population and how they created new extended learning periods to overcome it. Leader One added an extra period at the end of the day and Leader Four added one at the beginning. This allowed the students additional time to engage with educational technology without taking away from existing class time. Artifacts provided by Leaders One and Four detailed the ways in which their period schedules were manipulated to add the additional period and allow all their students the opportunity to take part in the program. These artifacts were schedules with room assignments and times for different students to access the ALEKs program.

Leader One, Leader Four and Leader Three spoke about how they relied on their leadership teams to help them vet programs and ensure they ran smoothly. Establishing “buy-in” from their staff was seen as crucial by most of the participants as well. This could be done by being clear about the goals of the program and how they tied in to the mission and vision of the school. This ‘intentionality’ was frequently cited as a major indicator of whether or not a program adoption would be successful. Having a clear and comprehensive plan for how the program would be rolled out and utilized was seen as very important, and the lack of such a plan was seen as a primary reason why many program adoptions fail. Another factor seen by several participants as a key to establishing "buy-in" was having a deep understanding of the capabilities and personalities of their staff.

Understanding the strengths and weakness of personnel was mentioned by several of the participants as a key to successful program implementation. Leader Four spoke about having people in their building they call "fundamentalists", or teachers with more experience who tend to push back against any type of any new technology being introduced into the classroom environment. This form of pushback could be ameliorated by stationing fundamentalists on their leadership teams, so that they could be well versed in the new program prior to its implementation. This would lead these traditionalists to have less hesitancy and a higher level of comfort with the program itself. It may even lead to them helping make other staff members more comfortable with the implementation. Leader One discussed encountering resistance when implementing a new AI-based program, saying that, "there was a lot of pushback from classroom teachers because they thought we were taking away from the educational program in order to have them play on a computer."

This perception was reported by many of the participants, and it tended to be the more experienced teachers who would push back the most. Leader One went on to talk about how their younger teachers helped to boost a 1:1 computing initiative they had championed earlier in their career, and how they were eager to experiment with the new technology while other teachers had no interest. They also felt that some recalcitrant teachers need to see results in their students before they buy into a new program, saying that, "You'll get people who follow you philosophically, just because they're in sync with you and all of that. But for most teachers, until they actually see the results in the kid, they won't really make any change." Leader Three believed that they had an easier time implementing an AI program because their teachers were already used to using technology in the classroom, “I think we already kind of indoctrinated the classroom teachers to technology.” Establishing a school-wide culture of technology usage can lead to teachers expecting to continually adopt newer and better educational programs rather than balking at each new implementation.

Another program adoption consideration that was mentioned frequently was communication. School leaders need to determine how and when to communicate with their stakeholders about educational technology adoptions. Leader One mentioned that it was easier to get parents on board for a new technology program then a new instructional strategy.

Cost was also mentioned by most participants as an important consideration. Many of the leaders spoke about having to balance the cost of the programs with the potential benefit of adopting them. Interestingly, although this was seen as an important consideration by many leaders, none of this described it as their primary concern. Each leader that mentioned cost had it ranked as a moderate concern, which was exemplified by Leader Seven’s statement that, “if there's a really good argument on buying a program for the school, then cost comes somewhere in the middle.”

Several leaders also spoke about how they found AI programs to be more useful for mathematics courses than for Language Arts courses. Leader Seven referenced this dynamic by stating that, “with the math even though it's concepts and learning concepts, generally with math, there's a right or wrong answer. So these programs are able to kind of say, Hey, this is right, this is wrong. With Language Arts, it's more of a subjective answer.”

The large number of considerations discussed by the participants helped to clarify the magnitude of the adoption decisions faced regularly by educational administrators. They are often operating without a clear direction as to when or how to use AI technology, and must rely on their best judgment and that of those around them to make their decisions.

Benefits of Artificial Intelligence. Throughout our discussions, the participants all seemed to have a generally positive view about the usage of artificial intelligence in education. Although they all were cognizant of potential drawbacks, they all seemed happy with the performance of ALEKs and other AI programs they utilized in their schools. Many spoke about wanting to utilize new AI programs in the future as well. Leader Seven said that, “I believe, and as a school, we do believe that there are more pros than cons with any AI program.”

Adaptability, individualization, and prediction were seen as the greatest benefits of utilizing artificial intelligence programs. These three elements were each mentioned by a majority of participants interviewed. Other benefits that were each mentioned by several participants included the ability to quickly gauge student understanding, the engagement of students and the prevention of potential teacher bias.

Prediction. The predictive aspect of AI programs was seen as an important asset, particularly in this age of high stakes testing that we are in. Leader Two stated:

> That's what's getting a lot of principals and administrators, based on high stakes testing, interested in this type of learning because of the predictability. If your child spent the next 25 minutes doing this program this week, we predict that they're going to score this much higher on their test.

Leader Five shared their similar experiences, saying that ALEKs is, “able to tell you where the kid is at, what the kid knows and what the kid doesn't know really quick.” The ALEKs program does this by having the students take a pre-test to gauge their level of understanding in different mathematical domains then prescribing work to push them forward and remediate any deficit areas. Leader Three also spoke about the importance of, "being able to predict how students are going to score on their end-of-year tests and giving a direct correlation with student deficits."

Several leaders interviewed spoke about their usage of AI programs to enrich the learning of students who may be showing below-grade level. Leader Six suggested that these programs can help and be, "really beneficial for our students because they're able to identify gaps in learning in their foundational math skills," which can help them to remediate academic deficits that may not have been identified otherwise. Leader Seven said that, "a big part of education is to be able to learn a particular student, and ALEKs helps you to do that." Leader Two spoke about how AI programs can be particularly beneficial in schools with large numbers of struggling learners, because of the large amount of material these students need to learn to get back to grade level standards. The AI programs could be used to provide substantial, individualized remedial support that the teacher may not have time for.

Individualization/Adaptability. The ability of AI programs to allow for more individualized instruction was seen as a major benefit, with all of the participants mentioning it at least once. Leader Four reflected on this: "One thing that I learned early on as a teacher was that we don't all learn at the same rate, right. So you have to meet them where they are, and that's where technology helps." Leader Seven shared a similar notion when they stated that, "these AI programs are very, very beneficial to their independent and individualized learning. Everyone learns a different way and everyone's got their own way of learning."

As the students are using an AI program, it is constantly adapting itself to provide them with new material at their current level of understanding. Leader Five described still being amazed at what an AI program was capable of, “If you think of really, truly what ALEKs is doing, I think like, as the kids are typing, it really is like searching into their brain and trying to see what pathways and ideas are connected to this and the little neurons. It's weird.” Leader Seven mentioned this adaptability as well when they said that, “artificial intelligence helps us kind of adapt and target, more specific educational needs.”

Several participants mentioned the idea of engagement being a primary benefit to the usage of AI technology. Keeping students engaged with the material can be difficult, and the ability of AI programs to keep students engaged by delivering rapid feedback and additional learning opportunities was seen as a significant advantage over traditional classroom teaching. Leader Two stated that, “if they aren't engaged it's just not gonna work.” Leaders Five and Seven spoke about the ability of AI programs to eliminate teacher biases. Whether consciously or not, many teachers may have biases that impact how they interact with certain students. An AI program does not develop prejudices, it simply provides work and offers feedback. Leader Five described this dynamic by saying, “You have like the bias of the teacher sometimes, and everyone has biases. Whereas the technology, there is no bias.”

While all of the participants did tend to have a positive view of educational technology in general, it was clear that they thought of AI-driven technology differently. Many spoke positively about the potential of future AI applications in schools, and several seemed to believe that AI will truly usher in a new age in education. All spoke about how they had seen meaningful change in their students’ academic outcomes due to the programs they had chosen, and several remarked about trying to convince colleagues to adopt similar programs.

Drawbacks of Artificial Intelligence. Several drawbacks to increased artificial intelligence in education became evident through the data analysis, and this section will touch on the most common ones. These drawbacks were the glut of educational technology programs, potential student difficulties, and the lack of a human touch. Leader Five encapsulated the dissonance felt by many educational leaders weighing the appropriate balance between educational AI usage and traditional teaching when they stated that, “So it's like a love/hate thing when it comes to the technology piece, it has it’s uses but it’s easy for schools to form an overreliance.”

Excessive Technology Choices. The new era of educational technology we are in can make it difficult for school leaders to determine which program is best for their student body. Several leaders mentioned being constantly inundated with advertisements and sales calls about the next new innovation. This can lead to leaders actually being less likely to pick up a new technology because there are so many options. Leader Six spoke about being overwhelmed by the sheer number of educational programs now available to administrators, and the difficulty of having to wade through them all to determine what was best for their school. Leader Three shared their similar concerns, stating that, “When I think about some of the programs that come out now, every major educational consulting company is wanting to sell you something.” This may be part of the reason that all of the participants tended to rely more on their social networks than anything else when weighing a new program adoption.

Student Difficulties. Several participants worried about the side effects of technology usage with their students. One participant shared their thoughts about the troubles inherent in an AI program revealing sections of curriculum that students hadn’t yet been exposed to. They felt that this could be unnecessarily worrying to both advanced and lower level learners. Lower level learners could be made distraught by the graphic depiction of the amount of material they had yet to learn, while higher level students could be made upset by the fact that they considered themselves proficient yet there were still areas in need of mastery.

Leader Two mentioned that some students can quickly become discouraged when using any type of educational program, and that they would just click random buttons the whole time. This would require constant teacher vigilance to ensure that students were using the program appropriately, and it is hard to be vigilant when you are monitoring an entire classroom of students. Leader Five cautioned against teachers using AI programs without fidelity just to lighten their workload. This could become a problem, "if you have a lazy teacher and the teacher just wants the kids in front of the computer and wants an easy day, that's all they'll do." Leader Two mentioned how difficult it was to utilize AI programs as intended, due to the difficulty inherent in ensuring they are able to access the program at home. It also presented a scheduling challenge, as they were aware that any class time spent utilizing the program would take away from face-to-face learning time with their teacher.

Less Human Interaction. Another drawback commonly cited by the participants was the fear of AI programs replacing human interaction. Any usage of AI could potentially lead to less interaction with a human teacher, which could be damaging to some children. Leader Five espoused this view when they said that, "Although kids like technology, they want somebody in person. They want somebody there. And I think it's that social interaction that they are craving for and that they need." Leader Two also worried that some parents would use that as an excuse, possibly blaming, "the lack of interaction with the teacher as to why their child is not successful." Leader Seven shared a similar view, remarking that, "when these artificial intelligence programs are teaching students, you do lose the whole element of emotions." This idea is supported by research that shows that relationship building and emotionality are areas where humans clearly have the edge on AI programs (Holmes, Bialik, & Fadel, 2019).

The wholesale replacement of human teachers was a real concern of these administrators.

Leader Five highlighted this by saying:

> I do wonder if computers will replace teachers as much as I don't want that to be a thing, I do wonder if that's going to start to happen. What's to say that a computer can't do everything that teachers are already doing? ALEKs can pinpoint what a kid knows and what he doesn't know and give them information for it. Why can't they just teach that? So I really wonder if that's where we're going to go.

Leader Seven had a similar viewpoint, stating that, "I do believe that artificial intelligence programs are putting teachers kind of out of a job. We still need teachers, but the artificial intelligence programs are more accurate in and asking targeted questions and stuff like that." While this may be somewhat related to the misconception of all AI programs as all-knowing robots, it also could be grounded in the very real progression of artificial intelligence as a viable teaching tool across many disparate educational arenas. As their capabilities increase, so too does the very real possibility that eventually they may be a viable replacement for human teachers.

Discussion

The information gained from this study has answered the guiding questions by providing new insights into how school administrators are experiencing the advent of artificial intelligence in education. By exploring their perceptions and experiences, a number of important themes emerged that help reveal the ways in which administrators are guiding their schools in adopting this new technology. The themes highlight the characteristics shared by administrators who utilize AI technology, the changing nature of education, the diffusion of AI in education, and the impact that generational change is having on the increasing use of technology in the classroom. Several themes were clustered around the positive and negative experiences administrators had while implementing this technology as well. I believe that the themes of generational change and diffusion networks are of primary importance, because they reveal the most about how AI is diffusing through education.

The decision to utilize an AI program is not a small one, and the participants of this study all shared the myriad factors that were behind their decisions. Potential uses, alignment to school goals, benefits, drawbacks, and cost all had a bearing on the leaders' decisions. While this lends credence to the idea that, "The initial cost of an innovation may affect its rate of adoption," (Rogers, 2003, p. 230), it was informative that none of the participants believed that cost was the definitive factor. AI usage in schools is growing exponentially (Holmes, Bialik, & Fadel, 2019), and the many considerations only serve to highlight the need for further research in this area so that future school administrators can possess a clearer idea of whether AI is right for their schools.

The participants of this study all believed that the diffusion of AI in education was already well underway and that it will continue to trend in an upwards direction. This affirms the progress of educational AI program usage along the S-shaped curve governing innovation diffusion (Rogers, 2003), and suggests that AI in education may soon become an innovation utilized by all educational leaders. This diffusion, while primarily informal in nature, is creating a new understanding of potential applications for AI in education than ever before. The social networks that educational leaders belong to play a vital part in this diffusion, which confirms Rogers' (2003) beliefs about the important role that social networks play in the diffusion of innovations. While educational AI may not yet have reached the 'critical mass' stage whereafter future diffusion is self-sustaining (Rogers, 2003), the interconnected nature of social networks make it likely that it will soon reach that point.

The generational change referenced throughout the interviews suggests that educational leaders will have fertile ground to implement new technologies such as AI-driven programs in their schools. Students and parents are increasingly familiar with the usage of technology, and AI should become the next new thing to be introduced to them. This means that educational leaders must endeavor to not let their own biases and trepidations stand in the way of the need to explore new AI technology with which they may not yet be familiar. Students and their parents are ready to accept more innovative technology, and leaders must be prepared to provide them with the potential benefits that educational AI programs can provide.

There is a very real chance AI technology will devastate the industry of higher education (Ford, 2015), and it is not absurd to think that it may similarly alter K12 education, whether it be through changing the role of teachers, reducing the number of teachers, or eliminating them entirely. Many of the administrators in this study saw the elimination of educational jobs as a real threat. The fact that individuals with firsthand knowledge of the capabilities of educational AI still see this as a real possibility lends credence to the notion that this may not be that far down the horizon. “Artificial intelligence applications are poised to increasingly encroach on more skilled occupations,” (Ford, 2015, p. 252) and education will not be spared. School administrators must remain educated to the best ways of using AI so that they can prepare their schools, communities, and staff for the continuing changes to the educational landscape.

As stated by Holmes, Bialik, and Fadel (2019), “Whether we welcome it or not, AI is increasingly being used widely across education and learning contexts” (p. 180). Educational administrators must be prepared for this new reality, and to do so will require them to learn new skills and concepts so that they can determine the best way to utilize this new technology in a way that makes sense for their schools. To be an effective educational leader requires a detailed understanding of what's going on in every classroom, and this cannot be done without an understanding of the technology teachers are using and why they are using it. While it would be helpful if all teachers are adept with new technology, for school leaders it is vital. As the participants of this study have attested, school technology leadership starts at the top and successful program adoption largely hinges on what the school leaders do or do not do to affect implementation.

Limitations

While purposive sampling was identified as the most natural fit for the aims of the study, there were are also several limitations. The most evident limitation would be the lack of geographic diversity. By focusing only on the educational leaders from one specific county, the depth of experiential knowledge necessary to provide a clear picture of the effects AI integration is having on schools worldwide may not have been achieved. Another drawback was the choice to interview only educational leaders who have already utilized AI in their schools; using a more representative cross-section of leaders may reveal data that more accurately reflects the current status of AI in schools. However, since the focus of the study is exclusively on those leaders who have already adopted AI technology, using other leaders would unnecessarily broaden the scope of this research and in doing so perhaps muddle the findings.

One limitation common to diffusion studies is the oversimplification inherent in treating all types of innovations as related units (Rogers, 2003). This has been limited in this study by focusing mainly on one individual innovation without comparing it's rate of adoption with other, potentially dissimilar, innovations. Another potential limitation lies in the generalization of AI programs. While many of the interview questions dealt specifically with the ALEKs program, some participants had utilized multiple different AI programs and tended to discuss all AI programs interchangeably. This can make it difficult to draw conclusions about whether their perceptions were based on the ALEKs program specifically or educational AI programs in general.

Practical Implications and New Directions

By studying the perceptions of educational leaders who have already grappled with AI technology, we can gain a deeper, more operational knowledge of the best ways to utilize it based on their real-world experiential knowledge. While this may look different based on each school's individual characteristics, that only increases the need to expand the existing literature so that more in-depth guidelines can be created that would guide educational leaders through the adoption process. This would give educational leaders a more functional knowledge they could use to make educated decisions and avoid making the same mistakes as their peers.

One common thread throughout lectures and surveys about AI has been the question, "When you think of AI, what is the first thing that comes into your head?" (Holmes, Bialik, & Fadel, 2019, p. 84). This question was included in my interviews, and every participant said, "Robots," which is what the vast majority of participants in earlier AI research said as well (Holmes, Bialik, & Fadel, 2019). This was very interesting because it speaks to common misconceptions of what AI is and how it can be used. Many people believe that educational AI refers to the education of students by robot teachers (Holmes, Bialik, & Fadel, 2019). The reality of educational AI programs is far more complex, and this simplistic belief may actually lead educational leaders to be less likely to adopt a potentially beneficial program simply due to a misconception. A change in thinking is needed among educational leaders, wherein they begin to see AI as simply a component in an instructional program which they may use already without even knowing it.

An ideal set of guidelines would be based on the perceptions and experiences of a broader range of leaders than just the ones selected for this study, so that any interested school leader could easily study the AI adoption efforts of other leaders from schools with similar demographics, allowing them to bypass some of the initial trial and error that pioneering educational leaders have experienced. No two schools are identical, and there exists a huge variety of programs with which to serve them. This plethora of options can be overwhelming or even disheartening to any educational leader weighing programmatic adoption possibilities, particularly those who don't have trusted individuals in their network who are already utilizing AI technology. Each participant in this study spoke about the increasing amount of educational technology programs available, and it can be difficult to wade through the options and choose the best fit.

Determining which programs to use and how to use them can be an imposing task that would be made far easier if research-based guidelines existed that could guide leaders to the best option for what they wish to accomplish, potentially accompanied by testimonials from school leaders facing similar circumstances.

This study only further validates the need to expand existing paradigms about best practices for educational technology, with each participant being guided by their own experiences and those of their colleagues more than any existing formal guidelines. The participants all referenced a lack of formal training related to educational AI usage, whether through their degree coursework or any type of on-the-job training. This would seem to necessitate a greater focus on educational technology in educational leadership programs. There is a clear need for more technology-related coursework that would provide leaders with some degree of background knowledge before they are asked to make these difficult decisions about what programs to purchase and how to use them. As technology becomes ever more embedded in education, the need for more targeted educational leadership preparation will only continue to grow.

Conclusions

"Education is slow to change," (Holmes, Bialik, & Fadel, 2019, p. 9). This prevalent notion that the industry of education changes only gradually, if at all, was borne out through this study. Leader Seven stated as much, saying, "my personal opinion about education is that we're far behind on the way that the rest of the industries are moving." Leader Five had an even harsher assessment, stating that, "I think the research shows we're not doing well in education as like a whole country. And it's because we're doing the same thing that worked 30, 40 years ago, over and over again, but it's not working now and we need to change it up."

There are signs, however, that this may finally be changing. Younger generations who have been raised on technology are finally taking the helm in schools around the nation, and this is leading to the adoption of more technologies such as AI that would have been unheard of in years past. One thing that shone through in the interviews was that all of the participants believed that other administrators would be open to utilizing more AI technology, particularly once they were educated about its potential benefits and usages. The placement of five of the participants in Rogers' (2003) 'early majority' category also seems to suggest that most members of their school system who have not yet adopted AI technology will soon do so.

The impact of individual administrators on educational technology usage cannot be overstated. The independent decision-making ability of most school administrators on what technology their school adopts has always been important, but its repercussions may never be more meaningful then they are now. The constantly accelerating pace of technology has created a world where jobs and their associated skill sets are changing rapidly, and students must be prepared to meet these challenges head-on. School leaders must be prepared to equip these students by providing them with the best educational technology available, and right now that is AI.

Individualized learning has long been a buzzword in education, although actually providing individualized learning programs for students can be quite difficult. AI programs can finally make this dream a reality, as they can enable teachers to easily supervise whole classes of students who are each on their own individualized educational path. This could potentially revolutionize the role of a classroom teacher, as they begin to focus more on facilitating their students' interactions with AI technology than the actual act of 'teaching' students. While remaining in the classroom to provide encouragement and discipline, the teaching could now be done primarily through the usage of AI programs.

Fear of the unknown is still a factor, with concerns about the loss of jobs being salient for many of the educational leaders interviewed. This comports with existing research surrounding jobsolescence, or the changing nature of employment in the face of increasing automation (Holmes, Bialik, & Fadel, 2019). This seems like a valid concern, particularly given the knowledge that, "Individuals forget academic content at the rate of 50% every two years" (Holmes, Bialik, & Fadel, 2019, p. 17). This fear of embracing new technology may be preventing some school leaders and teachers from embracing new programs for their school. While the productivity increases caused by the accelerating pace of technology felt across other industries have yet to fully impact education (Ford, 2015), educators must begin preparing to meet these challenges head-on.

The participants in this study tended to have a rather nuanced view of the viability of AI's usage in education. While they all expressed relatively hopeful views about AI's future potential in the educational arena, this was tempered by a knowledge of its shortcomings that they gained through their experience with AI programs. This is exemplified by Leader Five’s statement that, “I think the piece to this is that we have to use it with caution, but it is the future and it's the way of the world.”

This aligns with existing literature that has suggested that any type of technology diffusion moves through similar stages, typically experiencing massive growth before plunging back to earth and rising again in a slower, more sustained way (Holmes, Bialik, & Fadel, 2019). It also suggests that the spread of AI through education is following the traditional S-shaped curve trajectory from diffusion of innovations theory, and will soon become far more widespread (Rogers, 2003). The participants’ knowledge of AI programs’ utility in the educational realm seems to have helped all of them pass though the “Peak of Inflated Expectations” stage of the “Hype Cycle” as well (Gartner Hype Cycle, 2020). The “Peak of Inflated Expectations” stage typically features few distinctions as to what an innovation is truly capable of, and all things seem possible. The participants do not seem to have dwelled long in the “Trough of Disillusionment” stage, as they all expressed interest in continuing to utilize AI programs in their schools (Gartner Hype Cycle, 2020). This continued commitment would seem to place all of the participants in the “Slope of Enlightenment” phase (Gartner Hype Cycle, 2020), which portends a steady, measured increase as the capabilities of the new innovation become more widely realized. This all suggests that the study of AI in educational leadership is an area in desperate need of clarification, so that best practices can be established to guide school leaders prior to this innovation’s universal adoption.

This steady growth tempered by realistic knowledge gained through occupational experiences seems to be where educational AI usage is heading, but it cannot get there without the trailblazing efforts of innovative educational leaders such as the ones that participated in this study. The willingness of educational leaders to not only take a risk on a new program but also do the hard work necessary to determine what optimal implementation looks like for their schools will be pivotal in determining the direction that artificial intelligence will take in coming years. One can only hope that this new generation of educational leaders will have the curiosity needed to search for programs that could be advantageous to their schools and the courage needed to grapple with the unknown as they create new educational environments for the benefit of their students and society as a whole.

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APPENDICES

Appendix A: Interview Questions

Appendix B: Interview Question Matrix

Appendix C: Research Study Script to be Sent to Potential Participants

Appendix A: Interview Questions

Interview Questions
What is your educational background and how long have you been employed as an administrator?
When you think of AI, what is the first thing that comes in to your head?
Describe your experiences with Artificial Intelligence in your school.
Where do you get most of your information about educational technology such as ALEKs?
What made you choose to utilize the ALEKs program in your school?
How does the adoption of this AI program align with your school’s educational goals?
How did you train your teachers to utilize the ALEKs program?
What challenges or obstacles did you face with the implementation of ALEKs in your school?
How did the quality of the program impact its implementation?
What do you think are the greatest advantages and disadvantages of AI utilization in schools?
Are there any other ways that you use AI in your school? Could you envision any other ways?
How do you think your fellow school administrators feel about the usage of AI in their schools now or in the future?
In terms of using technology in your personal life, how long does it usually take for you to switch to using a new product or service?
How do you see AI impacting the field of education in the next ten years?

Appendix B: Interview Question Matrix

Guiding Questions	GQ Sub-factors	Diffusion Elements
1. What do educational leaders perceive as factors influencing the diffusion of artificial intelligence in education?	– Networks – Utility -Student Population -Implementation	Types of Adopter (TA)
2. How do school leaders influence artificial intelligence implementation in their school?	-Leader Characteristics -Implementation -Perceptions -Program Factors	Diffusion Channels and Networks (DCN)

Interview Question	Guiding Question	Diffusion Element
What is your educational background and how long have you been employed as an administrator?	2 – Leader Characteristics	TA
When you think of AI, what is the first thing that comes in to your head?	2- LC & P	TA
Describe your experiences with Artificial Intelligence in your school.	2 - Perceptions	TA, DCN
Where do you get most of your information about educational technology such as ALEKs?	1 – Networks 2 - Characteristics	TA, DCN
What made you choose to utilize the ALEKs program in your school?	1 – Networks 1 - Utility	DCN, TA

	2 – L. Characteristics	
How does the adoption of this AI program align with your school's educational goals?	2 - Perceptions	n/a
How did you train your teachers to utilize the ALEKs program?	2 - implementation	DCN (Maybe)
What challenges or obstacles did you face with the implementation of ALEKs in your school?	2 – implementation 2 - Perceptions	n/a
How did the quality of the program impact its implementation?	2 – implementation 2 – Perceptions 2 – Program Factors	n/a
What do you think are the greatest advantages and disadvantages of AI utilization in schools?	1 – possibly all 2 - Perceptions	DS, TA
Are there any other ways that you use AI in your school? Could you envision any other ways?	1 – possibly all 2 - Perceptions	TA
How do you think your fellow school administrators feel about the usage of AI in their schools now or in the future?	1 – possibly all	DCN
In terms of using technology in your personal life, how long does it usually take for you to switch to using a new product or service?	2 – L. Characteristics	TA
How do you see AI impacting the field of education in the next ten years?	1 – possibly all 2 - Perceptions	TA, DCN

Appendix C: Research Study Script to be Sent to Potential Participants

My name is Matthew Tyson and I am currently working on my doctorate at Georgia State University. I am working on a study that looks at the perceptions of educational leaders who have utilized artificial intelligence in their schools. I have been given your name from the ALEKS corporation as someone who uses their program in your school. For the purposes of this study, I would like to have a brief, hour-long interview with you about your experiences with this program. You will be given a pseudonym and your identity will be kept confidential. If you agree to participate, please e-mail me back and we will set up a date and time for your interview. Thank you!

-Matthew Tyson

Doctoral Candidate

Georgia State University