ABSTRACT

TATAR, CANSU. Rethinking English Language Arts Classrooms with Artificial Intelligence Education: Teachers' Confidence and Views (Under the direction of Dr. Kevin Oliver and Dr. Shiyan Jiang).

Artificial Intelligence (AI) literacy skills have become essential to prepare youths for 21st- century needs. Despite the efforts to broaden AI education in K-12 classrooms, teaching AI concepts is mostly limited to Computer Science classrooms. Nonetheless, approximately half of U.S. high school students cannot access any Computer Science classes. This causes unequal access to AI education. To tackle this challenge, the utilization of curriculum integration emerges as a potent and effective strategy to facilitate interdisciplinary learning. Integrating AI concepts into non-STEM classrooms, especially English Language Art (ELA) classrooms can broaden access to AI education and reduce inequalities. However, teachers are key stakeholders in effective curriculum integration. Their views and confidence level play a critical role in providing sustainable curriculum integration. The current literature is limited in explaining high school ELA teachers' level of confidence and views in the context of integrating AI concepts into their classrooms. Thus, this study aims to fulfill the gaps in the research of non-STEM teachers' pedagogical beliefs, confidence, and experiences in learning and teaching AI concepts. Specifically, this study answers four research questions: 1) What was ELA teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program? 2) What were ELA teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program? 3) What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms? 4) What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms? By following the Social Cognitive

Theory (SCT) and Technological Pedagogical Content Knowledge (TPACK), this study examines ELA teachers' experiences in a curricular professional development program and their classroom implementations. The findings of this study revealed that after attending the PD, teachers' level of confidence in presenting and explaining AI topics to their students and facilitating and supporting students around AI concepts increased significantly. Teachers considered several factors (e.g., relevancy of the topics, opportunities for their students, and opportunities for their professional growth) when they were sharing their views on the integration. Additionally, after teachers implemented an AI curriculum into their classrooms, they identified opportunities (e.g., introducing AI-empowered careers and supporting students' critical thinking skills), challenges (e.g., technology issues), and needs for changes (e.g., adding scaffolding activities). Regarding the findings, this study discussed the implications for curriculum developers, ELA teachers, and make suggestions for educational researchers in the field of AI education.

Rethinking English Language Arts Classrooms with Artificial Intelligence Education: Teachers' Confidence and Views

by
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DEDICATION

This dissertation is dedicated to the two strong women in my life, my mom, Yenigul Tatar and my grandmom, Gulbeyaz Guven. You always believed in me and supported every decision in my journey. You taught me to never give up, no matter what, and just follow my passion. Thank you for your love and support. I love you.

BIOGRAPHY

Cansu Tatar grew up in Ankara, Turkey. She completed her Bachelor of Science degree in Computer Education and Instructional Technology at the Middle East Technical University. While completing her college degree, she had opportunities to work with significant scholars in emerging instructional technologies. Her experiences shaped her career to become an instructional designer who was passionate about games, simulations, and virtual reality. After college, she started to work for a company to design and develop instructional materials for adult learners. When she was working on different projects as an instructional designer, she developed an interest in understanding how to support learners' experiences effectively through technology-integrated instructional materials. This interest led her to pursue an academic career and started her journey at North Carolina State University. Her research interests center on exploring teachers' agency in the context of AI education and supporting K-12 students with technology-integrated learning. Through her research, she aims to create more inclusive and accessible learning experiences for K-12 students.

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When people ask me what it feels like to pursue a doctoral degree, I always give them same response. I believe that a Ph.D. journey is like riding a rollercoaster. During the journey of completing a Ph.D., it is common to undergo fluctuations in self-confidence, experiencing both highs and lows. During those moments, having a supportive circle of people around you can elevate your journey to even greater heights. I have been incredibly lucky to be surrounded by supportive folks in my journey.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1- INTRODUCTION

The global information world is rapidly evolving with digital technologies such as social networks, big data, and Artificial Intelligence (AI), impacting the key elements of the marketplace, society, businesses, and schools (Dokuchaev, 2020; Reis et al., 2018). Scholars call this process the "Digital Transformation" (Nambisan et al., 2017). As advanced technologies have developed, AI has made a significant impact on the rise of the digital transformation (Kim et al., 2021; Siebel, 2019).

AI supports our everyday activities such as searching on the web, connecting with people on social media, and getting movie recommendations (Marr, 2019). In the United States, the majority of the population interact with AI with or without recognizing the technology or acknowledging how it works (Gallup & Northeastern, 2019; Williams, 2021). The accommodation of these technologies in our lives has started to shape the needs of society. Put differently, in accordance with the digital transformation and a rapid development of AI technology, 21st century demands specific knowledge and skills to adapt the changes and to tackle the challenges (Cantú-Ortiz et al., 2020). Therefore, having AI knowledge, understanding its applications in real-world settings, and the ability to assess potential aids and risks of AI became essential skills for the 21st century (Steinbauer et al., 2021). Developing these skills has become critical for future career opportunities. According to McKinsey report on automation with AI, in the United States, approximately 23% of working hours will be automated, and 39 million workers will be displaced by 2030 based on the speed of the automation (Manyika et al., 2017). Furthermore, it is projected that automation of the jobs would displace a range of 400 million to 800 million individuals by 2030. Thus, McKinsey reported that millions of people would have to find new occupations or improve their skillset to adopt to evolving job requirements. For this reason, AI knowledge has become a crucial skill set in this digital era (Ng et al., 2021; Chui, 2017).

Teaching AI skills has traditionally taken a place at college-level courses (Steinbauer et al., 2021). However, early exposure to Computer Science (CS) concepts may have a significant impact on youths' careers (Vanderberg et al., 2021). In order to be successful in today and future economy and society, there is a growing need to prepare K12 students to understand and utilize AI-enhanced technologies (Eguchi et al., 2021). Having these skills is critical for students to be a productive member of a society rather than consumers (Rouhiainen, 2018). Therefore, in recent years, many initiatives and organizations such as the Association for the Advancement of Artificial Intelligence (AAAI), CSforAll, and UNESCO, put efforts on developing policies and strategic plans to highlight the needs, opportunities, and challenges (Rodríguez-García et al., 2021; Pedró, 2019; Touretzky et al., 2019). For instance, AAAI launched a study panel with diverse experts in AI field to review AI's progress in different areas such as political science, economics, and engineering. After the panel, they published a report, the "One Hundred Year Study on Artificial Intelligence", to demonstrate the impact of AI on society. This report has become an inspiration for many countries, academic institutions, and researchers in terms of designing and developing academic AI training (Littman et al., 2021).

Similarly, UNESCO education team also made many calls for enhancing AI education. They published a guidance for policy makers and practitioners to share a common understanding of opportunities and challenges in AI education (Miao & Holmes. 2022). In this guideline, they present the ways of leveraging the opportunities and address the potential risks. Furthermore, UNESCO also collaborated with Ericsson (i.e., a networking and telecommunication company) and start a project, "Artificial Intelligence for Youth" for fostering youth's AI skill developments. This project aims to empower youth's AI understandings and provide a repository related to AI education (Pedró et al., 2019).

In accordance with these initiatives, researchers have also begun to examine how to engage youth in understanding AI (Jiang et al., 2022). Many scholars developed AI resources and activities to support students' AI understandings (e.g., Lee et al., 2021; Zhang et al., 2022; Ng et al., 2022). These initiatives and scholars are contributing the groundwork of AI education in K12 classrooms.

Statement of Problem

Despite the efforts to broaden AI education in K12 classrooms (e.g., Wong et al., 2020; Judd, 2020; Nadi et al., 2022), teaching AI concepts is mostly offered in Science, Technology, Engineering, and Mathematics (STEM) specialized schools, especially in Computer Science classrooms (e.g., Wallace et al., 2010; Torrey et al., 2016; Kandlhofer et al., 2019; Everson et al., 2022). Yet, only 51% of the U.S. high schools offer CS classes (code.org, 2021) and AI is not an essential teaching component in most of them. Therefore, a large majority of K12 students do not have a chance to engage with AI concepts. This causes an unequal access to K-12 AI education. Barretto et al. (2021) highlighted that current AI industry faced with diversity crises. According to the report of Wise Campaign, the large majority (78%) of AI professionals are male (Rigg, 2022). If we cannot provide accessible AI education for K-12 students, the diversity crises can continue and affect students' future careers. In other words, the lack of opportunity to access an adequate AI education can affect students' future career choices in an AI-empowered world. Put differently, due to the lack of access to AI curriculum in schools, students may not have AI literacy skills and pursue AI-empowered careers. Even though students do not want to pursue an AI career, they will be disadvantaged in terms of not having AI literacy skills to work around AI

(Tegmark, 2017; Anderson et al., 2018; Cetindamar et al., 2022). For these reasons, it is critical to provide an accessible AI education for all K12 students.

Curriculum integration is a powerful and effective way to foster an interdisciplinary study (Drake, 2000). Curriculum integration refers to a design that “engages students as active learners who make the most of the decisions about what they study” (Knowles & Brown, 2000, p. 123). Through curriculum integration, students can strengthen their skills they have encountered in one discipline while practice in another discipline (Lattuca & Stark, 1994; Thibaut et al., 2018). This interdisciplinary study can help them to master in their skills (Jones, 2010). Curriculum integration can also provide more accessible and equal education for marginalized students (Beane, 1995; Tomar & Garg, 2020). Integrating AI into different disciplines such as social studies, history, and English Language Art (ELA) can help all students to gain access to AI concepts and support their master skills in different disciplines (Jiang et al., 2022). As an example, Forsyth et al. (2021) developed an interdisciplinary AI curriculum that aligns with CS and ELA standards. Throughout the curriculum, middle and high school students engaged with AI stories and discussed the ethical issues in the stories. Forsyth et al. (2021) found that this curriculum fostered the students’ understandings of ethical dilemmas, bias, and privacy issues. These kinds of interdisciplinary curricula create opportunities to experience different subjects in the same context (Beane, 1995; Mason, 1996). Moreover, the interdisciplinary works demonstrate that teaching AI is not limited with CS classes. Schools with lack of sufficient resources can also integrate AI into non-STEM classroom and introduce AI concepts to prepare their students for future opportunities.

However, integrating new topics into the existing school curriculum may require challenging adjustments (Ferguson,1995; Drake, 2000; Shernoff et al., 2017). Teachers may decline the integration of new topics if they do not perceive the innovation to fit with their vision of their classrooms (Blumenfeld et al., 2000; Garet et al., 2001). To tackle this challenge head-on, a key strategy is to involve experienced teachers in the design process and heavily draw upon their professional knowledge. Experienced teachers are those who hold a rich set of knowledge including content, pedagogy, technology, and their intersections, such as pedagogical content knowledge or technological content knowledge (Koehler & Mishra, 2009). When evaluating an educational innovation, they consider whether they are able to master the new content, teach with the new pedagogy and technology, and whether the innovation is consistent with their own values and beliefs (George & Sanders, 2017). Over many years of interacting with students, experienced teachers have developed mental models of their students' knowledge, skills, abilities, and interests and are able to search and evaluate new resources to update their teaching practices. Furthermore, they consider how much work the innovations require, how the innovations may impact their students, and how their colleagues are considering the innovations (George & Sanders, 2017). With this unique set of knowledge resources, teachers have much to bring to the table in educational innovation initiatives.

Many studies show that exploring teachers' perspectives and conceptions are critical for a successful integration of different disciplines (Hixon & Buckenmeyer, 2009; Lam et al., 2013; Lin et al., 2021). Their teaching practices evolve through their conceptions and values (Bauch, 1984; Raths, 2001; Vartuli, 2005; Anders & Evans, 2019). In other words, teachers' classroom practices (e.g., applied pedagogical methods, teaching tools, and resources) can gradually change with the combination of their attitudes, beliefs, prior experiences, interactions with their students as well as the professional development. For instance, a teacher might only use teacher-centered approaches when she started her teaching career. After she observes her students' engagement and learns about their interests, she might value student-centered approaches and change her teaching practices. Additionally, if teachers truly conceptualized AI literacy (i.e., "educating learners about acquiring fundamental concepts, skills, knowledge and attitudes that require no prior knowledge" (Ng et al., 2021, p. 4)) and see values, they might be willing to integrate it into their classrooms. To broaden the AI education in K12, it is critical to investigate teachers' conceptions, values, and perspectives (Sanusi et al., 2022). For this reason, a few studies examined teachers' perspectives and conceptions of AI (e.g., Wollowski et al., 2016; Lindner & Romeike, 2019; Williams et al., 2021; Kim et al., 2022). These studies demonstrated that teachers saw the value of teaching AI. Yet, they needed more training and support to integrate AI concepts into their teachings. On the other side, these studies mostly focused on STEM teachers, especially CS teachers. Less is known about non-STEM teachers' perspectives and conceptions of AI. Furthermore, these studies are limited to explain how teachers' agency evolves through their experiences with AI in the context of integrating AI concepts in their classrooms.

Theoretical Frameworks

In this dissertation, I followed the social cognitive theory (SCT) (Bandura, 2001) as a main theoretical framework. The theory focuses on how learning occurs in the context of social, dynamic, and reciprocal interaction. Furthermore, SCT puts emphasis on individuals' past experiences, expectations, and expectancies to understand their behaviors and actions. For example, a teacher who has a negative experience with a technology-enhanced learning as a learner might demonstrate a resilience to use technology-enhanced learning materials in her classroom. In this example, teachers' past experiences shape their behaviors and actions. The main goal of SCT is to understand how individuals control their actions and attitudes through regulation and reinforcement. This framework will help to gain insights about the high school teachers' beliefs and decision-making processes. In addition to SCT, this study also follows the Technological Pedagogical and Content Knowledge (TPACK) (Koehler & Mishra, 2006) as a conceptual framework to understand how teachers' knowledge and experiences affects their adoption to the innovative learning approaches. Especially, TPACK is critical to highlight the relationship between teachers' knowledge and their teaching practices. Since this dissertation aims to explore high school teachers' learning and teaching experiences of an AI curriculum, these approaches will provide detailed insights on this manner.

Purpose of the Study

This dissertation aims to fill the knowledge gap in the literature by exploring teachers' AI learning and teaching experiences. To address the gaps in the literature, this study will investigate ELA teachers' experience, beliefs, and confidence before and after they participated an AI professional development (PD) and experienced AI curriculum activities. Exploring teachers' confidence and their views will contribute to understand teachers' needs and concerns to integrate AI into their classrooms. Additionally, this study investigates high school teachers' classroom implementation experiences to reveal how they approach AI curriculum to support their students' learnings, what kinds of challenges they face, how they overcome those challenges, and what opportunities they see while teaching this curriculum. Specifically, the following research questions will be investigated in this research:

- **RQ1:** What were ELA teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program?
- **RQ2:** What were ELA teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program?

- **RQ3:** What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms?
- **RQ4:** What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms?

Significance of the Study

Preparing K12 students for "digital transformation" (Nambisan et al., 2017) with digital technologies, especially AI and ML, is critical for them to be more productive members of society. Students equipped with digital literacy can play a role in the development of these technologies instead of only being consumers (Alexander et al., 2016). These technologies offer enormous job opportunities in the coming years (Veldhoven & Vanthienen, 2022). Even if students do not prefer to be part of technology development, they still need to recognize and understand how these technologies work and impact on their future jobs (Zimmerman, 2018). However, teaching these technologies is mostly limited to STEM classrooms, particularly CS classes (Chen et al., 2020). Integrating these technologies beyond STEM classrooms is vital to broaden accessibility and reduce inequity in education. Despite the recent efforts to broaden AI in K12 classrooms, AI education is still in its nascent stages (Pedró et al., 2019). Currently, the field of AI education is neither a standardized subject nor a standalone course in U.S. K12 schools. To spread AI education beyond STEM classrooms, more empirical research is needed to explore non-STEM teachers' pedagogical approaches, confidence, and experiences in integrating AI into their classrooms. Teachers are not only experts on their students' needs and learning experiences but also stakeholders in curriculum interventions (Johnston, 1987; Debarger & Choppin, 2013; Huizinga et al., 2014). Therefore, it is critical to investigate these constraints.

In any discussion of technology-enhanced curriculum integration, there are key variables (i.e., knowledge and skills, self-efficacy, and pedagogical beliefs) to facilitate teachers (Ether & Ottenbreit-Leftwich, 2010). Even though teachers believe proposed technologies are essential, they might not feel confident to bring these technologies into their classrooms (Ghavifekr & Rosdy, 2015). On the other hand, the first step of a successful implementation relies on being confident in technology integration (Ertmer & Ottenbreit-Leftwich, 2010). One of the ways to understand teachers' confidence is to provide a learning environment where they can experience these technologies as a learner and discuss their concerns with other teachers and experts from the field. Professional development is a natural fit for teachers to experience such learning environments. Yet, less is known about K12 teachers' confidence and experiences before and after they participated in a PD workshop related to technology integration, particularly AI curriculum integration. Therefore, in this dissertation, I will explore high school ELA teachers' confidence and experiences before and after they participated in the AI PD workshop and experience AI curriculum activities as a learner. This can contribute the field in understanding the role of teachers' confidence and learning experiences on their AI teaching practices. Additionally, the findings can inform AI curriculum initiatives while designing AI PD workshops and curriculum resources as well as researchers to understand the challenges and opportunities in terms of integrating AI into K12 classrooms.

Moreover, teachers' pedagogical beliefs and knowledge shape their teaching practices (Fives & Gill, 2014). Examining their practices and pedagogical beliefs is critical for an educational innovation (Borg, 2017). Put differently, understanding teachers' beliefs and practices can provide insights into whether educational innovation is having the intended effect (Borg, 2017). For instance, if an AI curriculum put emphasis on exposing AI careers for students but teachers do not reflect this in their classrooms, investigating their pedagogical beliefs can provide insights about the effectiveness of the curriculum. Teachers may perceive challenges or opportunities to remove or reframe the activities in the curriculum based on their pedagogical beliefs. Observing their teaching practices and exploring beliefs can provide value to design effective curricula. Thus, this dissertation will explore the ELA teachers' practices and pedagogical beliefs who attended an AI PD workshop and implemented related curriculum into their classrooms. Exploring teachers' practices and pedagogical beliefs can contribute to understanding perceived challenges and opportunities to broaden AI education in K12.

Collectively, exploring perceived challenges and opportunities that teachers faced through PD and curriculum implementation can contribute to the literature by broadening the understanding of technology integration from teachers' perspectives. More specifically, this dissertation will explore how non-STEM teachers integrate AI concepts into their classrooms as they are simultaneously becoming proficient in learning and teaching AI concepts. The findings of this dissertation will provide a deep understanding of the challenges and opportunities associated with AI integration in K12 schools. With a deep understanding of the challenges and opportunities, scholars and curriculum practitioners will be able to develop effective design strategies to support teachers to overcome the challenges. Furthermore, this study will also reveal effective ways to facilitate teachers' integration efforts for future curriculum intervention studies. Scholars can benefit from the design of this study to foster non-STEM teachers' involvement in AI education for K12 students.

In summary, the proposed research aims to fulfill gaps in the research of non-STEM teachers' pedagogical beliefs, confidence, and experiences in learning and teaching AI concepts. This research will investigate ELA teachers' confidence and learning experiences before and after they participated in the AI PD workshop and experience AI curriculum activities. Finally, it will investigate teachers' pedagogical beliefs and teaching practices in terms of perceived challenges and opportunities in integrating AI curricula into their classrooms.

Subjectivity Statement

As an educational researcher and practitioner, this dissertation reflects my professional experiences for the last three years. Throughout my academic life, I have been involved in different research projects that foster K-12 students' understanding of 21st-century skills. Integration of these skills into the existing curriculum at the K-12 level is crucial to prepare K-12 students for future career opportunities. However, without efficient professional development, it is challenging for teachers to incorporate new concepts, especially a technology-enhanced curriculum into their classrooms. Furthermore, many studies demonstrated that teachers need support to feel confident in using educational technologies and understand how to incorporate these technologies into their classrooms (Boulden, 2020).

During my doctoral studies, I started to work on projects that aim to support K-12 students' sense-making of AI and ML concepts across K-12 classrooms, including ELA, Social Studies, and Computer Science. As a research assistant in these projects, I experienced similar challenges in different classrooms; teachers did not feel confident in integrating a technology-enhanced curriculum into their classrooms due to their lack of knowledge and experience about AI concepts. Therefore, in some of our curriculum implementations, the researchers in the projects had to teach the curriculum activities instead of the teachers. As a result, this does not provide an effective curriculum integration and does not take a program beyond a one-time use. For this reason, as a researcher, I became more motivated to investigate ways that make teachers more confident in the integration of innovative approaches into their existing curriculum.

In particular, my work on the StoryQ project (i.e., fostering AI concepts through narrative modeling practices, funded by NSF, PIs: Drs. Carolyn Rosé, Jie Chao, Shiyan Jiang, and William Finzer) provided opportunities for me to develop distinct research ideas with regard to my motivation. The goal of the StoryQ project is to create an effective, scalable, and sustainable exemplary program for high school students, especially those underrepresented and underserved in the field of AI, to develop foundational knowledge of AI and interest in AI-rich careers. To address this goal, the project holds professional development series to support K-12 teachers' pedagogical and content knowledge of AI. After these workshops, the project team supports teachers to integrate a technology-enhanced AI curriculum into their classrooms.

Thus, the StoryQ project became a unique opportunity to explore K-12 teachers' confidence and experiences in learning and teaching a technology-enhanced AI curriculum. Throughout this project, I worked on developing instruments to explore teachers' confidence, views, and experiences before and after they participated in an AI professional development workshop as well as investigating teachers' experiences after they integrated a technology-enhanced AI curriculum into their classrooms. As an educational researcher, I brought a critical lens at the intersection of Social Cognitive Theory (Bandura,1978) and the Technological Pedagogical Content Knowledge (Koehler & Mishra, 2006) to deeply understand how non-STEM teachers develop confidence in incorporating an AI curriculum in their classrooms.

Since AI is sub-discipline of CS, AI education is mostly associated with CS classrooms. Many scholars envisioned AI education with regard to CSTA (i.e., Computer Science Teacher Association) standards for K-12 classrooms. CSTA standards focus on four goals:

- Starting from elementary school level, all students should be introduced the basics of Computer Science concepts.

- Secondary school level of CS should support students' CS, mathematics, or science graduation credits.
- Encourage schools to offer advanced CS courses for fostering interested students to seek CS education at colleges or CS-empowered jobs in their future.
- Provide accessible CS courses, especially for underrepresented students (CSTA, 2017)

Regarding these goals and CSTA standards, Touretzky et al. (2019) identified five big ideas to envision K-12 AI education that refers to what every K-12 student should know about AI. These big ideas are listed as:

- Big Idea 1: Computers perceive the world using sensors (Perception).
- Big Idea 2: Agents maintain models/representations of the world and use them for reasoning (Representation and reasoning).
- Big Idea 3: Computers can learn from data (Machine Learning).
- Big Idea 4: Making agents interact comfortably with humans is a substantial challenge for AI developers (Natural Interaction).
- AI applications can impact society in both positive and negative ways (Societal Impact). (Touretzky et al., 2019, p.9797)

These five big ideas guide many AI curricula to develop learning activities. As an example, Sabuncuoglu (2020) developed a 36-week AI curriculum for middle school students by adopting the five big ideas. The curriculum included three main modules: "1: How do computers interact? 2: How do computers see? 3: How do computers hear?" (Sabuncuoglu, 2020, p.97). Through this curriculum, middle school students can explore different AI topics, including pixels and algorithms, learning from data, and classification tasks in AI. Even though this curriculum heavily relied on the connection between science and innovation, Sabuncuoglu (2020) highlighted the importance of creating an interdisciplinary curriculum approach. Although AI is a part of CS, many scholars perceive AI as an interdisciplinary field since it requires specific domain knowledge based on contexts. Zhuang et al. (2020) explained the interdisciplinary nature of AI through current AI developments. They shared different examples of how AI took a place in different contexts such as aerospace, healthcare, and material design. After examining different examples, they envisioned the future of AI as an interdisciplinary endeavor that requires collaboration between various fields. By coming from a similar perspective, I also perceive AI as an interdisciplinary approach that draws upon mathematics, statistics, linguistics, and psychology.

Definition of Terms

Artificial Intelligence: the term was defined as "the science and engineering of making intelligent machines" (McCarthy et al., 2006) and eventually evolved to the simulation or mimicking of human intelligence in machines that are programmed to act like humans. Artificial Intelligence technologies can perform specific tasks that require human intelligence like face or voice recognition.

Social Learning Theory: is known as Bandura's psychological theory that examines how people learn and acquire new behaviors through observing and imitating others.

Social Cognitive Theory: an evolved form of Social Learning Theory, it focuses on how personal, behavioral, and cognitive factors shape human behaviors.

Self-efficacy: from Social Cognitive Theory perspective, self-efficacy is defined as "a judgment of one's ability to organize and execute given types of performances" (Bandura, 1978, p.21).

Technological Pedagogical and Content Knowledge: a theoretical framework that aims to understand interaction among content, pedagogy, and technology knowledge in teaching and learning (Koehler & Mishra, 2006).

Professional Development: a professional learning process to seek and gain certain skills and/or knowledge. In this dissertation, professional development refers to attending a workshop to learn Artificial Intelligence concepts in a curriculum.

StoryQ Project: a National Science Foundation-funded project to broaden Artificial Intelligence education in K-12 classrooms. The main goal of the project is to help K-12 students to envision their future paths in an AI-empowered world.

Organization of the Dissertation

This dissertation will include five chapters. The first chapter demonstrates the overview of the study by presenting the purpose of the study, problem statement, and theoretical frameworks. The second chapter presents a broad literature review of AI education in K-12 classrooms and the importance of teachers' perspectives and conceptions of AI education. The third chapter provides information about the context of the study, participants, and methods to address the research questions. The fourth chapter will present the findings of each research question while the fifth chapter will discuss the findings and implementations.

CHAPTER 2: LITERATURE REVIEW

The rapid development of Artificial Intelligence (AI) systems from personal virtual assistants (e.g., Siri, Alexa) to self-driving cars has become a ubiquitous facet of our daily lives. Along with the growth of data and computational power, AI has become a transformative force in industry and society from self-driving cars to fraud detections (Dwivedi et al., 2021; Makridakis, 2017). As AI continues to expand rapidly across fields and industries, it becomes necessary to develop a workforce with a strong AI understanding and knowledge (Lee et al., 2021). Following this trend, significant efforts have been made to create accessible AI education and to develop AI understandings at K12 levels (Gardner-McCune et al., 2019). Many organizations developed instructional lessons, tools, and resources to motivate K12 students in understanding AI through engaging with Machine Learning (ML) algorithms like Google’s Teachable Machine (Google, 2018) and Machine Learning for Kids (Druga, 2018).

Additionally, many studies have started questioning how and to what extent to foster K12 students’ AI understandings. For example, Tang and colleagues designed an AI curriculum for high school students that aims to teach core ML concepts through image classification tasks. The students were asked to take photos of objects (e.g., water bottle, hair tie, paper, etc.) and train the ML models to classify these objects. This study revealed that the students who did not have any prior knowledge and experiences developed ML understandings and created successful models while engaging with classification tasks. Similarly, Zimmermann-Niefield and colleagues (2019) conducted a study with high school students to investigate how they incorporate ML models. They developed a mobile application that allows students to collect physical data and develop ML models. In this study, the students created a dataset by tracking their own physical activities like passing or kicking a ball and then developed ML models to predict the physical activities.

The findings of this study showed that the students developed an understanding of the iterative process of ML models. Collectively, these two studies highlighted that classification tasks are frequently used to engage K12 students in learning ML concepts. Yet, K12 AI education needs more studies to investigate how to support students to develop ML understandings in K12 classrooms (Steinbauer et al., 2021). To achieve these goals, at first, the researchers should focus on K12 teachers, since the successful integration of AI into K12 classrooms depends on the teachers' perspectives (Lindner et al., 2020). However, the teachers' perspectives on the integration of AI into their classrooms, particularly Non- Science, Technology, Engineering, and Mathematics (STEM) classrooms, are still under-researched. Therefore, this dissertation aims to fill this gap in the literature by investigating high school ELA teachers' perspectives on this matter and will address the following questions:

- **RQ1:** What were ELA teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program?
- **RQ2:** What were ELA teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program?
- **RQ3:** What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms?
- **RQ4:** What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms?

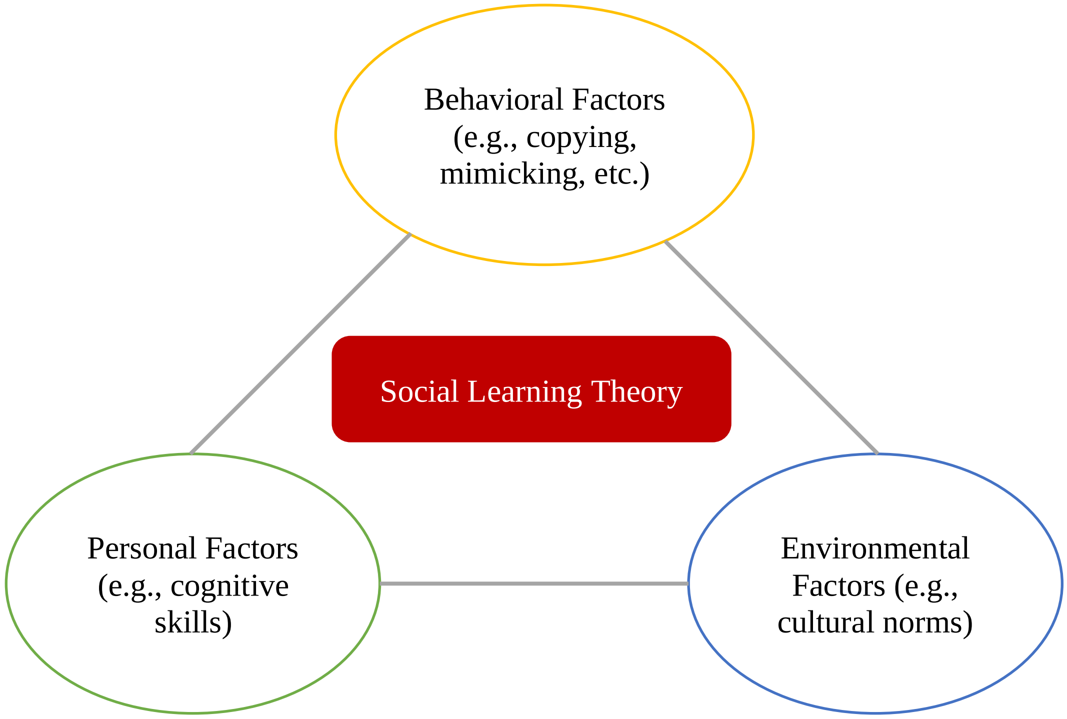
The purpose of this literature review is to give a broad overview of prior research on AI education in K12, teachers' perspectives and conceptions of AI education, AI and teacher education, as well as the backgrounds of AI and ML. In particular, the synthesis will provide extant literature on AI trends and issues.

Theoretical Frameworks

Social Cognitive Theory

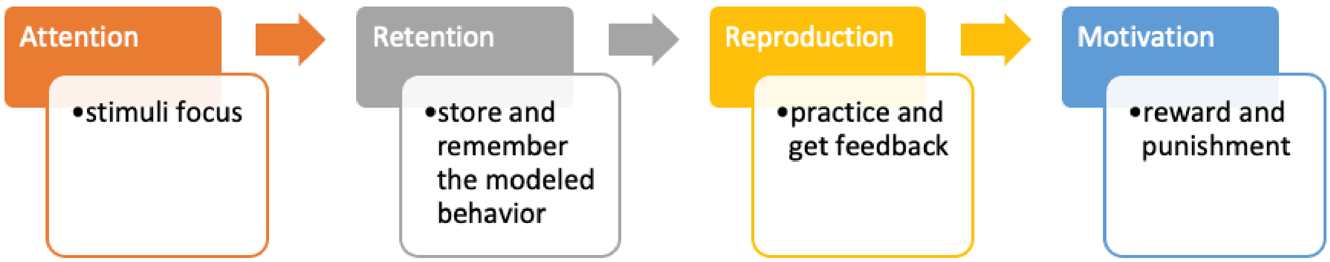
The origins of the Social Cognitive Theory (SCT) (Bandura, 1989) rely on Social Learning Theory (SLT) (Bandura, 1977). While developing SLT, Bandura (1977) considered behavioral theories such as classical conditioning and operant conditioning to understand the interaction between human learning and the environment. According to Bandura's theory (Fryling et al., 2011), these behavioral theories were limited in explaining all types of learning. In other words, while behavioral learning theories explain all types of learning as a result of reinforcement and direct interaction, Bandura advocates that learning can occur without any direct interaction and reinforcement (Bandura & Walters, 1977). For instance, if you hand a spoon to a child who did not have any direct experience, she might move the spoon to her mount because she observed someone doing this behavior. Thus, Bandura's theory moves beyond the behavioral theory and incorporated two significant ideas: "observational learning" and "mediational processes" (Bandura, 1961). In observational learning, Bandura's theory supports that learning can occur through observations. According to SLT, these observations are not limited to seeing someone performing a task. People can also learn by following a symbolic model (e.g., characters in science fiction books) or a verbal instructional model (e.g., guidelines or instructions for completing a task). Additionally, Bandura also puts emphasis on the role of mental processes in determining whether a behavior is learned or not. He believes that people's mental states and motivation can significantly affect their learning. Therefore, SLT considers behavioral, personal, and environmental factors to determine learned behaviors (Figure 2.1).

Figure 2.1 *Bandura's Social Learning Theory*



Moreover, Bandura claims that four steps (i.e., attention, retention, reproduction, and motivation) are critical to determining the success of social learning (see Figure 1.2). For a successful observational learning and modeling process, learners need to pay attention to learning tasks. SLT describes that any distractions can create negative impacts on learners' observational learning process. After the attention, SLT demonstrates the importance of storing observed behavior. To imitate the observed behaviors, learners need to remember. Retention can be specifically difficult for remembering verbal instructional models. After putting attention to the observed behavior and acquiring the essential information, it is critical to practice the observed behavior. Reproduction of the observed behavior can facilitate improvement and the progression of skill attainment. Ultimately, the success of the learning relies heavily on the learners' motivation to imitate the behavior that has been modeled. At this step, reinforcement and punishment strategies can play a crucial role in promoting and sustaining motivation.

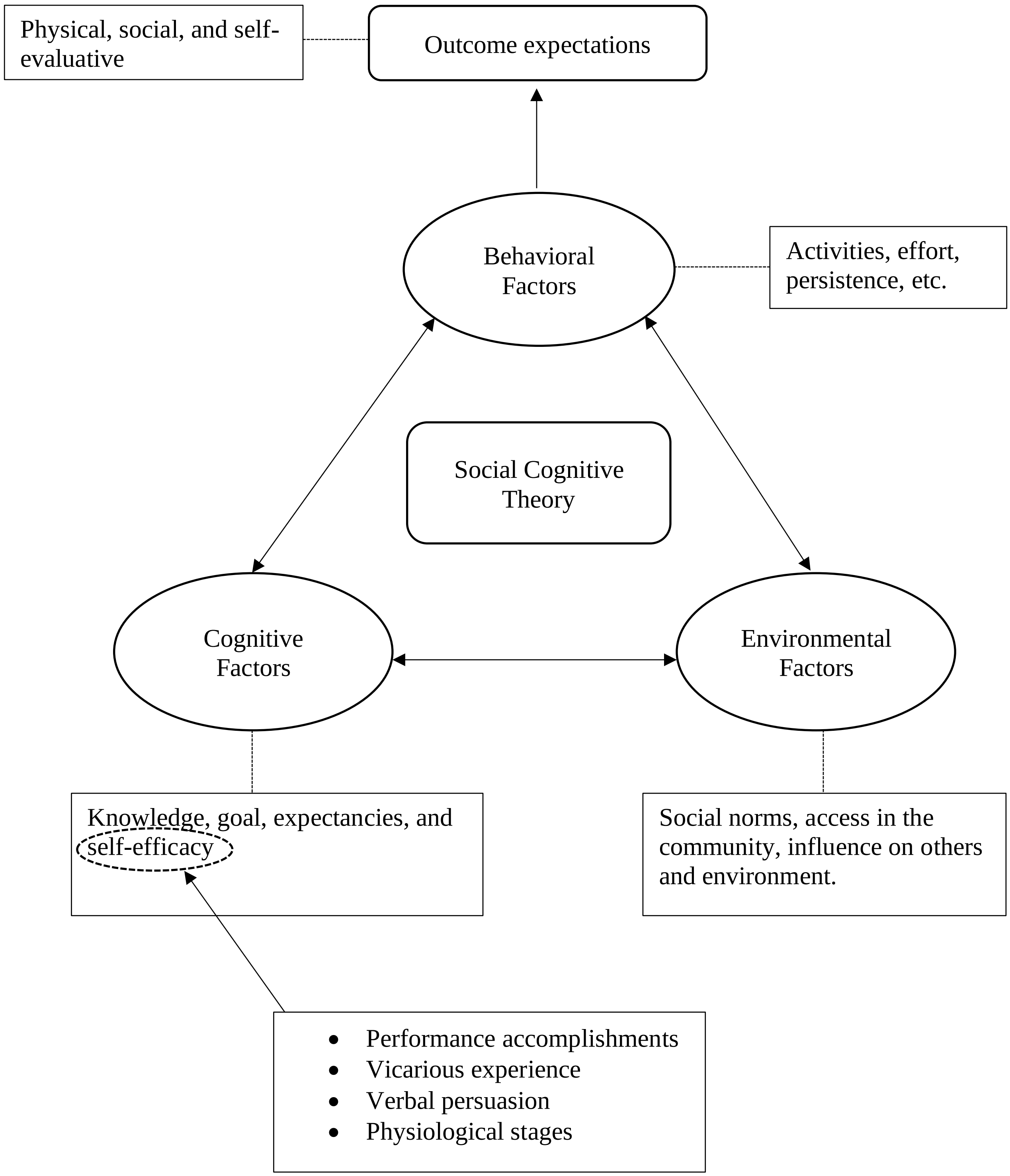
Figure 2.2 *Steps that Affect the Success of Social Learning Theory*



As an extended version of SLT, Bandura started to examine the impacts of cognitive processes (e.g., conception, judgment, and motivation) on individuals' behaviors and their environments (Bandura, 1991). His work shifted from focusing on behaviors to more on the impacts of cognitive factors (Luszczynska & Schwarzer, 2015). With this new focus, Bandura introduced the Social Cognitive Theory (SCT) (Figure 1.3) (Bandura, 1986). This theory examines the effects of environmental and cognitive factors on people's behavior and learning. Thus, SCT perceives every individual as an active agent who continuously acquires knowledge with regard to external and internal reinforcement (Schunk, 2012). The theory mainly considers learners' previous experiences as a critical factor in determining the likelihood of a behavior being performed. These experiences affect the reinforcements, expectations, and expectancies that shape learners' decisions to engage in particular behaviors, as well as explain the reasons behind the decisions.

Over the years, Bandura's theory evolved into six constructs to describe how learners regulate their actions through control and reinforcement to attain behavior. While developing SLT, he focused on five main constructs: reciprocal determinism, behavioral capability, observational learning, reinforcements, and expectations. In the SCT, these five constructs were finalized, and reciprocal determinism became a central concept (Bandura, 1983). Bandura's theory explained reciprocal determinism as "individuals function as a result of a dynamic and reciprocal interaction" (McGiboney, 2016, p.16). Put differently, reciprocal determinism described the mutual and changing relationship between individuals' learned experiences, the surrounding environment or social context, and behavior as a response to stimuli, all of which work together to accomplish contextual objectives (Bandura, 1978). As an example, a student can struggle at school because of the interaction among cognitive, environmental, and behavioral factors. In the classroom, she might demonstrate a lack of engagement (behavioral), and this can be a result of her lack of motivation (cognitive) toward the class topics. At the same time, this might also be related to difficulties at home (environmental). These constructs can create a cycle of mutual influence on the student's behavior.

Figure 2.3 *Social Cognitive Theory (Bandura, 2000)*



In addition to reciprocal determinism, Bandura introduced self-efficacy as a crucial aspect of SCT. Bandura (1977) defined self-efficacy as “a judgment of one’s ability to organize and execute given types of performances” (p. 21). In other words, self-efficacy refers to an individual’s beliefs about performing a specific task successfully. SCT posits that self-efficacy plays a critical role in shaping an individual’s cognitive, emotional, and behavioral responses in various circumstances.

According to SCT, Self-efficacy can be shaped by four main sources: past performance accomplishments, vicarious experiences (e.g., observing others’ experiences), verbal persuasion, and physiological and emotional states. An individual’s self-efficacy beliefs can play a critical role in setting goals, demonstrating efforts to achieve those goals, dealing with challenges, and becoming more persistence in completing tasks. Self-efficacy beliefs can change through experience, feedback, and knowledge. High self-efficacy leads to greater motivation, effort, persistent, and resilience while low self-efficacy can lead to low motivation and poor performance. In SCT, self-efficacy is accepted as a central mechanism that affects behavior.

Furthermore, while Bandura was working on the self-efficacy concept, he emphasized teachers’ perceived self-efficacy in creating effective learning activities to foster students’ cognitive abilities. In SCT, teacher perceived self-efficacy refers to teachers’ ability to create desired outcomes related to their students’ engagement and learning (Tschannen-Moran & Hoy, 2001). Bandura’s theory indicates that teachers’ self-efficacy beliefs shape both their classroom activities and assessment strategies to evaluate students’ intellectual abilities (Bandura, 1978). To understand the importance of teachers’ self-efficacy beliefs, Gibson and Dembo (1984) conducted a study with teachers. They investigated the teachers’ beliefs in their abilities to motivate and engage low-performing students who face difficulties in their close environments.

They found that teachers with high self-efficacy were more willing to motivate these students with extra help and support. In contrast, teachers with low self-efficacy believed that they are limited in their ability to motivate and engage these low-performing students. This study showed that teachers' perceived self-efficacy is a crucial component of their instructional efficacy. Similarly, many studies also showed that teachers with high self-efficacy are more willing to incorporate innovative teaching methods and tackle challenges through new strategies (Tschannen-Moran & Hoy, 2001). Therefore, self-efficacy is accepted as one of the centerpieces of SCT.

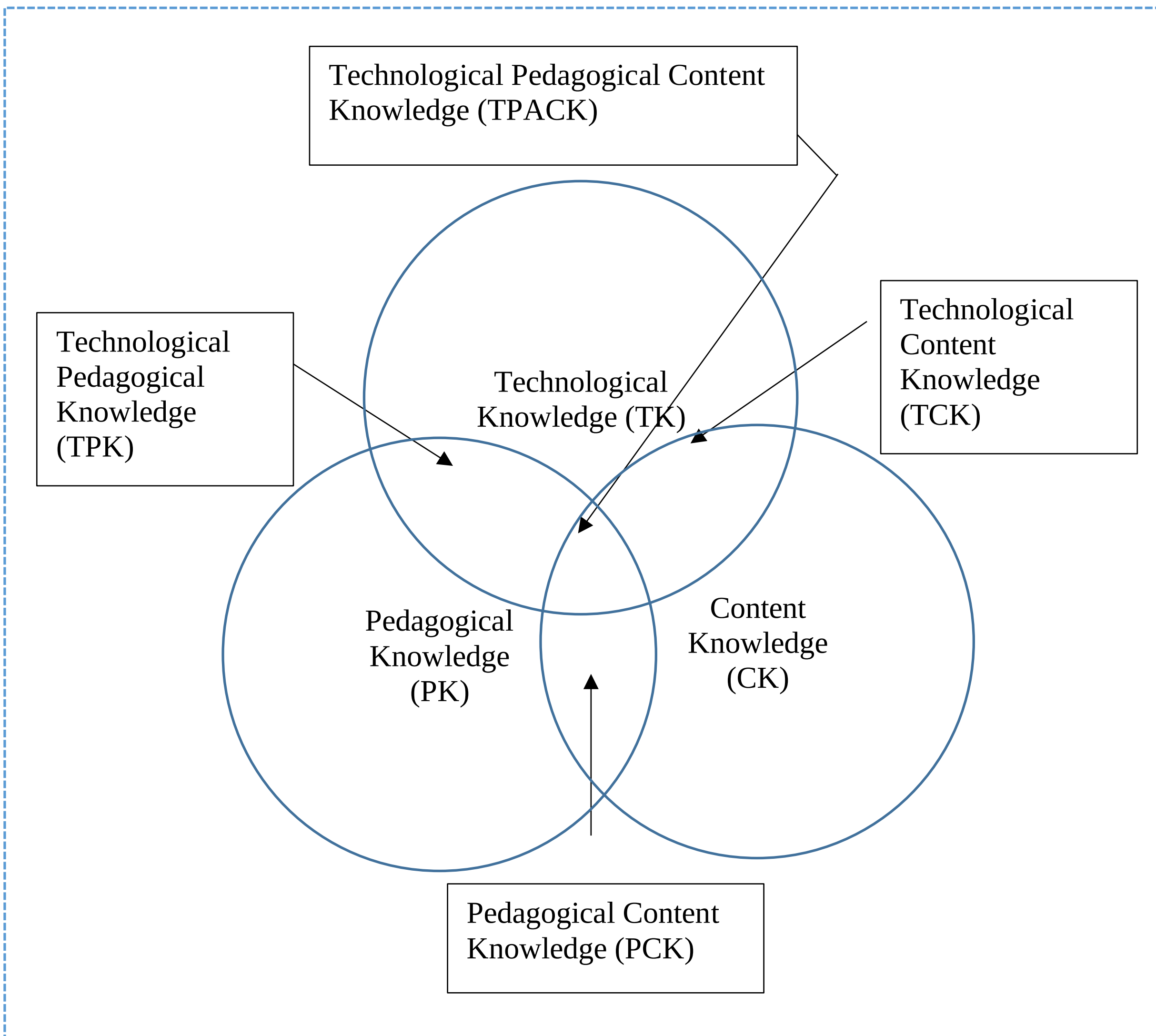
In the context of SCT, another key component that affects the behavior is outcome expectancy. Bandura (2011) explains outcome expectancy as an individual's belief about whether an outcome occurs as a result of a change in certain behavior. This belief about outcome expectancy affects individuals' decision-making processes. As an example, a teacher might change her instructional materials if she believes that this change would motivate her students. In other words, she makes changes regarding the possible outcomes. This outcome expectancy drives her to make behavioral changes. From the outcome expectancy perspective, SCT aims to explain why individuals decide to engage in certain behaviors and understand their decision-making processes.

Overall, SCT can provide valuable insights related to teachers' behavior, cognition, and decision-making processes. In the context of this dissertation, following SCT operates as the main theoretical framework, helping to investigate the factors that affect teachers' behaviors and performance in the classrooms. In particular, examining teachers' self-efficacy and their outcome expectancy can provide a deep understanding of how teachers make decisions on integrating an innovative approach into their classrooms.

Technological Pedagogical Content Knowledge (TPACK)

The TPACK framework (Koehler & Mishra, 2009) has evolved and expanded upon Shulman's Pedagogical Content Knowledge (PCK) concept, examines the connection and interaction between teachers' technology knowledge (TK) and PCK. This framework consists of three main constructs: teachers' content, technology, and pedagogy knowledge. It highlights the essential skills and knowledge for effective technology-enhanced teaching and learning experiences.

Figure 2.4 *Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2006)*



Content Knowledge. This construct refers to teachers' expertise in the subject matter. The content of every classroom subject is different than the others. Therefore, content knowledge is a dynamic construct based on context. For example, the content of a middle school science classroom might be different than a college-level science classroom. Shulman (1986) emphasizes that teachers' content knowledge is crucial for their teaching practices. Different subject matters require different inquiry methods, and teachers must possess a firm understanding of subject matter and inquiry methods. As an example, in a science classroom, teachers are supposed to have adequate scientific knowledge, facts, and theories as well as evidence-based reasoning to enhance their students' science understanding. On the other side, an art classroom teacher needs to be equipped with art knowledge related to the history of art, famous artists, aesthetic, and psychological theories. National Research Council (2000) explained the importance of teachers' CK from students' learning perspective. They mentioned that an inadequate foundation of CK can come with a significant cost, as students might receive inaccurate information and develop undesired conceptions.

Pedagogical Knowledge. It refers to teachers' understanding of the teaching and learning methods and processes. This knowledge shapes by teachers' values, goals, and beliefs (Koehler & Mishra, 2006). PK includes teachers' knowledge about classroom management, lesson planning, and assessing students' learning. This knowledge helps teachers to understand how their students acquire knowledge and which educational techniques are more effective to foster their students' understanding of a subject matter. To possess PK, teachers need to understand how cognitive, social, and developmental learning theories apply to their students.

Pedagogical Content Knowledge. By building upon Shulman's PK, Koehler and Mishra (2006) explains PCK as "the transformation of the subject matter for teaching" (p.64). In other words, PCK combines teachers' content knowledge with pedagogical knowledge and focuses on how to deliver content effectively through different pedagogical approaches. TPACK advocates that the transformation occurs when teachers interpret content, find new methods/ways to present the content, and build upon their students' prior knowledge and experiences. PCK incorporates the core aspects of teaching, learning, and curriculum. According to the TPACK framework, particularly the PCK construct, for effective teaching, teachers need to understand their students' conceptions and prior knowledge to be equipped with effective teaching strategies.

Technology Knowledge. TK is one of the core components of the TPACK framework. Unlike other components (i.e., CK and PK), Koehler and Mishra (2006) define TK as "a state of flux" (p.64), since the definition of "technology" can be changeable over time. In the TPACK framework, they define TK regarding the definition of Fluency of Information Technology (FITness) (NRC, 1999). FITness refers to an understanding of how to use information technologies (e.g., video conferencing equipment, personal computer, etc.) to be productive at work. Thus, TK focuses on teachers' interpretation of how technology can be used in the classrooms to support students' learning. TK includes any kind of technology knowledge (e.g., educational tools and resources) to support teaching practices.

Technological Content Knowledge. This construct combines CK and TK to provide insights into how technology can support content knowledge. TPACK explains that teachers need to have adequate content knowledge and understand how technology can support to enhance content knowledge. Put differently, teachers need to understand which and how educational technologies can be used to support their students' understanding of the subject matter. For example, a science teacher can use virtual simulations to help her students to understand abstract scientific concepts through her TCK. Similarly, an art teacher can adopt digital storytelling technologies to support her students' art skills.

Technological Pedagogical Knowledge. TPK refers to an understanding of how technologies affect the way of learning and teaching. This construct includes an understanding of how to use technologies effectively from a pedagogical perspective as they shape teaching practices and strategies. TPACK framework suggests that to have a strong TPK, it is imperative to understand the constraints and affordances of technology, as well as the disciplinary contexts in which it functions. For example, with a strong TPK, a high school ELA teacher can use personalized language learning technologies to foster her students' ELA experiences. In this case, this teacher understands how to use a specific technology to achieve specific learning objectives.

Technology, Pedagogy, and Content Knowledge. TPACK refers to interaction among CK, PK, and TK. This construct provides an emerging understanding of three core components within the framework. The foundation of TPACK is to understand how to present content through technology, utilize pedagogical approaches that demonstrate how to use technologies to introduce subject matters, recognize learning challenges and trajectories, acknowledge students' prior knowledge and experiences as well as know the ways of using technologies to build upon students' prior knowledge. Overall, the intersection of TK, CK, and PK emphasizes the importance of teachers' understanding of their subject matter, the pedagogical approaches they are following, the educational technologies they are incorporating into their classrooms, and how to incorporate these technologies to foster their students' learning process.

Background of Artificial Intelligence

Even though it is difficult to pinpoint the exact dates of AI origins, there are some mentions of AI around the 1940s. Haenlein et al. (2019) acknowledged one short story "Runaround" (i.e., a story of a robot) that is written by an American Science Fiction writer in 1942 as an example of an AI idea. They further explained this story had become an inspiration for many scientists in the field of robotics and AI. Simultaneously, a mathematician, Alan Turing, developed the Enigma machine to crack intercepted coded messages during the Second World War (Deavours et al., 1977). Afterward, an article was published related to the ways of creating intelligent machines and testing their intelligence (Turing, 2012). Today, Turing Tests are still being used as a benchmark to determine the level of intelligence of a system (Hernández-Orallo, 2020). After that, the 1956 Dartmouth summer research project was proposed to discuss the aspects of AI such as "automatic computers" and "how can a computer be programmed to use a language" (McCarthy et al., 2006, p.13). In this summer project, the definition of AI was introduced as "the science and engineering of making intelligent machines, especially intelligent computer programs" for the first time (McCarthy, 2004, p.2). Throughout the years, AI has transformed into intelligent machines and algorithms that mimic human intelligence (McCarthy, 2007).

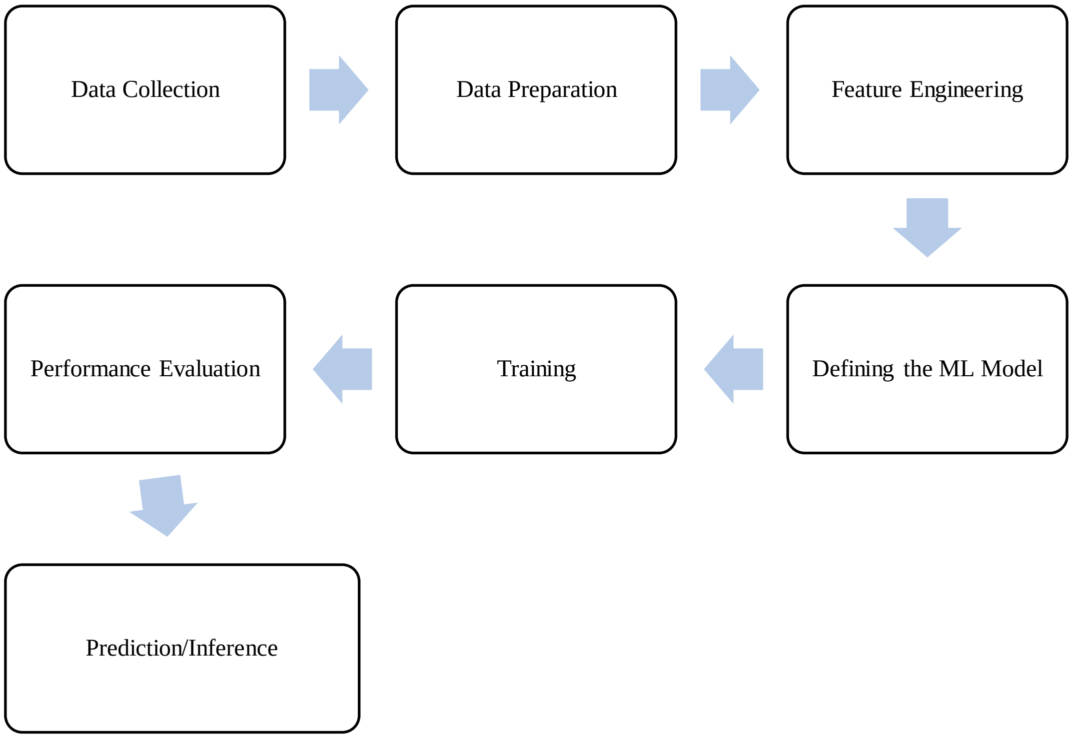
Furthermore, many researchers have expanded the definition of AI with regard to the ability to problem-solving and perform complex cognitive tasks (Wang, 2019). With these abilities, AI has been involved in many facets of our lives from industrial developments (e.g., manufacturing and marketing) to daily-life applications (e.g., personalized shopping and voice assistants) (Lee & Yoon, 2021). The widespread nature of AI-enhanced technologies has brought discussions about AI literacy and education. The idea of exposing youths to AI started around the 1970s (Papert et al., 1971; Kahn et al., 1977). Yet, AI education in K12 has gained rapid momentum over the last few years with the increased integration of AI into our lives (de Freitas & Weingart, 2021).

Background of Machine Learning

In 1959, Arthur Samuel introduced the term "Machine Learning" while describing a machine's process of solving the game of checkers (Joshi, 2020). ML was defined as learning a specific behavior through an experience without programming the behavior explicitly (Mitchell, 1997). It is a critical subset of AI to learn from data and provide accurate outputs (Holzinger et al., 2018). Put differently, many researchers define ML as experimental learning that follows computational algorithms to learn and improve its system (e.g., Bini, 2018; Naylor, 2018). These algorithms use large datasets as an input to identify patterns and to train the models for specific tasks like recommending movies or shows.

The ML algorithms can be divided into several broad categories with regard to their learning style and methods based on time (Ayodele, 2010; Goodfellow et al., 2016). Among all categories, the most frequent learning styles are supervised learning, unsupervised learning, and reinforcement learning (Joshi, 2020). In supervised learning, the algorithms build a mathematical model from a dataset that includes both the input and the desired outcomes. As an example, an ML application can be developed to detect spam emails with a given real-world dataset that includes text (i.e., input) and spam or not spam label (i.e., output). In unsupervised learning, the algorithms can build the mathematical model by only using inputs (Alloghani et al., 2020). These algorithms are mostly used to find patterns in the data. In reinforcement learning, the ML models are trained by getting feedback. The algorithms follow a trial-error sequence and receive rewards or penalties based on their decisions (Sutton, 1992). Autonomous vehicles mostly employ these algorithms (Isele et al., 2018). A general ML process requires following seven main steps regardless of the algorithm type (Alzubi et al., 2018). The initial process starts with the data collection and ends with prediction or inference (Figure 2.1).

Figure 2.5 *A generic ML model flow*



Data collection and data preparation are critical steps in the generic ML flow since these steps specify the quality of ML prediction/inference. After that, features are selected from the data to build ML models. The model is trained with the selected features. Therefore, this step is essential for the model performance in terms of getting more accurate results. When the model is trained, the next step is to evaluate the performance. According to the model evaluation, the previous steps can be repeated. The last step in the flow is to deploy the results and get predictions or inferences. In K-12 AI education, predominantly supervised algorithms, especially two common algorithms (i.e., classification and regression) have been used to teach ML concepts

(Marques et al., 2020). K12 students experience this generic ML flow through these algorithms (e.g., Kaspersen et al., 2021).

Artificial Intelligence Education in K-12

To date, many AI initiatives (e.g., AI4K12, CS for All) developed standards and frameworks as guidance for best practices for engaging K-12 students in AI learning (Wong et al., 2020). These efforts reveal a significant need to broaden access to AI concepts and practices. One common way of broadening access is to integrate the learning of AI with other disciplines. Researchers and practitioners have explored ways to support students' AI learning by designing and developing activities that involve building machine learning models with data that has connections with STEM (science, technology, engineering, and mathematics) learning (Van Brummelen, 2019). For example, Sakulkueakulsuk and colleagues (2020) proposed an approach for supporting middle school students' integrated STEM and machine learning understandings. In this study, students built machine learning models to predict whether mangoes were sweet using features such as color and softness. They found that students developed an "interdisciplinary view" of AI and an understanding of the application of AI in food sciences. In another example, Wan and colleagues (2020) developed a hands-on learning environment to foster high school students' scientific thinking through integrating ML technologies into STEM education. In this study, eight high school students interacted with this environment and completed ML activities (e.g., K-means clustering with facial expressions) through scientific inquiry methods (e.g., question asking, justification, and evidence finding). In the learning environment, students were asked to sort smiley faces with regard to their similarities and differences. While completing these activities, they demonstrated scientific inquiry behaviors like asking questions and generating hypotheses. The analysis of students' data indicated that the students developed a basic understanding of ML concepts and sense-making patterns. This study also showed the use of ML in K-12 STEM education as a data-driven approach that supports evidence-based scientific discovery. Overall, these studies support our current understanding of how machine learning is integrated into STEM classrooms to support K-12 students' STEM skills and develop ML understandings.

AI is a multidisciplinary field that connects with many other disciplines such as ELA, journalism, and social studies (Tatar et al., 2021; Stray, 2019; Berson et al., 2004). Yet, scholars' knowledge about integrating AI into Non-STEM and non-programming disciplines is limited (Sulmont et al., 2019). Only a few studies demonstrated comprising efforts on promoting AI education in these disciplines. As an example; Forsyth et al. (2021) proposed an interdisciplinary approach aligned with ELA and computer science disciplines to support youth's understanding of AI ethics. They developed an AI curriculum with short AI stories and asked middle and high school students to explore the critical aspects of these stories. 11 middle school and 32 high school students participated in a summer camp to learn the AI curriculum. In each unit, students explored critical aspects of short AI stories through online AI learning activities. The researchers collected the data through pre/post survey, students' artifacts in the activities, and observations. Their analysis of students' artifacts demonstrated that the short stories played a critical role for students' understanding of critical AI issues. Also, they found that students developed awareness and critical thinking of AI ethics after completing the curriculum. This study contributes to the AI education field by demonstrating ways of integrating AI education into the ELA curriculum and providing open resources for educators. Similarly, Way et al. (2016; 2017) carry out a project to create a broader and more accessible AI education for non-programming classes. They provided open resources for educators to integrate AI learning modules (e.g., introduction to AI, supervised learning, and unsupervised learning) into their disciplines. One of their learning modules was tested in an Art classroom for three semesters and they explored students engaged with learning activities enthusiastically. While these studies demonstrated an understanding of how AI can be integrated into Non-STEM and non-technical disciplines, more empirical efforts should be devoted to exploring how these integrations support students' content-related comprehensions and AI understandings. Additionally, in many studies, AI modules were developed and taught by researchers either in formal or informal settings. The current literature is limited to explaining the teachers' views and roles in integrating AI into K12 classrooms.

Introducing Computing Concepts into Non-STEM Classrooms

Digital competencies such as computational thinking (CT), data science, and AI are traditionally associated with Computer Science (CS) classrooms (Oliver & Houchins, 2019). Many scholars advocate integrating these competencies into STEM classrooms, particularly in CS classrooms since they see a natural fit (e.g., Kubat, 2018; Roehrig et al., 2021). However, not all U.S. public schools provide CS classes for their students (Code.org, 2021). Presenting these concepts only in CS classrooms leads to inequity in education, especially when they are accepted as 21st-century skills that everyone should have (Karakoyun & Lindberg, 2020).

Yamada (2018) emphasizes the importance of globalization and interdisciplinary studies to support youths' future career opportunities. Additionally, many studies note that these competencies are beyond STEM classrooms (e.g., Jiang et al., 2022; Guven & Gulbahar, 2020). Therefore, Non-STEM teachers should also integrate these concepts into their classrooms to foster their students' learning.

Curricular integration has been a powerful way to integrate these concepts into Non-STEM classrooms. However, education is a paradigm that changes rapidly with technological developments, and teachers are unprepared for these changes due to a lack of professional development and resources (Schrum,1999; McPhail, 2018). Thus, integrating CS topics into Non-STEM classrooms is often a daunting experience for teachers who have little experience, or no training related to CS discipline (Trygstad, 2013). Cabrera (2019) conducted a systematic literature review to explore teachers' preconceptions of CT. Her study demonstrated that even though teachers saw CT as a critical skill, they believed that it is difficult to integrate it in K12 classrooms because of curriculum and instruction constraints. To foster curricular integration, she calls for initiatives to highlight how the integration of these concepts can be helpful for students' understanding and engagement in the existing curriculum. She also emphasizes the importance of teacher education to foster interdisciplinary study.

Furthermore, Ray et al. (2019) explored non-STEM teachers' perceptions of integrating coding in their classrooms as a teaching and learning tool. The teachers participated in a master-level online technology integration course and engaged in coding activities. The analysis of their pre-and-post questionnaire responses and artifacts from the course demonstrated that after the training, most of the participants became more confident to teach coding in their classrooms. Yet, some teachers mentioned that although they understood the coding and were willing to teach it, they asked for more support to integrate it. These studies showed the challenges to integrate CS concepts into Non-STEM classrooms from teachers' perspectives. Collectively, they exposed the importance of teacher education for interdisciplinary curriculum integration. Although these studies closely examined CT and coding as CS topics, similar challenges are also valid for the integration of AI. As an illustration, Lin and Brummelen (2021) held a co-design workshop with K12 teachers to examine how they perceive challenges and opportunities in AI curriculum integration. Fifteen K12 teachers including STEM and Non-STEM teachers, participated in the co-design workshop for two-days and completed AI activities. The findings showed that the teachers needed more scaffolding to integrate AI curriculum in their classrooms. Additionally, teachers mentioned general learning opportunities to support students' subject understandings with AI (e.g., support students' argumentation skills through data analysis in AI curriculum) as well as engaging them with different technological tools. They also brought challenges in terms of logistics (i.e., technological resources and being prepared to students' questions). These findings support the prior findings related to integrating CS concepts into K12 classrooms. Collectively, they point to those two main considerations; (1) teachers need training to feel confident about teaching CS concepts and (2) they should be informed about resources and tools. Yet, current studies are limited to explain the impacts of teacher trainings on their confidence in teaching CS concepts and how teachers' experiences evolve before and after they integrate CS topics in their classrooms. Understanding teachers' confidence, views, and needs is critical for establishing interdisciplinary studies. Even though technologies are replaced with new developments, exploring these concepts can bring to light on future studies.

Teachers' Perspectives and Conceptions of Artificial Intelligence Education

The need for formal AI education in K12 is an undoubted fact to prepare students for an AI-powered future (Ashri, 2019). Yet, a successful and sustainable integration relies on teachers' perspectives and conceptions of the integration of AI topics into their classrooms (Lin et al., 2021). Teachers' conceptions play a significant impact in their teaching practices (Chen et al., 2012). Furthermore, Eley (2006) indicated that teachers' conceptions and their actual teaching practices are correlated. Also, many studies suggest that the way teachers think about specific subjects has a profound effect on their classroom practices and performance (Belbase, 2013; Mishra, 2020). Since AI education is neither a standalone subject nor integrated into a nationwide standardized curriculum, it is essential to investigate teachers' conceptions of this subject matter (Sanusi et al., 2022). Understanding teachers' perspectives and conceptions of AI education is a key to spreading AI practices in K12. However, current literature is limited to providing empirical research on the teachers' perspectives and conceptions of teaching AI (Lindner & Romeike, 2019).

Only a few studies examined the teachers' perspectives and conceptions of AI education. For example, Wollowski et al. (2016) conducted a survey study with AI educators and practitioners to understand their current states of AI education and practices. They developed two different online surveys to gather information from both perspectives. The main goal of the educators' survey was to explore current teaching practices related to AI while the practitioners' survey aimed to investigate the AI concepts and techniques that are followed in practice. 59 computer science (CS) educators from higher education (i.e., including faculty members and Ph.D. students) and 31 practitioners participated in the survey. The educator's survey included questions related to AI courses that offered at their institutions and the topics that covered in these courses. The practitioner's survey aimed to reveal what kind of AI tools and techniques practitioners currently use and what topics/techniques an AI introductory course should include. They analyzed the survey responses to reveal the similarities and differences between educators' and practitioner's perspectives. Their findings demonstrated the needs in the practice seem to match with the instructed education in higher education. Put differently, the AI courses offered in the institutions address the needs in industry. In terms of differences, while practitioners focus on supporting students' system engineering problem-solving skills, educators put emphasis on introducing the basics of AI through "toy problems" like solving puzzles. Additionally, educators aim to highlight the ethical and philosophical aspects of AI rather than AI tools and techniques.

Similarly, Sulmont et al. (2019) carried out a study with non-CS faculty members (i.e., psychology professors, business management professors, etc.) and practitioners (i.e., data scientist and instructor) to explore their pedagogical content knowledge (PCK) in teaching AI concepts to non-CS majors. They interviewed the instructors to identify their PCK in the form of the students' preconceptions of the ML topics and the instructional tactics. They found that students understood the importance of learning ML, but they also overestimated its applications in the context of solving real-world problems. Therefore, they carried out preconceptions about their lack of abilities to learn ML. Thus, to overcome the challenges in the students' preconceptions, the instructors followed specific instructional tactics such as using real-world applications and visualizing the concepts. Also, they found that the instructors recognized the challenges of teaching ML concepts to non-CS majors. Yet, the instructors believed that certain tactics and sufficient PCK are key to handling these challenges. In general, the findings of these two studies informed us about the perspectives and conceptions related to AI and ML in the context of higher education. Despite that, these studies only examined the contexts in which instructors were already teaching AI topics in their classrooms, and they investigated the perspectives and conceptions through the teaching practices.

Concerning the K12 contexts, there are few studies that examined the high school teachers' perspectives and conceptions of AI education. As an example, Lindner & Romeike (2019) developed a survey to evaluate high school teachers' perspectives of AI. Thirty-seven CS high school teachers participated in this study. They found that the teachers' content knowledge was under the influence of the media and social discourse. Also, the findings revealed that the teachers mostly supported the integration of AI into the CS curriculum with diverse learning goals including teaching social-cultural and technical aspects of AI. Additionally, the findings also showed that the teachers identified the challenges of teaching AI as a lack of teaching materials, sufficient tools, and lack of AI-content knowledge. After this study, Lindner & Berges (2020) conducted a study related to high school teachers' pre-conceptions about AI in the context of a professional development workshop. They conducted a semi-structured interview through an online survey with twenty-three CS teachers. Their findings demonstrated that some teachers had basic information about AI but not detailed technical knowledge while some teachers had "science-fiction" knowledge. Also, the teachers mostly perceived AI ethics as a relevant and necessary concept to teach in schools.

Furthermore, Sanusi et al. (2022) also conducted a similar study to analyze high school CS teachers' pre-conceptions of teaching ML. They conducted semi-structured interviews with twelve teachers to explore their conceptions. They found that the teachers understood the importance of supporting their students' AI knowledge to prepare them for workplaces. Also, the teachers mentioned their needs in terms of teaching resources and professional development practices. Collectively, these studies contributed to our understanding of teachers' perspectives and conception of AI in the context of high school CS classrooms. Yet, they are limited to providing comprehensive understandings for Non-STEM classrooms.

Artificial Intelligence and Teacher Education

Despite the growing interest in AI education, it has still not been integrated a nationwide curriculum across countries. Even though many countries, especially China (Yang, 2019), India (Jaiswal et al., 2021), and the United States (Touretzky et al., 2019) published calls for action on this matter, only Israeli took an action to integrate AI into high school CS curriculum (Mike & Rosenberg-Kima, 2021). Consequently, teachers' preparedness and training have become an essential discussion for the successful and sustainable integration of AI into K12 classrooms

(Lee et al.,2022). On the other side, current teacher education programs have not started to provide AI education to prepare pre-service teachers to teach AI concepts (Sanusi et al., 2022). Only a few attempts have been found in the literature related to formal pre-service teacher education. As an example, an ML course module was added to a CS teacher preparation program to support pre-service teachers' ML knowledge (Mike & Rosenberg-Kima, 2021). Through this module, the pre-service teachers gained a basic understanding of ML. This program aimed to help pre-service CS teachers to be ready to teach ML concepts in high school CS classrooms. Yet, this program only considered CS classrooms and it did not provide interdisciplinary teacher education.

Along with pre-service teachers' training, few efforts have also been devoted to fostering in-service teachers' AI understandings and knowledge. For example, Vazhayil et al. (2019) held an AI teacher education program with thirty-four CS teachers for two days in India. The goal of the program was to train the teachers to teach AI concepts in their classrooms. After the workshop, semi-structured interviews were conducted to reveal the teachers' AI understandings and their perspectives related to the AI curriculum. This study demonstrated that the teachers had become knowledgeable about the concepts and motivated to integrate this curriculum into their classroom. However, they mentioned the technology and administrative barriers in their schools. Furthermore, there are few studies that engage K12 teachers with AI topics through co-design curriculum workshops. For instance, Sabuncuoglu (2020) developed an AI curriculum for middle school students and designed workshops with teachers and students to introduce this curriculum. Eighteen middle school Information and Communication Technology (ICT) teachers participated in the meetings to discuss AI concepts and the curriculum. The findings of this study mostly focused on how the teachers reflected on the curriculum rather than their understandings of AI.

In a similar way, Lin and Van Brummelen (2021) also conducted a study with K12 teachers to explore their values and considerations in the design of an AI curriculum. They held a two-day virtual co-design workshop with fifteen teachers: including ten STEM and five Non-STEM teachers. In the workshop, the teachers explored the AI concepts and discussed the curriculum activities. The findings of this study showed the teachers valued the curriculum activities to engage their students with AI topics and saw the connections to how to integrate the AI curriculum into their classrooms.

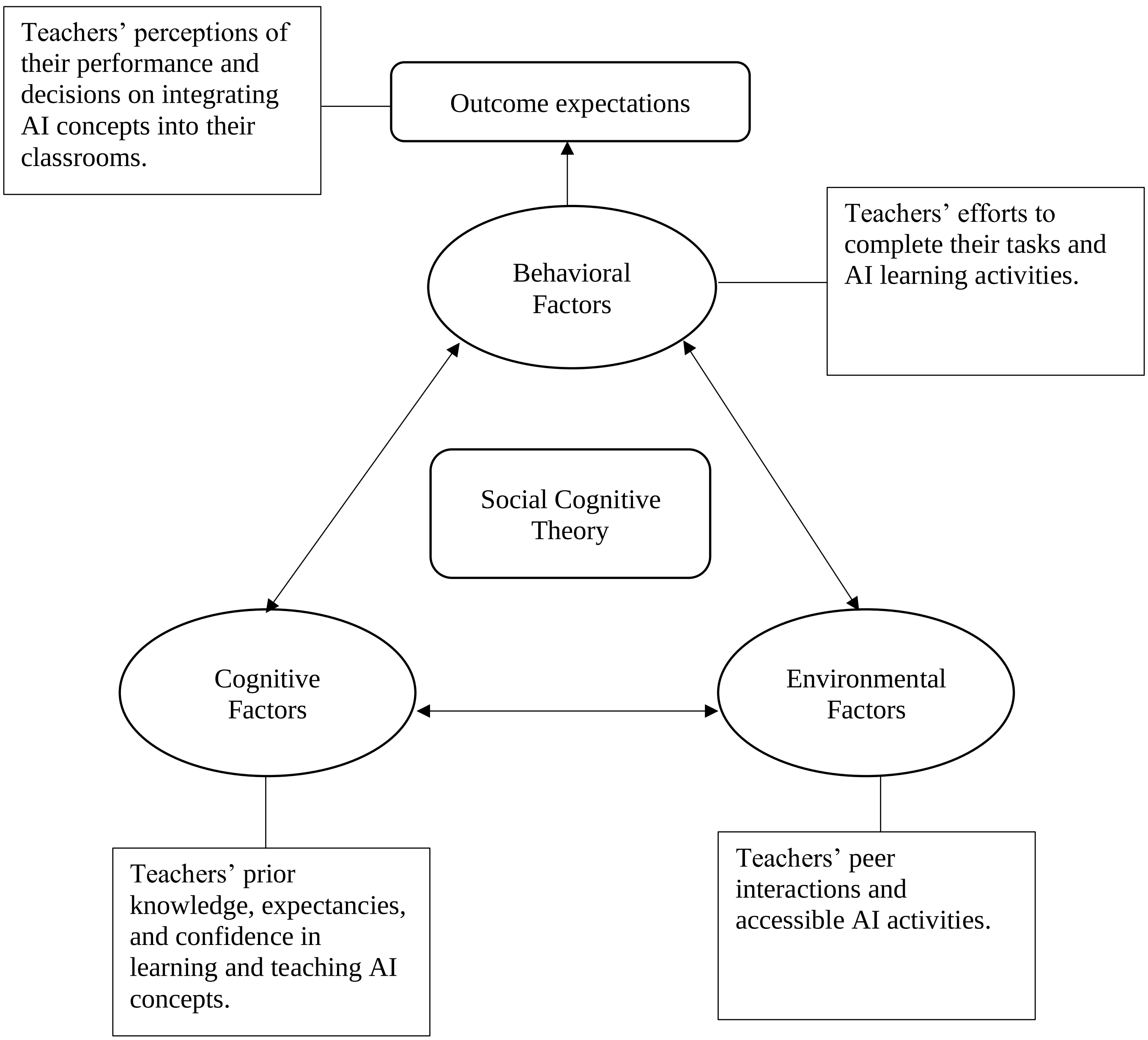
Overall, these studies provide insights into how teachers' education and training related to AI concepts took a place in the literature. At the present time, most studies focused more on CS teachers' training. Only one study demonstrated diverse participatory AI training in terms of the teachers' subjects. Additionally, the studies mostly targeted the teachers' perspectives on their designed AI curriculum. More efforts should be dedicated to exploring how AI professional developments help Non-STEM teachers to gain the confidence to teach AI topics in their classrooms and support their conceptual understandings.

Chapter Summary

This chapter demonstrates a deep understanding of current trends and gaps in K-12 AI education literature. Current studies show that AI education becomes essential in K-12 classrooms to prepare youths for AI-empowered jobs. Many efforts have been devoted to finding effective ways to engage K-12 students with AI and ML practices. Many organizations and initiatives put efforts to design and develop AI education tools and resources. Additionally, many studies have started to investigate how K-12 students develop an AI understanding. However, current studies mostly take a place in STEM classrooms, specifically CS courses. This means that most of the K-12 students cannot have access to AI education in their schools. As a result, this unequal access to AI education creates a lack of opportunities for many students, especially underrepresented and underserved students. To provide equal opportunities, AI education should go beyond STEM classrooms. Many scholars highlighted curriculum integration as an effective way to create more accessible education. Through curriculum integration, most of the K-12 students can have opportunities to engage with AI concepts beyond STEM classrooms. Yet, the scholars also highlight the importance of teachers' role in successful curriculum integration. Many studies found that introducing CS concepts in non-STEM classrooms was a dreadful experience for teachers. To deal with such challenges, scholars advocate providing adequate training for teachers. Nonetheless, current literature is limited to explain what kinds of efforts have been devoted to preparing non-STEM teachers to integrate AI concepts into their classrooms. Also, there has not been any AI education provided in current teacher education programs to prepare pre-service teachers for teaching AI. For this reason, the scholars' attention turned to providing professional development workshops to support teachers' AI knowledge. Yet, many studies mostly focused on STEM teachers and their perspectives on AI in these workshops. Current literature is limited to explaining how these AI professional development workshops support non-STEM teachers' confidence in the integration of AI concepts. This dissertation aims to contribute to the literature by demonstrating an understanding of non-STEM teachers' confidence and views after they participated in an AI professional development workshop. Furthermore, this dissertation examines non-STEM teachers' classroom implementation experiences after they integrated an AI curriculum into their classrooms.

Moreover, this chapter provides an overview of two theoretical frameworks, Social Cognitive Theory as the main theoretical framework and Technological Pedagogical and Content Knowledge as a conceptual framework. In the context of this dissertation, the professional development workshop builds upon the Social Cognitive Theory (see Figure 2. 6). The cognitive factors refer to teachers' prior knowledge, expectancies, and confidence in learning and incorporating AI concepts into their classrooms. The workshop was designed to give opportunities for teachers to share their expectancies, build upon their prior knowledge, and develop confidence in teaching AI concepts while completing the AI learning activities.

Figure 2. 6 *SCT in the context of the Professional Development Workshop*



The environmental factors, in the context of this dissertation, focus on the interactions among teachers, accessible learning activities, and technologies. The workshop aimed to create an AI learning community where teachers can share their learning experiences and get feedback from their colleagues. Additionally, the AI learning activities and technology were accessible on the internet without requiring learning fees. Therefore, the teachers can integrate any of the AI learning activities at any time. The behavioral factors refer to teachers' efforts to complete their tasks and AI learning activities throughout the workshop. The workshop included weekly assignments and tasks for teachers. Every week, the teachers were responsible to complete these assignments. The efforts they demonstrated in the workshop are considered as behavioral factors. Lastly, the outcome expectancy of the workshop was to lead teachers to integrate the AI learning activities into their classrooms. In this dissertation, the outcome expectancy emphasizes how teachers' workshop experiences lead them to incorporate the AI learning activities into their classrooms.

In addition to SCT, this dissertation employs the TPACK as a conceptual framework. In the context of this dissertation, each TPACK construct was defined as follow.

- TK: Teachers' technology knowledge to use an AI learning technology.
- PK: Teachers' knowledge of how to incorporate AI concepts, address students' learning challenges related to AI concepts, and assess students' AI learning progress.
- CK: Teachers' knowledge of their subject matter and understanding of the connection between AI and their subject matter.
- TCK: Teachers' knowledge of how their subject matter can be supported by integrating the AI curriculum activities and technology.

- TPK: Teachers' knowledge of how integrating AI learning activities and technology shapes their teaching practices and strategies.
- PCK: Teachers' knowledge of presenting their subject matter and AI concepts to facilitate their students' learning.
- TPACK: Teachers' knowledge of integrating the AI learning activities and technology that align with their subject matter by using appropriate pedagogical approaches.

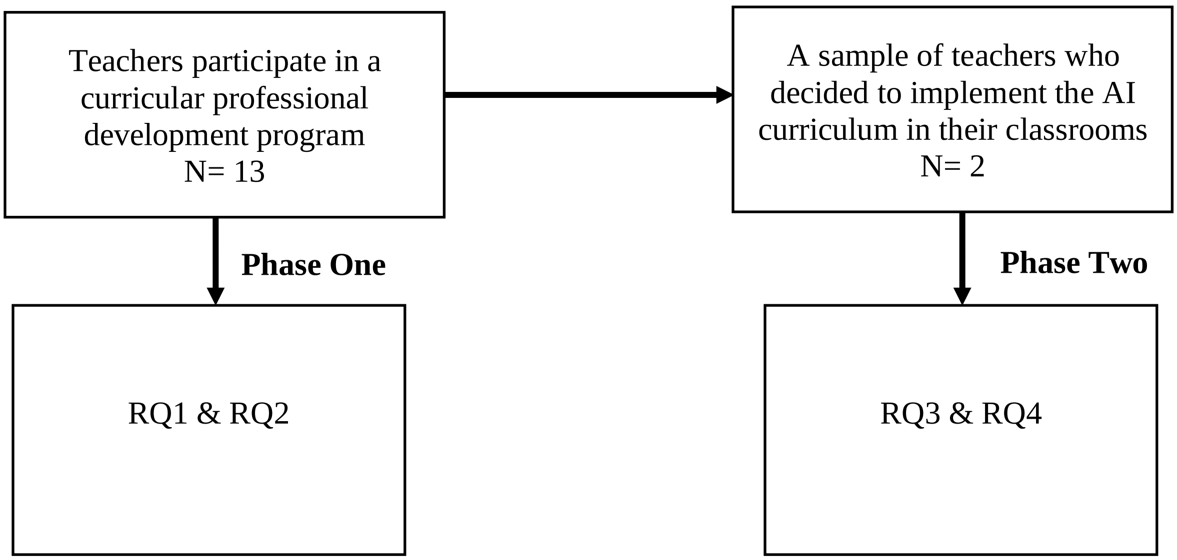
CHAPTER 3: METHODOLOGY

The purpose of this dissertation is to investigate high school English Language Art (ELA) teachers' perspectives and experiences on integrating a technology-enhanced AI curriculum into their classrooms. By drawing the lens of Social Cognitive Theory (SCT) and Technological Pedagogical, and Content Knowledge (TPACK) frameworks, the following questions guide this dissertation work.

- **RQ1:** What was ELA teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program?
- **RQ2:** What were ELA teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program?
- **RQ3:** What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms?
- **RQ4:** What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms?

This chapter demonstrates the steps to address the aforementioned research questions in a detailed way. This dissertation discussed coherently to investigate the teachers' perspectives and experiences on the integration of an AI curricula into high school ELA classrooms. This dissertation followed an exploratory mixed method case study approach. The first two research questions specifically focused on the ELA teachers' confidence and views on incorporating AI into their classrooms after they participate in a professional development workshop. The RQ3 and RQ4 investigated the teachers' experiences in integrating the AI curriculum in their classroom, particularly in identified challenges, opportunities, and recommendations to other teachers. Figure 3.1 describes the conceptual overview of the dissertation.

Figure 3.1 The *Conceptualized View of the Dissertation Study*



Context Phase One, Training (Related to RQ1 and RQ2)

High school English Language Arts (ELA) teachers attended a one-month curricular professional development program. It was a virtual program with a mix of synchronous and asynchronous activities. In the program, teachers learned AI concepts using the StoryQ technology, provided feedback for an AI curriculum (it includes eight activities focusing on building machine learning models with texts; see details in the AI Curriculum section), created mini-lessons, and developed mini-lessons for their ELA classrooms.

Each week, the research team and teachers met synchronously through Zoom (i.e., a video conferencing tool) to discuss weekly activities and assignments. While introducing the curriculum activities, teachers were not informed about how each curriculum lesson supported specific ELA learning objectives. The PD workshop was designed to provide flexibility for teachers to discover ELA connections as they completed the activities. The total time of these synchronous sessions was six hours (i.e., approximately 1.25 hours per week). Specifically, in the first-week synchronous session, as a warm-up activity, in small groups, teachers used the Google Jam board to create posters about their perceptions of AI. Afterward, the research team guided teachers to test a model for classifying sentences as either light on or light off. For instance, the sentence "please turn it on" should be classified as light on as the person who wrote this sentence intended to have the light on. After this activity, teachers worked in small groups to test the model with self-generated sentences and discussed why the model made correct or incorrect classifications. At the end of the session, teachers shared their model testing results. Building on teachers' ideas, the research team revealed the dataset that was used to generate the model and explained that the model learned patterns and how these patterns are used to classify sentences. As asynchronous activities, this week, teachers were asked to complete the first three activities of the curriculum as students and provide feedback for each activity. In addition, they needed to create a mini-lesson based on one of the three activities, post the lesson on Padlet (i.e., a collaborative web platform), and comment on mini-lessons created by peer teachers. Teachers could choose any topic or format that they were comfortable with. Some examples of mini lessons were video recordings of explaining a difficult concept to students, video recordings of describing a detailed plan of how they would implement a particular activity, and word documents that specify anticipated student responses to a particular activity.

In the following weeks, each synchronous session was structured in the following way: teachers first asked questions, reflected on their learnings of the assigned activities in the previous week, discussed how they would implement these activities in their classrooms, and then the research team presented one activity from the activities that they needed to learn as students in that week. In the synchronous days, the presented learning activities were selected carefully regarding the core AI concepts and practices, including creating features, building models, and conducting error analysis. As asynchronous activities, teachers completed weekly learning activities (activities 4-5 for week 2 and activities 6-8 for week 3) and created mini lessons based on these learning activities. The asynchronous activities for week 4 were for teachers to complete incomplete assignments from previous weeks.

During asynchronous activities, the teachers were supported through Slack (i.e., an online communication platform) and one-to-one office hours (i.e., synchronous meetings via Zoom). Teachers were encouraged to sign up for weekly office hours to discuss their questions and feedback for curricular activities with the research team members. Teachers could also use their office hours as a space to test their mini lessons, with the research team being their students and audiences.

Context Phase Two, Implementation (Related to RQ3 and RQ4)

After this workshop, two teachers; A journalism and ELA teacher (Heloise) from School A and an English to Speakers of Other Languages (ESOL) and ELA teacher (Marsha) from School B connected with the research team to plan the integration of the curriculum. Heloise and Marsha saw opportunities to enrich the classroom discussions related to AI. Especially, Heloise was motivated to bring discussions about AI and Journalism into her classroom. Therefore, she approached the research team to employ the curriculum in her Journalism classroom for two weeks (i.e., 15 class days). Similarly, Marsha also wanted to discuss AI concepts in her ESOL class and decided to integrate the first five activities of the StoryQ AI curriculum into her class for 10-days. To plan the classroom implementation, the research team and the teachers had individual meetings to discuss the details of the implementation like research instruments and infrastructure.

The Journalism class was an elective class and was open to any grade level. Therefore, the population of the class was diverse in terms of grade level, race, and gender. Twenty-eight students were taking this class: including three 10th graders, nine 11th graders, and sixteen 12th graders. Also, sixteen of the students were African American, six students were White, six students were Latinx, and one student preferred not to answer. Additionally, in terms of gender, there were nineteen female and nine male students. The students' prior AI knowledge was limited. Twenty-five students mentioned they heard the term AI through mass media like movies or shows but none of the students got any formal training. For the curriculum implementation, Heloise moved her classroom to the computer science class to provide one desktop computer for each student. The students engaged with the seven curriculum activities throughout the implementation.

The ESOL class was a beginner class for the 9th and 10th graders. This class had four students: three 9th graders and one 10th grader. Among them, three of the students were male and one student was female. Also, in terms of their race, there were two Hispanic, one Latinx, and one Middle Eastern. Similar to the Heloise's classroom, these students also heard the term AI from movies, TV shows, or their family/friends but they did not attend any formal training. For the curriculum implementation, each student used one Chromebook to complete the five curriculum activities.

In both classes, each period lasted for 45-minutes and was structured in the following way: the teachers spent approximately five minutes for students to prepare and be ready for the class, introduced the activity for 10 minutes, asked for students to complete the activities approximately for 20-minutes, and asked students to reflect and discuss their learning experiences for 10 minutes. During the classroom implementation, the research team supported the teachers through Slack and Zoom. In the Journalism classroom, Heloise used Slack when she had questions or needed support. In the ESOL classroom, one researcher participated the class via Zoom and helped Marsha when she needed. Furthermore, the technology team was supporting the classroom implementation remotely in the case of an emergency.

Participants

Thirteen English Language Art (ELA) teachers from public high schools in the Northeastern part of the United States attended the one-month curricular professional development program. The teachers were invited to participate in the program via email. In the email invitations, we shared the program’s goals, timeline, and tasks. Eight of thirteen teachers (Female, 7; Male, 1) consented to participate in the study (Table 3.1). Their teaching experiences varied from 4 years to 18 years, with only one teacher reporting under 5 years of experience. Out of eight participants, two teachers came from a high-level diverse school where the minority enrollment rate was more than 90%.

Table 3.1 *Characteristics of Teacher Participants*

Characteristics	Number of participants
Gender	
Female	7
Male	1
Teaching Experiences	
Less than 5 years	1
5 to 10 years	2
More than 10 years	4
School Minority Enrollment Rate	
Less than 20%	4
Between 20% to 50%	1
More than 50%	2

Note. One participant was a faculty member whose work was to train ELA teachers. Thus, only gender information for her was included in the table.

The pseudonyms were used for all participants. One participant, Emma, was a faculty member in a state college. She taught in-service ELA teachers to integrate new literacy practices in classrooms. All the other participants were in-service ELA teachers. They attended the program for a variety of reasons, including exploring the connection between AI and ELA to meet students' interests (Amy, Douglas, Emma, Heloise, Paola), learning new ways of teaching ELA (Harper, Marsha), and looking for AI technologies for individualized instructions (Harper, Maria).

In addition to teaching ELA and AP literature classes, teachers taught other classes such as Journalism (Douglas, Heloise, Paola), ESOL (English to Speakers of Other Languages; Marsha), and Mythology (Maria). Among them, two teachers (Harper and Marsha) taught in science and technology magnet schools and two teachers (Harper and Paola) had master's degrees in educational technology. Two teachers were in a leadership role in their schools: Harper was an English Department head who came to the program to learn new ways of teaching ELA and Marsha was leading an ESOL initiative. As we can see, participants' school characteristics, educational background, and roles in the school might have played a role in motivating them to choose this program.

Materials: The StoryQ AI Curriculum

The AI curriculum used in this study is titled "StoryQ AI curriculum", which is part of a three-year research and development project called Narrative Modeling with StoryQ. This project was conducted by Dr. Shiyan Jiang (North Carolina State University), Dr. Carolyn Rosé (Carnegie Mellon University), Dr. Jie Chao (Concord Consortium), and William Finzer (Concord Consortium). The purpose of this project was to help K12 students envision AI-powered future careers by integrating the AI curriculum into K12 classrooms. For this reason, the team developed a web-based text mining and narrative modeling platform, StoryQ. This platform allowed students to design, build, test, and iteratively improve their ML models while completing the curriculum activities.

The curriculum included a sequence of eight activities that introduced the machine learning workflow with a focus on text classification and the role of human insights in the process of building machine learning models. Each activity includes activity-specific questions and feedback questions. The first four activities were "Introduction to AI", "How to model natural language", "How do humans classify text", and "Machine learning with alien language". These activities provided an introduction to machine learning topics and aimed to help students to reason about how humans and computers make decisions. After these activities, more advanced machine learning topics were presented in the following three activities: "Sentiment analysis", "Features and models", and "All the words as features". In these activities, learners explored a real-world dataset (i.e., reviews from Yelp), made interpretations about the classification tasks (i.e., building a classification model to differentiate negative and positive reviews), built machine learning models, and evaluated models' performances. At the end of the curriculum, learners completed the "Who creates AI" activity and learn about career opportunities in the AI-empowered society. Table 3.2 shows each activity with the learning objectives. The learning objectives were prepared from an AI learning perspective. The curriculum designers did not include an ELA learning objective for each lesson. The curriculum was designed to support students' general ELA understandings in terms of grammar, word choice, and sentiment analysis. The estimated time to complete this curriculum was approximately eight hours.

Table 3.2 *Eight Curricular Activities And Corresponding Learning Objectives*

Activity	**Learning objectives**
1. Introduction to AI	Students can define AI, describe AI technologies in everyday life, and know the relationship between machine learning and AI.
2. How to model natural language	Students can use probabilistic language to describe an expression's meaning, explain why we use probability to describe meanings, and explain how a model uses words to derive meaning.
3. How do humans classify text	Students can suggest features to separate reviews into negative and positive ones, consider both characteristics and features, and recognize that certain characteristics have straightforward features while others are more nuanced and harder to describe.
4. Machine learning with alien language	Students recognize that counting features is one way to analyze language, understand that models should be revised, and recognize the difference between presence and weight.
5. Sentiment analysis	Students can define "sentiment", "feature", and recognize that using a large dataset is important for training a model.
6. Features and models	Students can extract a feature using the StoryQ technology, analyze a feature to determine whether it will be useful to a model, and recognize that features may exist in both positive and negative reviews because people use language in multiple ways.

Table 3.2 (continued) *Eight Curricular Activities And Corresponding Learning Objectives*

7. All the words as features	Students know the difference between a unigram model and a model built by selecting features, can use a distribution graph to select highly weighted features, and describe how the computer assigned a feature a particular weight.
8. Who creates AI?	Students have a basic understanding of the history of AI and see themselves as capable of holding a job in the future that includes interaction with AI.

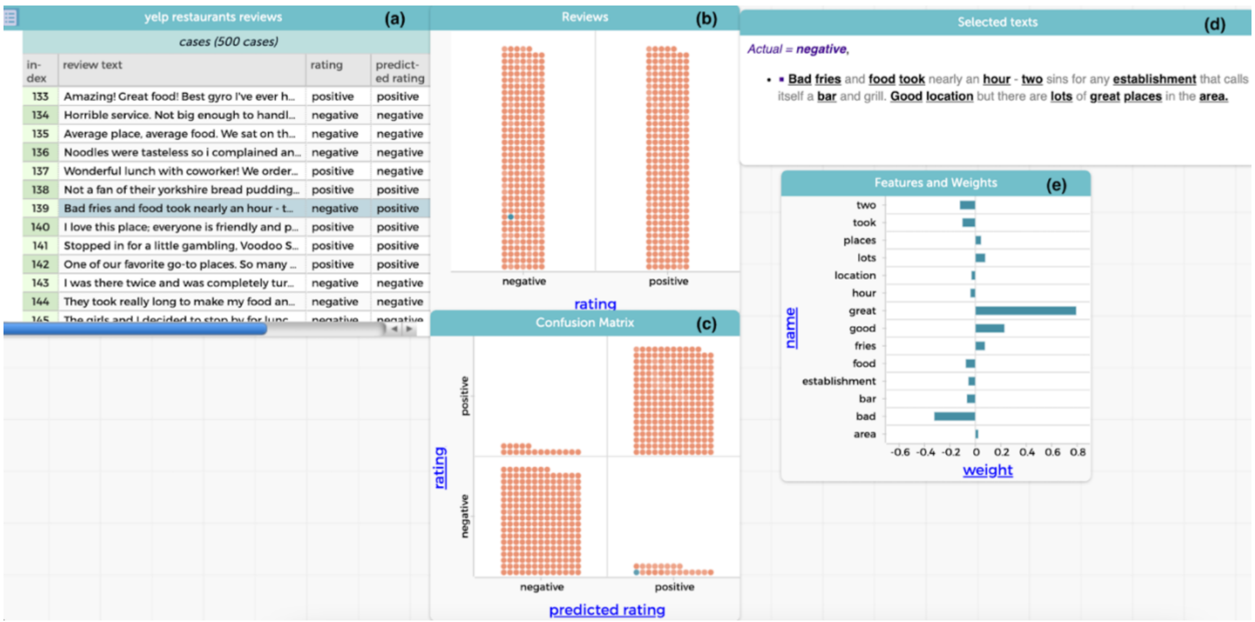
Materials: The StoryQ Technology

The StoryQ technology, developed by the research team, was a web-based text mining and narrative modeling platform that aims to support students' text mining practices in an engaging and accessible way. This technology allowed users to build, test, and iteratively improve machine learning models in a visual, interactive manner with dynamic representations. In this study, the machine learning models used logistic regression over unigram features (i.e., single words) to predict reviews' labels (i.e., positive and negative). We purposefully used the Yelp Frozen Dessert review dataset since the content did not require prior knowledge from learners. This dataset included 500 reviews with positive and negative labels.

As an example, Figure 3.2 demonstrates the machine learning model for predicting the review texts' labels. The task was to build models for predicting whether a review is negative or positive. Figure 3.2b shows the distribution of the reviews in Figure 3.2a. The distribution graph indicates that the number of positive reviews and negative reviews are the same. When learners selected a review from the distribution graph, it was highlighted in Figure 3.2a. The highlighted review was “Bad fries and food took nearly an hour - two sins for any establishment that calls itself a bar and grill. Good location but there are lots of great places in the area” (Figure 3.2d). Figure 3.2c was a confusion matrix for evaluating the model performance. Learners could compare actual and predicted labels to assess the accuracy of the model. In Figure 3.2c, learners could examine the highlighted review that the actual label is negative, but the predicted label was positive. Using confusion matrices, learners could analyze misclassified reviews and improve model performances based on such analysis. This process was called error analysis.

While conducting the error analysis, learners could create Figure 3.2e to explore features with their weights in the model. Figure 3.2e demonstrated the features that the model takes into consideration while predicting the label. The word “great” has a large weight (approximately 0.8). The sum of all feature weights determines the predicted label; if it is positive, the predicted label is positive. If the sum is negative, the predicted label is negative. Since the sum is positive, therefore, the machine learning model predicted the review as positive while it should be negative. The exploration of features allowed learners to revise the feature space to improve models. Thus, model development was an iterative process.

Figure 3.2 *Screenshot of the StoryQ environment: (a) Yelp review dataset with three columns, review texts, actual label, and predicted label. (b) The label distribution of the Yelp review dataset. (c) Confusion matrix. (d) Selected review(s). (e) Features that the model used to make predictions of the highlighted review.*



Note. (a), (b), (c), (d), and (e) are dynamically linked. When users change the highlighted review, the highlighted row in (a), highlighted dot in (b) and (c), texts in (d), and features in (e) will be updated accordingly.

Data Sources: Phase One

In the one-month curricular professional development program, multiple sources of data were collected to investigate teachers' experiences and views about integrating AI into ELA classrooms, including pre-and post-survey, semi-structured interviews, mini-lesson artifacts, video and audio recordings of synchronous sessions, asynchronous online interactions in Slack and Padlet, field notes, and curriculum activity reports.

In the pre-survey, teachers answered a series of Likert-scale and open-ended questions to share their attitudes and experiences toward learning and teaching AI concepts and practices. It consisted of 8 Likert-scale questions (i.e., ranging from 1-strongly agree to 5-strongly disagree) and 5 open-ended questions about teachers' beliefs and interests. An example of a Likert-scale question was rating the following statement: I am interested in learning about AI. The post-survey included 63 Likert-scale and open-ended questions which measure the impacts of the program, teachers' feedback on the activities and technology, and their satisfaction with the program.

In addition, the semi-structured interviews (Patton, 1990) with five volunteer teachers (Emma, Harper, Heloise, Marsha, and Paola) were conducted for approximately an hour. The purpose of these interviews was to explore the teachers' perspectives on integrating the AI curriculum into their classrooms. Furthermore, the synchronous sessions, including weekly meetings and office hours were recorded and we took field notes of these sessions. We also collected teacher-generated artifacts, such as mini-lessons and their asynchronous online interactions with each other (e.g., comments on each other's mini-lessons). Moreover, teachers completed activity-specific questions while learning curricular activities as students. Their responses were recorded in the curriculum activity report.

Data Sources: Phase Two

Similarly, in the classroom implementation, a variety of sources of data were collected to explore the identified challenges and opportunities and to explore the teachers' recommendations, including video and audio recordings of the class periods, semi-structured interviews, teachers' self-reflections after each day, online interactions in Slack, and field notes. In the Journalism class, Heloise used a video camera to record her classes for each day. She sent these recordings to the research team via e-mail. In the ESOL class, I attended the class through Zoom and recorded each session. These recordings included whole curriculum implementation such as teachers' presentations, their interactions with the students, and class discussions. Additionally, the teachers were asked to fill in self-reflection sheets after each class day. In these self-reflections, they responded to six open-ended questions (e.g., what is your biggest takeaway from today's implementation) related to their experiences. The purpose of these questions was to investigate the teachers' perspectives on their own teachings. These questions also helped them to think about the lesson plans for the next classes. For instance, when the teacher recognized a challenge, they mentioned this in the self-reflection and thought through the ways how to tackle this type of challenge in their next class. Additionally, at the end of the curriculum implementation, semi-structured interviews (Patton,1990) were conducted for approximately 45 minutes. We asked questions related to the teaching goals, changes, challenges, and recommendations. The interview protocol was designed to explore the teachers' curriculum implementation experiences in a detailed way.

Table 3.3 *Summary of Research Questions and Related Data Sources*

Research Questions	Data Sources
RQ1: What were ELA teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program? **RQ2:** What were ELA teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program?	• Pre-and post-survey • Semi-structured interviews • Mini-lesson artifacts • Video and audio recordings of synchronous sessions • Asynchronous online interactions in Slack and Padlet • Field notes • Curriculum activity reports
RQ3: What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms? **RQ4:** What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms?	• Video and audio recordings of the class periods • Semi-structured interviews • Teachers' self-reflections after each day, Online interactions in Slack • Field notes

Data Analysis Procedures

This dissertation employed an exploratory mixed method research design approach. Thus, data from each source was analyzed using different strategies to address the research questions. To address the first research question about teachers' confidence in presenting AI concepts, Wilcoxon Signed-Ranked test and descriptive statistics were employed to analyze pre- and post-surveys. Furthermore, to fully understand teachers' nuanced changes in confidence (when there were significant changes), content analysis of teachers' responses in the surveys was conducted to capture AI topics teachers felt more or less confident about. Also, the mini lessons were coded based on to what extent teachers revised the curricular activities. The content analysis of lesson plans allowed for further explore the nuanced changes in confidence as teachers who demonstrated significant change in their level of confidence might gradually become comfortable in making changes to the existing curricular activities.

To answer the second research question regarding teachers' views of integrating AI into ELA classrooms, I employed the following four phases of qualitative data analysis: creating teacher profiles, content analysis of interview transcripts and survey responses, generating case summaries, and cross-case comparison. Firstly, the portfolios for each case were created to sort all data sources chronologically. After that, the semi-structured interviews were transcribed and highlighted to explore the teachers' views on integration. The open coding strategies (Strauss & Corbin, 1998) were employed in the interviews and other data sources (i.e., video and audio recordings of synchronous sessions, asynchronous online interactions in Slack and Padlet, field notes, and curriculum activity reports) for revealing the themes related to the teachers' views. For the third research question (i.e., what challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms?), a live coding strategy (Parameswaran et al., 2020) was followed for analyzing the video and audio recordings. List (2007) explained live coding as "coding without transcription" or "not transcribing everything". This strategy included two main steps: (1) summarizing the content and (2) coding specific parts.

Therefore, while analyzing the recordings, I summarized the videos shortly and then created a coding structure to reveal challenges and opportunities during the classroom implementation.

Moreover, the three phases of qualitative data analysis (Miles et al., 2014) were followed while analyzing self-reflections and semi-structured interviews. The transcriptions of the interviews were created and imported into the MAXQDA with the self-reflections for the analyses. In the first phase of the analysis, the data was coded openly (Khandkar, 2009). This process helped to create the initial codebook. After that, I looked for patterns and main categories in the second phase of analysis. This finalized the codebook. Finally, in the third phase, I drew conclusions with evidence from the participants' quotes to address the research questions. The fourth research question (i.e., What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms?) was mostly addressed based on the analyses of the semi-structured interviews. Additionally, the online interactions and field notes were used to triangulate the data. After the data analysis, I identified patterns that are align with the theoretical frameworks and interpret the results regarding these frameworks.

Validation and Reliability

Creswell (2013) suggests engaging with at least two validation strategies to ensure the validity of the study. In this research, I followed triangulation (Ely et al., 1991) and peer debriefing (Lincoln & Guba, 1985) strategies. As I mentioned in the data analysis section, I used multiple sources of data to triangulate the analysis and provide validity to the findings. Additionally, for an external check of the process and interrater reliability, I engaged in debriefing sessions with the research team members and my advisors throughout the data analysis process. This helped the process to critically analyze meanings and interpretations. Also, I developed a codebook for the semi-structured interviews and self-reflection. For reliability, I asked a peer to code a part of the data by following the codebook. After that, I looked for the inter-rater reliability rate (DeCuir-Gunby et al., 2011). This process helped not only to make sure reliability but also to see the accuracy of data analyses. Creswell (2013) also mentions having detailed field notes and memos for reliability. Therefore, I maintained descriptive and detailed notes to support the evidence in the findings.

CHAPTER 4: FINDINGS

Findings from this exploratory case study investigate high school English Language Arts (ELA) teachers' confidence and views on the integration of an Artificial Intelligence (AI) curriculum into their classrooms. This study includes two research contexts; Phase One: Professional Development Training and Phase Two: Classroom Implementation. Phase one refers to the teachers' professional development experiences in learning about AI concepts through the StoryQ AI curriculum. In this phase, I explored the teachers' confidence and views after they completed the one-month professional development training. During this phase, I collected multiple sources of data, including pre-and-post surveys, semi-structured interviews, mini-lesson artifacts, video and audio recordings, online interactions, field notes, and curriculum activity reports. To explore teachers' confidence and views, I followed a mixed-method exploratory case study approach. I analyzed teachers' survey responses by employing quantitative research methods. Also, I employed qualitative approaches to analyze the semi-structured interviews and artifacts. On the other side, phase two explores the teachers' experiences with AI curriculum implementation in their classrooms. In this phase, I mainly examined learning challenges and opportunities that teachers perceived while implementing the StoryQ AI curriculum. Additionally, I also investigated teachers' general recommendations about the integration of AI concepts into the existing curriculum in ELA classrooms. During this phase, I collected a variety of data such as video and audio recordings of the classroom implementations, semi-structured interviews, and teachers' self-reflection notes. To gain a nuanced understanding related to classroom implementations, I followed qualitative data analysis strategies. This chapter first presents the findings of phase one by addressing the first two research questions. After that, it presents the findings of phase two by addressing research questions three and four.

Phase One: Training

The context of this phase took place in a one-month curricular professional development workshop. High school ELA teachers were invited through emails to participate in a virtual workshop to learn AI concepts through the StoryQ AI curriculum. The invitation emails included the StoryQ project goals, workshop timeline, and expectancies from the participants. The workshop was structured in a mixed format, including both synchronous and asynchronous days. The synchronous days included the introduction of the weekly assignments, general question and answer sessions, and teachers' reflections on the previous weekly tasks. In the asynchronous days, the teachers were responsible to complete their weekly assignments. In those days, they were encouraged to reach out to the research team when they had questions and concerns.

Teachers' Demographics

Thirteen ELA teachers from public high schools in the Northeastern region of the United States participated in the workshop. Eight teachers provided their consent to participate in this study, and therefore, the data analysis is based solely on the responses obtained from these consenting participants. When teachers applied to participate in the workshop, they were asked to complete a recruitment form. In this form, they answered questions related to their background such as years of teaching, the classes they teach, AI teaching experiences, and motivation to attend the workshop. The teachers were teaching a variety of ELA courses such as AP English, English to Speakers of Other Languages, Journalism, and American Literature and Composition and their years of teaching were varied from 4 to 18 years. Most of the teachers' experiences with using AI technologies and ML techniques in their classrooms were limited (Table 4.1).

Table 4. 1 *Participants' Experiences of Teaching AI*

Using AI technologies and ML techniques	Number of participants
No experience	3
Used AI-empowered technologies (e.g., Turnitin and No Red Ink)	2
Integrated CS topics into the class	1
Named AI learning resources and technologies	1
No response	1

Three teachers out of eight teachers mentioned that they did not have any experience with using AI technologies and ML techniques in their classrooms. Two teachers brought up specific AI-empowered technologies like No Red Ink and Turnitin to give feedback to their students. Additionally, one of the teachers explained that she integrated several CS concepts such as coding, ethics, and computational thinking into her classroom. Although she did not give details about how she used AI technologies and ML techniques, she indicated her experiences with integrating CS topics. Also, another teacher referred to AI learning and coding resources and the technologies that use ML. She did not clearly explain whether she used those resources in her classroom or she was only familiar with them. In general, teachers were novice learners in integrating AI concepts into their classrooms. Moreover, in the recruitment form, the teachers also explained their motivations to participate in this workshop (Table 4.2).

Table 4. 2 *Teachers' motivations to participate in the AI professional development workshop*.

Motivation to participate in the workshop	Number of participants
Professional development	3
Engage my students	2
Saw the relevancy to integrate AI into the class	1
AI is fascinating	1
No response	1

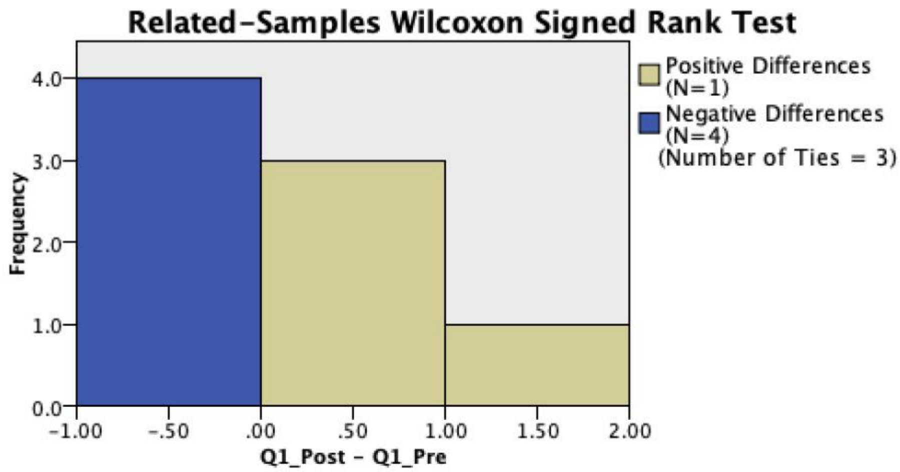
Most of the teachers believed that this workshop would be helpful for their professional development. For example, one of the teachers had a master's degree in educational technologies and she wanted to learn more about how AI and ML might shape teaching and learning. Also, two teachers brought up their students' engagement and interest toward AI topics when they were explaining their motivations. These teachers explained that their students were already talking about the developments in AI technologies, therefore; they wanted to learn AI concepts to discuss with their students. One teacher mentioned that before the workshop, he took classes related to AI and ML. Through these classes, he saw the relevance of teaching AI in the classroom and wanted to learn more about AI. Although teachers' motivations varied from building upon their professional development to consider their students' interests, the teachers demonstrated their motivations to learn about AI concepts.

Findings of Research Q1

This section demonstrates the findings for research question one: What was ELA teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program? To address this question, at first, I analyzed the teachers' responses to the pre-and-post surveys. In these surveys, teachers responded to three Likert scale questions related to their confidence in completing a semester-long introduction to AI course that does not require programming, presenting AI topics and explaining AI concepts to their students, and facilitating and supporting their students' learning or discussions about AI. Additionally, to gain a more nuanced understanding about the teachers' confidence, I analyzed other data sources by using qualitative approaches. This section demonstrates teachers' confidence in three main themes: (a) completing AI training, (b) presenting and explaining AI topics, and (c) facilitating and supporting students around AI concepts.

Completing AI Training. Before and after the workshop, teachers were asked to indicate their confidence in completing a semester-long introduction to AI course that does not require programming through a five-point scale (i.e., Strongly Disagree to Strongly Agree). The mean of their pre-survey responses was 4.12 while the mean of their post-workshop responses was 3.75. To understand the difference between post-survey and pre-survey, a Wilcoxon Signed-Ranks test was conducted. The analysis indicated that teachers' post-survey responses were not significantly different than their pre-survey responses ($Z=3$, $p > 0.18$) (Figure 4.1). This means that the workshop did not create a significant change in the teachers' confidence in completing a semester-long introduction to AI course. When the teachers' pre-survey responses were closely examined, I found that most of the teachers (n=6) started the workshop with high confidence (4: Agree and 5: Strongly Agree) in completing a semester-long AI course. Since the teachers were motivated to learn about AI concepts before the workshop, their attitudes and self-esteem might not change after they engaged in the AI activities throughout the workshop.

Figure 4.1 *Teachers' Confidence in Completing AI Training*



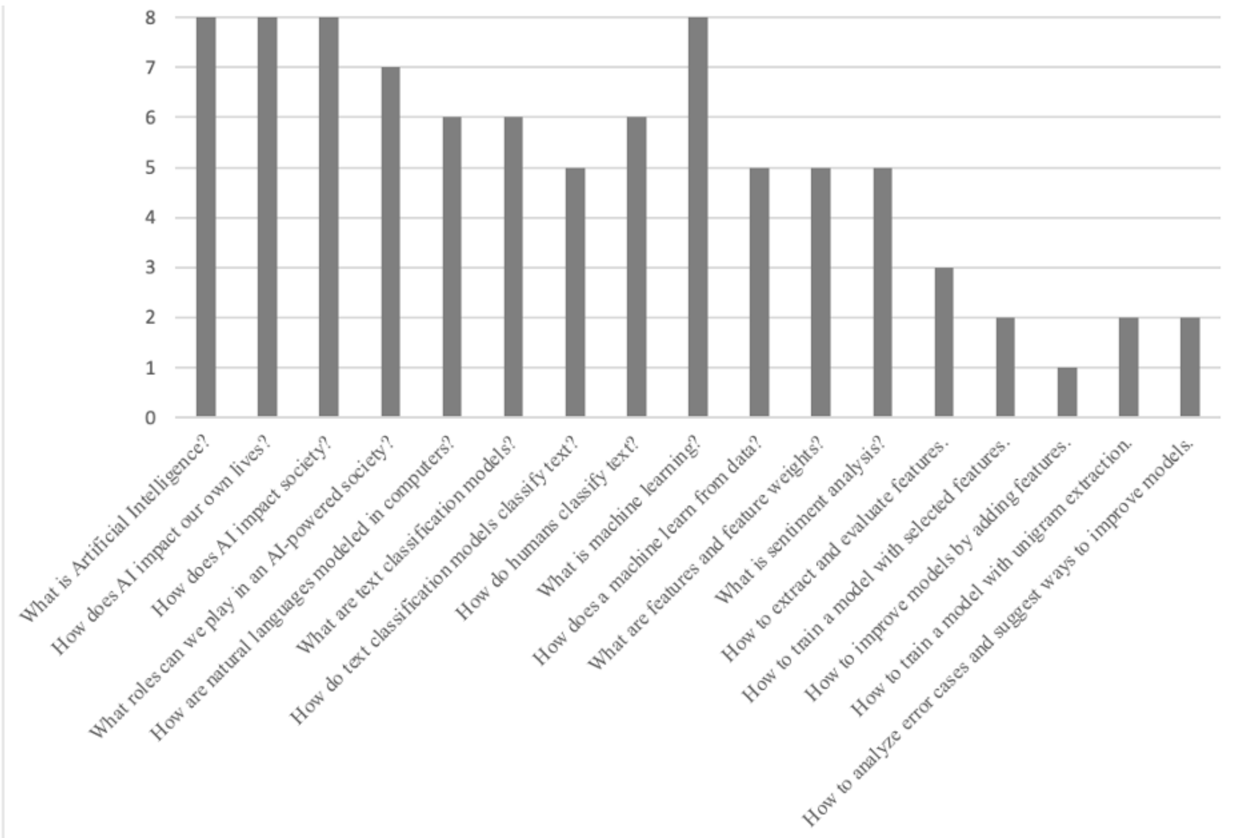
Total N	8
Test Statistic	3.000
Standard Error	3.354
Standardized Test Statistic	-1.342
Asymptotic Sig. (2-sided test)	.180

Presenting and Explaining AI Topics. In the pre-and-post surveys, teachers also indicated their confidence in presenting and explaining AI concepts to their students through a five-point Likert scale (i.e., Strongly Disagree to Strongly Agree). The mean score of their pre-survey responses was 3.38. This means that most of the teacher were not confident in presenting and explaining AI topics to their students. Indeed, six out of eight teachers chose "neutral" for indicating their confidence in presenting and explaining AI concepts. In the pre-survey, the teachers also answered an open-ended question to explain what kinds of topics or concepts they feel confident about. Their responses to this question were analyzed by using open-coding strategies. When I closely examined the teachers who chose "neutral" for their confidence, I found that they identified themselves as a learner. For example, Emma explained her confidence by stating: "I hope I will soon, but now I think I only have a general idea of what AI is and I'm not sure of its concepts." In her response, we can clearly see that she was not confident yet, but she was hoping to become more confident after learning more about AI concepts in this workshop.

On the other side, before the workshop, two teachers (i.e., Marsha and Paola) chose “agree” and “strongly agree” to explain their confidence in presenting and explaining AI topics. When explaining the topics and concepts that they felt confident about, these teachers mentioned certain AI concepts such as speech recognition, facial recognition, and ethics. To gain more understanding about these teachers, I examined their backgrounds in the recruitment form. I found that these teachers had some experiences with computer science concepts. For instance, when the teachers were asked to share their earlier experiences related to using AI technologies or ML techniques in their classes, Marsha mentioned voice recognition in online translation applications as an example of ML technologies. Since she was teaching ESOL classes from 9th grades to 12th grades, she thought of ML technologies around her classroom context.

After the workshop, the teachers were also asked to answer same question about their confidence in explaining and presenting AI concepts. The mean score of their responses was 4.00. Six out of eight teachers stayed or became more confident after they experienced the AI curriculum activities. As an example, Emma’s confidence shifted from “neutral” to “agree” after she learned more about AI concepts. Moreover, in the exit survey, the teachers were asked to identify the topics that they feel confident in teaching. Among the seventeen topics that were presented in the StoryQ AI curriculum, the teachers were mostly confident in explaining introductory topics such as “what is Artificial Intelligence?”, “What is Machine Learning?”, and “How does AI impact society?” (see Figure 4.2).

Figure 4.2. *AI topics that teachers felt confident in teaching.*



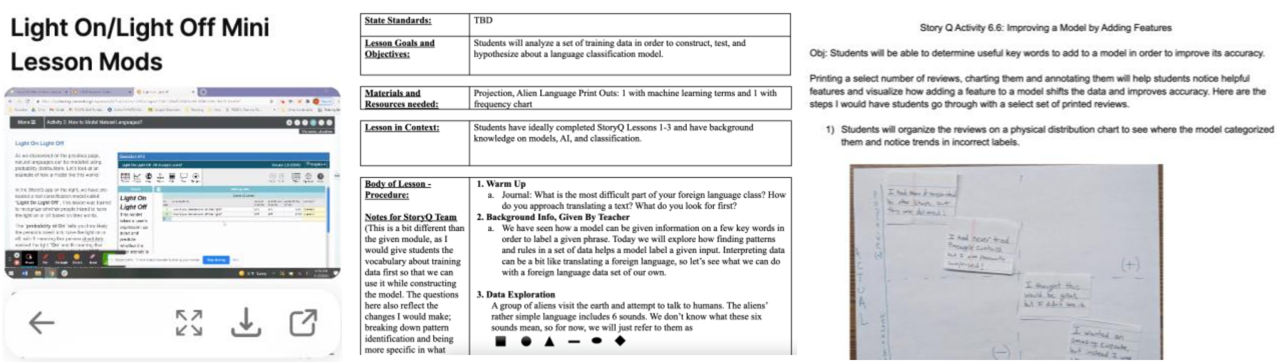
Furthermore, only a few teachers were confident in the advanced AI topics such as “how to extract and evaluate features”, “how to train a model with selected features”, and “how to improve models by adding features”. These topics were mostly related to the feature engineering concept which was relatively more challenging than the introductory ML topics. In the exit survey, the teachers were asked to answer: “For the topic(s) that you feel least confident about, please let us know what further support you’ll need”. The analysis of their responses to this question revealed three main challenges: the design issues of the StoryQ technology, lack of time, and lack of instructional materials. The design issues refer to the teachers’ experiences on the StoryQ technology. When the teachers were completing the feature engineering concepts, they were using multiple windows to analyze the features and observe the models' performance. One of the teachers specifically mentioned that the design of the technology made her learning experiences more challenging. She stated that:

> For me, I think the User Experience Design of the software tool made things complicated. I got lost in the 'click on this, then select this from the menu, and then this from the next menu, and then type this and type this and save and check the box and click Train' steps…I think the concepts would have been easier to grasp if I hadn't had to sift through the software as much. (Post-workshop Survey)

In her response, we can clearly see that her learning experiences impacted by the design of the StoryQ technology. She even claimed that she would understand the concepts more easily if the tool was easy to use. Moreover, the teachers indicated that they needed more time and instructional support to become more confident in these topics. As an example, Maria stated that: "More time in the app adding features and analyzing training data using graphs will help to build my capacity for ways to improve the models." Similarly, Heloise indicated that: "More video tutorials and background information videos would be useful for the sections that involve training a model." These teachers needed more time and supplementary materials to engage with the technology and understand feature engineering concepts.

To gain a more nuanced understanding about the teachers' confidence, I also conducted content analysis to the teachers' mini-lesson artifacts. Each week, the teachers were asked to create mini lessons by using their weekly learning activities. The goal of creating mini lessons was to help teachers to plan their classroom implementations and think through various scenarios. The content analysis of the mini lesson demonstrated that creating mini lessons and thinking possible scenarios to integrate the StoryQ AI curriculum activities into the classroom was a way of showing confidence to present and explain AI concepts. For instance, Heloise stayed "neutral" in her confidence after completing the StoryQ AI curriculum activities. However, she demonstrated a clear trajectory in developing confidence when she was designing her mini lessons (see Figure 4.3). At the beginning of the workshop, she began with little changes in the existing StoryQ AI curriculum. In the first week, she created a short video lesson related to Light on/off activity. She walked through the existing lesson activity and explained how she would teach this in her classroom. While she was teaching this activity, she was explaining how to make this activity more engaging for her students.

Figure 4.3 *A teacher's mini lesson artifacts from week 1 to week 3*



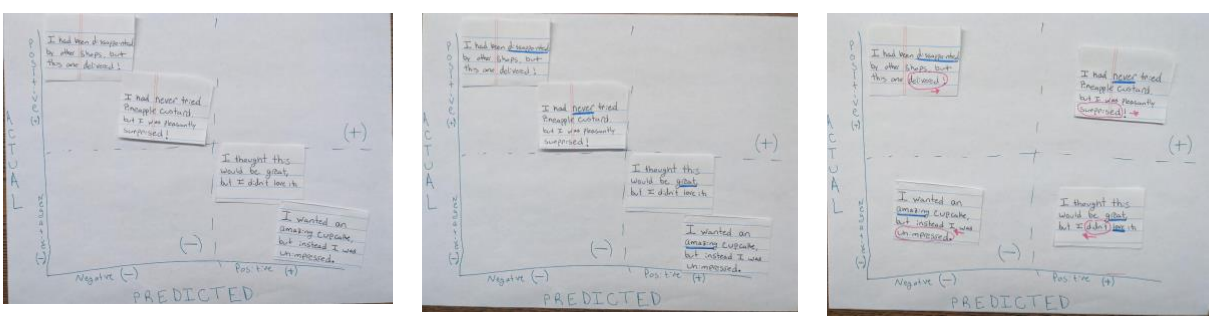
Furthermore, she chose to work on the "Machine Learning with Alien Language" lesson for her mini lesson task in the second week. When her mini lesson was examined, I found that she made some changes in the existing activities. She explained her lesson two as:

> This is a bit different than the given module, as I would give students the vocabulary about training data first so that we can use it while constructing the model. The questions here also reflect the changes I would make; breaking down pattern identification and

being more specific in what students are asked to do instead of jumping straight to "translation". (Mini-lesson Week Two)

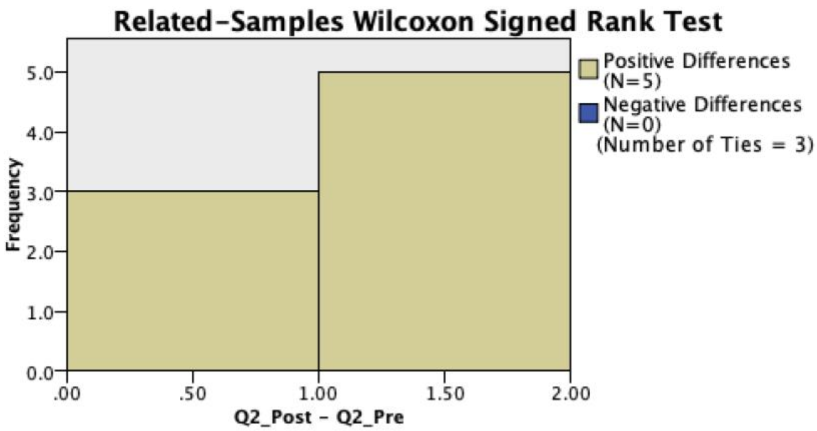
As an ELA teacher, she was mostly focused on introducing terminology, and then spending more time to digest the learning steps. Also, she redesigned this activity as a group work activity to allow her students to discuss the patterns in the dataset and share with their classmates. From week one to week two, she demonstrated a slight confidence in changing the activities and bringing new ideas to make the activities more engaging. Additionally, in the week three, she completely created a new activity by building upon her understanding of feature engineering concepts. She chose one of the topics she had difficulty as a learner and worked on that. She redesigned the "Improving a Model by Adding Features" as an unplugged lesson activity (see Figure 4.4). She wrote the reviews on the paper and visualized the error analysis as a physical distribution chart. In this hands-on activity, her students are supposed to highlight specific features that would improve ML models' performance. This lesson was conceptually similar to the learning activity in the StoryQ AI curriculum. However, instead of using the StoryQ technology, Heloise turned this activity into an unplugged hands-on activity. When her mini lessons were examined, it is clear that she demonstrated a significant change in her level of confidence in presenting and explaining AI topics to her students.

Figure 4.4 *A mini-lesson example of "Improving a Model by Adding Features"*



To understand the changes in the teachers' confidence in presenting and explaining AI topics before and after the PD, a Wilcoxon Signed Rank test was employed to the survey responses. The analysis demonstrated a significant change from pre-survey to post-survey ($Z = 2.23$, $p < .02$) (see Figure 4.5). This means that the PD helped the teachers to gain confidence in presenting and explaining AI topics to their students.

Figure 4.5 *Teachers' confidence in presenting and explaining AI topics*



Total N	8
Test Statistic	15.000
Standard Error	3.354
Standardized Test Statistic	2.236
Asymptotic Sig. (2-sided test)	.025

Facilitating and Supporting Students Around AI Concepts. Before and after the workshop, teachers were asked to indicate their confidence in facilitating and supporting their students' learning or discussions about AI through a five-point scale (i.e., Strongly Disagree to Strongly Agree). The mean score of their pre-survey responses was 3.63 with four out of eight teachers chose "neutral" to indicate their confidence. This means that most of the teachers were either neutral or slightly confident in facilitating and supporting their students' learning about AI.

In the pre-survey, the teachers were also asked to identify a topic and explain how they would support their students' learning or discussions. The analysis of their responses to this question illustrated that three teachers did not mention any topics and identified themselves as a learner while other teachers came up with ideas to explain how they would facilitate classroom discussions. As an example, one of the teachers who chose "agree", Pam, explained that she would bring AI ethics into the discussion to facilitate her students. She wrote that:

> Ethics. Teaching them why it is important to know about why learning ethics and ethical behavior is relevant to them and how their judgements today will affect our society tomorrow and beyond. (Pre-workshop Survey)

Also, she explained that she wanted to explain how ethical behaviors would impact their society. Before the workshop, she had some experiences to integrate CS topics such as computational thinking and robotics. She might experience to discuss ethics around these CS topics. Therefore, when she was asked for specific topics around AI concepts, she might think of ethics. After the workshop, the teachers were also asked to answer same question about their confidence in facilitating and supporting students around AI concepts. The mean score of their post-survey responses was 4.00 with six out of eight teachers stayed or become more confident after they experienced the AI curriculum activities. Only two teachers (Amy and Emma) stayed "neutral" after they experienced the AI curriculum activities. To gain a deep understanding about these teachers, their learning activities responses were analyzed. While completing the learning activities, they positioned themselves as a learner and thought about the learning challenges that their students might face. For instance, Emma felt overloaded while completing the learning activities. While she was answering the activity-specific question in these activities, she mentioned that how difficult to process all the information in the activities within a short amount of time. More specifically, when she was completing the Activity 4: Machine Learning with Alien Language, she stated that: “I find it difficult to process too much new information without a chance to practice, so much of this didn't 'sink in.' My students would have the same problem.” At first, she experienced this difficulty as a learner, and then she thought of her students might also have similar problems. Similarly, when she was working on the Activity 5: Sentiment Analysis, she faced with learning challenges and lost her interest toward the activity. When she was reflecting to the Activity 5, she wrote that:

> I found it frustrating that I wasn't even trying to 'break' the model, but my reviews (the first three) were incorrect. It was difficult then to get a sense for the features and I lost interest. My students would also lose interest. I also found it frustrating to have to go back, locate my review, then navigate back to this page. Now that I am at the bottom of the page, there is no 'next' - am I done?" Students would likely be frustrated at the same & just want to move on. (Curriculum Activity Response-Activity 5)

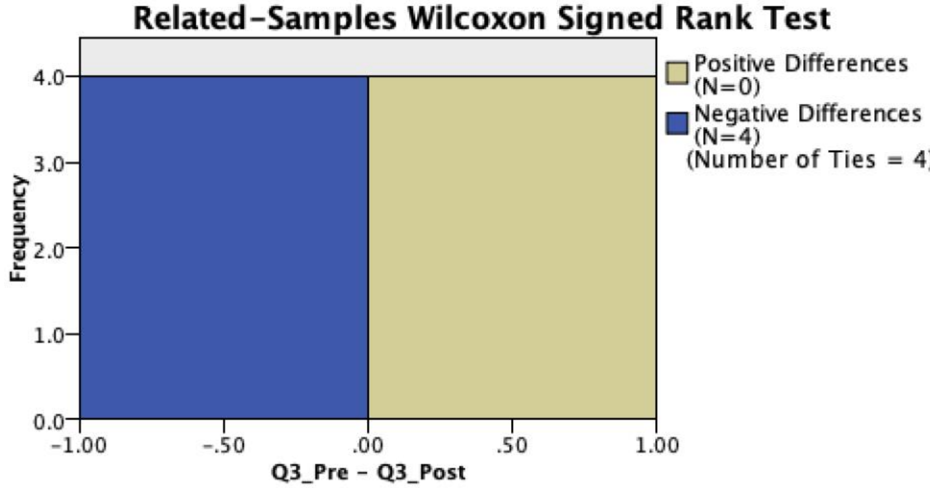
In the Activity 5, the teachers were asked to write reviews and test their ML models' performance. While Emma was working on this activity, she could not identify features that affect her model's performance. Thus, she became frustrated and lost her interest. With regard to her own experiences, she started to think that her students would also have similar experiences. Therefore, when she was indicating her confidence in facilitating and supporting students around AI concepts, she might evaluate based on her learning challenges and stayed “neutral” after the PD workshop. Similar to Emma, Amy also indicated learning challenges while completing the learning activities. When she was providing feedback in the activities, she mostly focused on how the content should be presented. She was evaluating the content with regard to her students' characteristics. For example, after she completed the Activity 4, she wrote in her reflection to the activity:

> Many of my students would turn off as soon as they saw the equation, but some would also really think it was interesting. I think a handout accompanying this would keep their attention and increase their understanding. I had to watch it more than once to get it. (Curriculum Activity Response-Activity 4)

In the Activity 4, the learners were introduced how ML models make decisions by calculating weights of the features. While introducing this concept, the mathematical equation behind the ML decision-making process was presented. By referring to this presentation, Amy explained that it was difficult for her to understand the concept at once. Therefore, she further explained that her students would also have similar challenges. Like Emma, she might also consider the learning challenges that she faced and stayed “neutral” in her confidence in facilitating and supporting her students. These teachers might make their decisions regarding to their learning experiences and students’ characteristics.

To clarify the changes related to teachers’ confidence in facilitating and supporting their students before and after the PD workshop, I also conducted a Wilcoxon Signed Rank test to the pre-and post-survey responses (see Figure 4.6). The analysis demonstrated that the median post-survey ranks were statistically significantly higher than the median pre-survey ranks ($Z=2.00$, $p < .04$) (see Figure 4.6). Although two teachers stayed “neutral” after the workshop, the results of Wilcoxon Signed Rank test demonstrates that most of the teachers’ confidence increased after the workshop.

Figure 4.6 *Teachers' confidence in facilitating and supporting students*

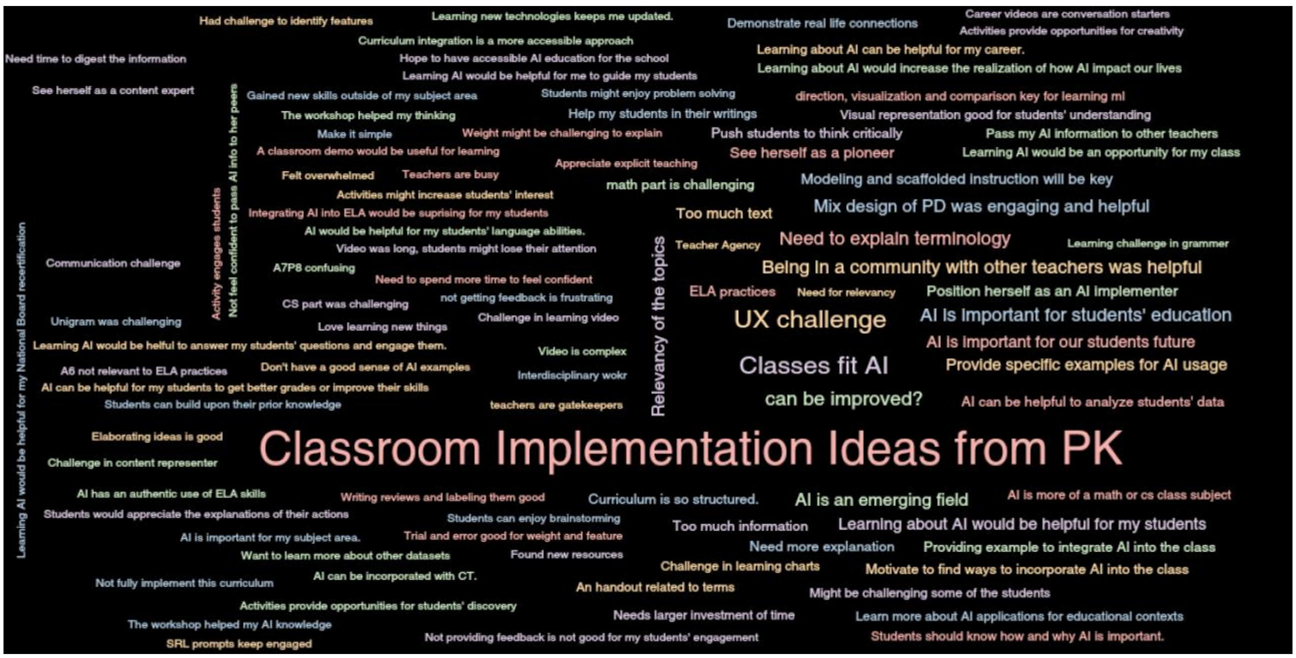


Total N	8
Test Statistic	.000
Standard Error	2.500
Standardized Test Statistic	-2.000
Asymptotic Sig. (2-sided test)	.046

Findings of Research Q2

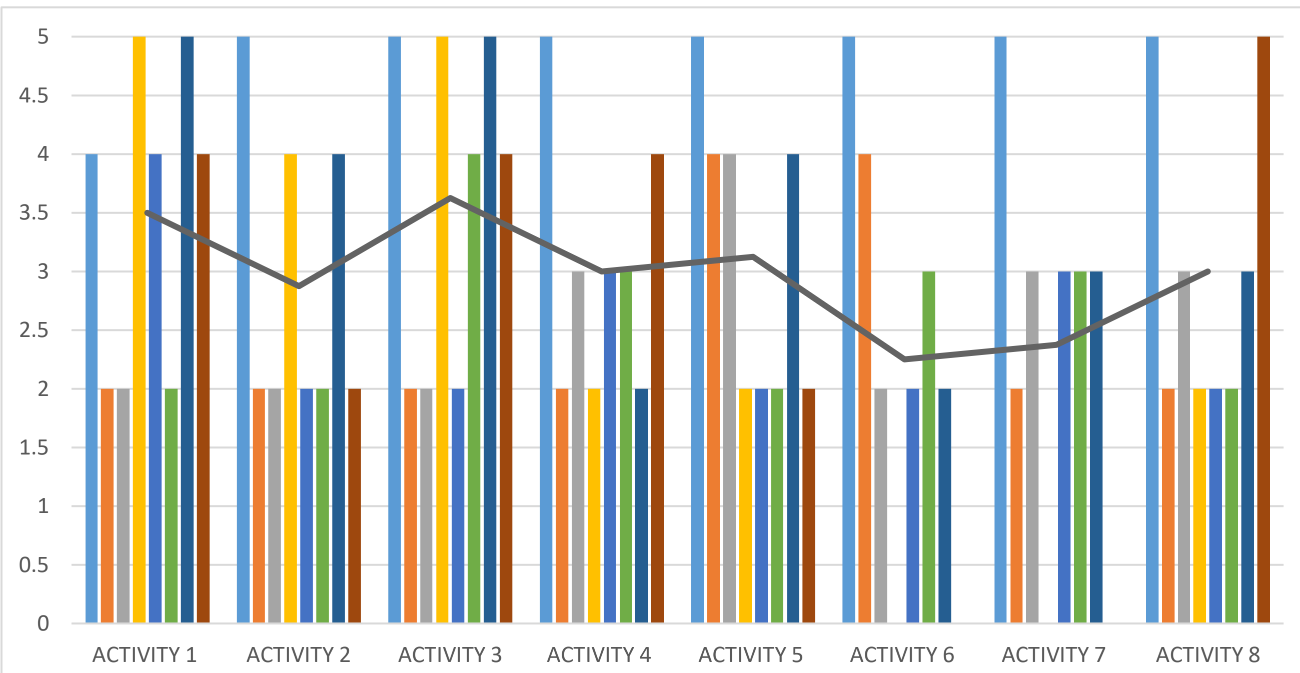
This section demonstrates the findings for research question two: What were ELA teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program? To address this question, at first, I created the teachers' portfolios to understand their process throughout the PD. For this reason, I chronically examined the data related to each teacher to identify similarities and differences among the participants. I followed open coding strategies (Strauss & Corbin, 1998) to code the participants' pre-and post-survey as well as their feedback for each of the activity pages. My initial coding resulted in 116 unique codes (see Figure 4.7). After that, I examined each code to see the similarities and identify initial categories. This process revealed five main categories: “relevancy of the topics”, “classroom implementation”, “opportunities for my professional development and teaching”, “perceived opportunities for my students”, and “challenges”. Additionally, I conducted content analysis of interview transcripts and other sources of data to support each category. The following section presents each theme with details and evidence from the participants’ data.

Figure 4.7 *The word cloud of initial codes in the data analysis process*



Relevancy of The Topics. When the teachers were thinking of integrating AI topics into their classrooms, they were critically analyzing how much the presented topics were relevant to their class. In other words, their decisions to implement this curriculum in their classroom relied on their understanding of how these topics match with their curriculum. In the exit survey, the teachers were asked to evaluate the relevancy of the topic from 0 (being completely irrelevant) to 5 (being the most relevant) for each learning activity. As shown in Figure 4.8, most of the teachers did not find activities 2, 6, and 7 relevant to their curriculum. In the Activity 2, the teacher explored the meaning of probability in the ML context through a Light on/off learning activity (see Figure 4.9). In this activity, the teachers were asked to create some sentences with an intention to turn on or off the lights. After they created their own sentences, they tested with the ML models. As you can see in the Figure 4.9, the ML models created a predicted label column. This refers to the ML model's prediction about the sentence. The teachers can examine these kinds of sentences to understand how the model made the prediction regarding to the "probability of on".

Figure 4.8 *The teachers' perceptions of the relevancy of each learning activity.*

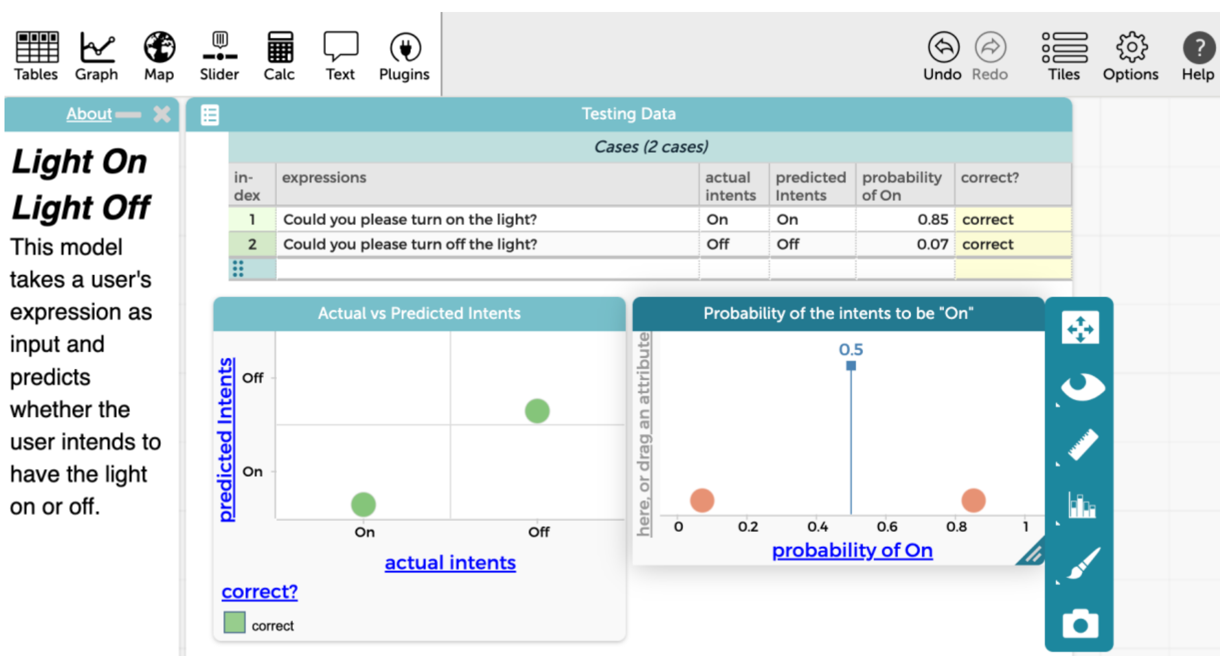


In the Light on/off activity, the teachers explored how ML models use the probability to make decisions. While the teachers were working on this activity, they provided feedback and explained what they needed. In their reflections, three teachers (Amy, Douglas, Heloise) mentioned that they needed more scaffolding to conceptualize the "probability" and "weight" concepts. For example, one of the teachers, Heloise, explained how she would introduce the “probability” and “weight” concepts in her classroom to help her students to comprehend these concepts easily. She came up with a new idea in her classroom implementation and said that:

> When teaching it in the classroom, I would ask them to categorize example words into 'Definitely means on' and 'Probably means on' and 'definitely means off' and 'Probably means off.' Then, students would have the idea of weight in their minds and start thinking about what the model 'looks' for. Once they had that, then I think they could access the graph and answer the questions included. (Curriculum Activity Response-Activity 2)

When she was imagining her classroom implementation, she was thinking to add a new activity for her students to practice the “probability” concept. In this way, she believed that her students might have a better understanding of the concepts. Since the teachers believed that these concepts needed more scaffolding to clarify the meaning of each concept in the ELA context, they might not see the relevancy of Activity two for their classrooms.

Figure 4.9 *The screenshot of Light on and Light off activity*



Additionally, this activity was introduced in the Week 1- synchronous meeting. In each synchronous meeting, the research team presented key weekly-activities and concepts. After that, the teachers were asked to work in small groups in the breakout rooms to practice the presented activity shortly and ask their questions. In each breakout room, one researcher recorded the teachers' discussions and answered their questions if they had any. The purpose of these group activities was to inform teachers about their weekly assignments. In the Week-1 synchronous meeting, most of the teachers shared their experiences with the light on/off activity and how they tested the ML model with their sentences. However, while sharing their experiences, they did not mention any ELA connection with this learning activity. For instance, Douglas and his friend started to test the model with complete sentences at the beginning of the activity. After a while, they started to try words instead of sentences to understand how the model makes the predictions (see Figure 4.10).

Figure 4.10 *The screenshot of Light on and Light off activity dataset*

in-dex	expressions	actual intents	predicted intents	probability of On	correct?
1	Could you please turn on the light?	On	On	0.8527	correct
2	Could you please turn off the light?	Off	Off	0.07159	correct
3	Turn on the light.	On	On	0.90747	correct
4	Light on	On	On	0.92155	correct
5	Would you turn on the lights now.	On	On	0.88897	correct
6	Make it bright	On	Off	0.5	incorrect
7	Kill the lights	Off	Off	0.47746	correct
8	Make light bright	On	On	0.55054	correct
9	Dark	Off	Off	0.5	correct
10	Light off	Off	Off	0.13529	correct
11	Lights up	On	Off	0.5	incorrect
12	On	On	On	0.90557	correct
13	Off	Off	Off	0.11326	correct
14	Light	On	On	0.55054	correct
15	Activate Light	On	On	0.55054	correct
16	Make it dark	Off	Off	0.5	correct
17	Hit the lights	On	Off	0.47746	incorrect
18	Would you turn off the lights on your way out.	Off	On	0.50561	incorrect
19	Turn out the light	Off	On	0.50561	incorrect
20	Out	Off	Off	0.5	correct

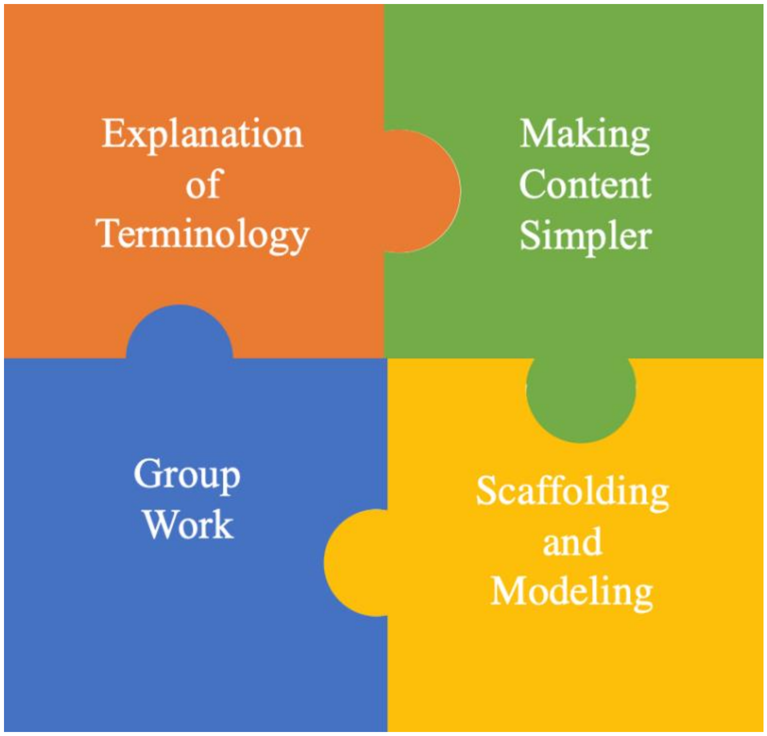
After testing the model with sentences and words, Douglas started to discuss the limitations of the ML model. He said that: “the model recognizes key words that are associated with either ‘on’ or ‘off’”. Yet, in the discussions, they did not mention how this activity might be relevant to their ELA classroom. The Activity two, the light on/off activity, was designed to support students’ understanding of grammar and word choices to clarify the speakers’ intentions. Nevertheless, when the teachers were experiencing this activity, they did not speak about how this activity might support their students’ ELA abilities. This might be related to how they perceive the relevancy of this activity in the context of ELA classroom.

Similar to Activity two, most of the teachers did not find Activities six and seven strongly relevant to their classrooms. These activities were mostly related to advanced ML concepts (i.e., feature engineering and unigram model). In Activity 6, the teachers were asked to extract features by examining the reviews, evaluate their own feature, train ML models, and improve their models’ performance. In Activity 7, the teachers were presented a unigram model with weights and explored the difference between a feature classification model and a unigram classification model. Most of the teachers found these activities more challenging than other activities (see Figure 4.1). In their reflections, five teachers (Douglas, Amy, Emma, Harper, and Paola) shared their learning challenges to complete this activity and further explained that they did not see relevancy of this activity in their ELA classrooms. For instance, after Douglas worked on training the initial model, he reflected on this page as “We have very much left anything related to the English curriculum far behind.” In this page, the teachers were given a set of features and asked to examine the impact of each feature on the ML model performance. This page included detailed information (i.e., frequency and weight) about each feature. The teachers were supposed to evaluate the performance of each feature regarding to their frequency rate and weight. The evaluation of the features and training ML models might be challenging for Douglas since the concepts were introduced with numerical representations instead of text-based explanations. Thus, he might think of this activity was not relevant to ELA concepts. Similarly, Paola mentioned challenges while completing Activity 6. These challenges were mostly about her experiences to use and navigate windows within the program. In her reflection to the activities, she stated that: "It *(the page of adding features to their models)* was very difficult to operate and interpret." Additionally, at the end of the activity, she reflected as "It *(refers to Activity 6)* was not user friendly, and it doesn't work well with ELA." Since she had difficulties with user-experience design, her perceptions of Activity six might be shaped by her experiences.

By drawing upon TPACK and SCT perspectives, relevancy of the topics was one of the critical components of the teachers' decision-making process. More specifically, from the TPACK perspective, the teachers brought up their content knowledge to evaluate the relevancy of the topics. If they did not see match between their curriculum and the presented topics, they were not willing to integrate AI concepts into their classrooms. Also, from SCT perspective, the teachers' personal experiences with the AI curriculum shaped their beliefs in terms of their perceptions of the relevancy of the AI topics.

Classroom Implementation. When exploring the teachers' views on integrating AI into ELA classroom, I found that the most salient theme was how teachers perceived their classroom implementations after they experienced the AI learning activities as a learner. When the teachers thought of their classroom implementation, they thought of what kind of challenges their students can face and how they can prevent these challenges with instructional methods. The teachers' classroom implementation ideas included (1) explanation of terminology, (2) making content simpler, (3) scaffolding and modeling, and (4) group work (see Figure 4.11). Five out of eight teachers (Douglas, Emma, Heloise, Maria, Harper) mentioned that they needed more explanation for clarifying the terms in the curriculum. While experiencing the curriculum, they mentioned about how their students might have challenges to understand the terminology. Therefore, when they are thinking of their own classroom implementation, they thought of specific terms that were needed to be explained more. For example, when Heloise was completing Activities two, five, and six, she mentioned that certain terms (i.e., algorithm, weight, and features) should be defined clearer. In Activity five, she said that: “students might need a more specific definition for features. Words? Sentence structures?”. Also, in Activity six, when she was completing a learning page related to features, she reflected as: “Remind students that 'feature' means word.” Her experiences in these activities demonstrated that she had difficulties in understanding the definition of “feature”, therefore she came up with her own definition (i.e., “feature means word”) while completing the activities. In another example, Douglas stated that “For students, you will want to explain what you mean by probabilistic” when he was completing Activity two. These examples showed that the teachers perceived that certain ML terms might be challenging for their students. For this reason, they needed clear explanation of the terms. Also, when the teachers were considering the integration AI curriculum into their classrooms, they particularly considered how they can help their students to understand the ML terms.

Figure 4. 11 *The teachers' curriculum implementation ideas*



Moreover, three teachers (Amy, Heloise, and Harper) explained that the activities should be presented in a simpler way to engage students. When the teachers were working on the activities, they were thinking the ways of how to present the content simpler and clearer for their students. For instance, Amy believed that the curriculum was text heavier, and she said that: "the simpler you can make the activities and reading, the better". While completing Activity three, she suggested to include a visual to make the activity "easy to navigate and more appealing to read the entire text." Like Amy, Harper was also thinking to add pictures to make content clearer. While completing Activity two, the teachers answered four activity questions that aim to demonstrate "what makes natural languages natural?" and how sentences can have multiple meanings based on how they structured. In this activity, Amy was thinking to add visuals to represent the sentences and make the content clearer for her students. She reflected as:

> I liked the focus on shifting words to change grammar and ambiguity. Images might help students figure out the ambiguity. If you presented the second sentence, for example, with a picture of a male observer and a female engaged in ducking under something and asked "Does this sentence describe this picture," and then a picture of a woman holding a duck (bird), and asked the same question, students might get the ambiguity. I'm not sure they would figure it out without prompting or going back to clarify. (Curriculum Activity Response- Activity 2)

In her reflection, she was trying to clarify the content by adding visuals. She believed that her students might not understand the ambiguity among the sentences without visuals and explicit explanation. As a "content expert" (i.e., Harper mentioned being a content expert in the exit survey), she critically approached the presentation of the content and make suggestions. After experiences the curriculum as a learner and as "content experts", the teachers considered their classroom implementations from a view of presenting the content.

Another sub-category in the classroom implementation was modelling and scaffolding. In the post-survey, two teachers (Douglas and Emma) mentioned that they might need to follow modeling and scaffolding strategies for the activities that they found challenging. For example, Douglas found Activity six as a strongly challenging activity. Therefore, when he was considering his classroom implementation, he stated that: "Modeling and scaffolded instruction will be key. I plan to project going through the steps with them when things become overly technical." He might think that the presented concepts might be technical and challenging for his students. Thus, he was thinking to employ modeling and scaffolding strategies when implementing these kinds of activities in his class. Like Douglas, Emma was also thinking to include modeling strategies in her classroom. In the curriculum, the teachers were asked to examine graphs to explore errors in their models. By referring to these graphs, Emma said that: "It has been years since some of my students have had to analyze graphs, so explicit instruction and modeling would be needed, but would likely be enough." Both teachers acknowledged their learning challenges as a learner and then thought of a pedagogical method to overcome these challenges.

Similar to the modeling and scaffolding strategies, three teachers (Marsha, Emma, and Heloise) brought up group work in their classroom implementation. The StoryQ curriculum activities are not particularly designed for supporting students' group work. Yet, the teachers saw some opportunities to engage their students with a group work. As an example, Marsha mentioned that students can work in groups to analyze reviews and discuss their ideas in terms of what makes the reviews either positive or negative while she was reflecting on Activity seven. Like Marsha, Heloise was also thinking to bring group work in her classroom implementation. When she was working on the Activity six, she explained that students might have challenges to compare actual labels with the ML model's predicted labels. For this reason, she was thinking to print 20 reviews and ask students to organize these reviews. In her mini lesson, she detailed her group work idea (see Figure 4.4). For the classroom implementation, she was thinking to turn the activity six into a hands-on activity where "students organize the reviews on a physical distribution chart to see where the model categorized them and notice trends in incorrect labels" (Heloise's mini lesson description). Even though the teachers had different motivations to include group work in their classroom implementation, they believed their students can get benefits from working together.

Overall, when experiencing the AI learning activities, the teachers considered how they would implement these activities in their classrooms and came up with different ideas.

Teachers' decisions and classroom implementation plans shaped by their own learning experiences. When they were experiences the activities, some of them mentioned how challenging the activities were. Regarding to these experiences, they came up with pedagogical approaches in terms of how they can provide better learning experiences for their students. By drawing upon TPACK and SCT perspectives, teachers' learning experiences were key for their classroom implementation ideas. From SCT perspective, as Bandura (1989) described that learners' prior experiences are critical in determining their behaviors. Put differently, in the PD context, teachers' learning experiences helped them to shape their classroom implementation ideas. Moreover, from TPACK perspective, teachers brought their pedagogical content knowledge to imagine their classroom implementations. Teachers understand their students' mental model and predict their learning experiences. By drawing those experiences as content experts, they come up with pedagogical and content knowledge approaches.

Opportunities for My Professional Development and Teaching. When teachers were thinking of integrating AI into their classrooms, they were considering how this would offer opportunities for their professional development and teaching. Teachers perceived these opportunities from different perspectives, keeping themselves up-to-date, acquiring new skills, leading in their schools, and effectively communicating with their students (see Figure 4.12). Four teachers (Douglas, Heloise, Maria, Harper) explained their perceptions of AI and how integrating AI would be beneficial for their careers. In other words, four teachers acknowledged AI as an emerging field and further explained that integration of AI into their classroom would help them to keep updated related to innovative educational technologies. As an example, in the pre-survey, Maria said that "We live in a technology-driven society. I believe our students will be receptive to seeing how AI functions." When she was participating in the workshop, she was aware of how AI affects her students. Thus, she was willing to learn AI to share her knowledge with her students. Furthermore, she also believed that integrating AI into her classrooms would "make (her) teaching more relevant and in step with the times". In other words, she was thinking that integrating AI into her class might make her teaching more up to date. Like Maria, Douglas also mentioned that AI as "an emerging field" and believed that integrating AI into his class might be beneficial by saying: "adds interest to my subject area." In the pre-survey, he explained that since AI is "an emerging field", he was looking for new ways to integrate this innovative technology into his classroom to facilitate his students. Overall, the teachers were willing to incorporate AI to keep their teaching relevant to current developments.

Moreover, the teachers also mentioned that integrating AI would be helpful for them to gain new skills. The teachers were thinking how this integration would be beneficial for their professional development. Two teachers (Emma, Heloise) mentioned that learning about AI and thinking the ways to integrate AI helped them to enhance their skillset. For example, in the post-survey, Heloise described the benefits of attending this workshop from the perspective of her career development as:

> I gained practice introducing students to material outside of my content area. I also saw new connections between technology and the language arts, and I found new resources to consult in my planning that will help me make those connections with my students. I gained proficiency in new data analysis programs and networked with other fabulous teachers in my area! (Post-workshop Survey)

In her response, she mentioned that how this PD would be beneficial for her teaching and professional development. In terms of new skills, she was explaining that AI knowledge and skills were outside of her content knowledge and skills. Thus, she was thinking to gain new skills related to AI. Additionally, in terms of teaching, she explained that she gained new resources to facilitate her teaching. When she was thinking of the opportunities, she was thinking from different directions, including her professional development, teaching, and being in a community. On the other side, Emma was mostly focused on how she gained new skills outside of her comfort zone. In her post-survey, she said that: "It (learning about AI) has taken me outside the box in terms of how I could consider teaching language and diction and given me some ideas about the greater context of language." In terms of new skills, she was mentioning to learn new ways to integrate AI into her classrooms. Both Emma and Heloise brought up "outside of the box" term when they were talking about AI. They were perceiving AI as outside of ELA practices. Thus, they specifically mentioned to gain new skills outside of their discipline.

Figure 4. 12 *Opportunities for Teachers' Professional Development and Teaching*

In addition, the teachers saw an opportunity to be pioneers in their schools. Three teachers (Emma, Heloise, Paola) mentioned that they would be first implementer who integrates AI into their classrooms. For instance, Paola explained her takeaways from the workshop by saying: “Offering an AI pathway and integrating the terminology into all classes. I would be a leader in bringing it into the school.” After attending the workshop, Paola positioned herself as a leader who can bring AI education into her school. Like Paola, Emma also reflected as “I am the only person who does what I do, so no school-wide take overs here!” These teachers demonstrated that being pioneers in their schools would be an opportunity for them to share their AI knowledge and experiences with students and their colleagues.

Lastly, when the teachers were thinking of opportunities, three teachers (Douglas, Emma, Heloise) brought up integrating AI into their classes would help them to communicate with their students effectively. As an example, Douglas described how it is important to integrate AI into K-12 classrooms. In the pre-survey, he mentioned that bringing AI into the classrooms would “improve our students real-world readiness.” Also, he further stated that: “Let's open doors for them by giving them some basic foundational understanding to both get jobs in this field but also to understand how technology affects their lives.” He believed that integrating AI would be helpful for their students’ future career opportunities. At the same time, he was describing his roles and responsibilities during this integration as “be someone to answer questions and help others.” He was aware that learning about AI and integrating it into his classrooms would be an opportunity for him to communicate with his students in terms of their future careers. Like Douglas, Heloise was also looking from a similar perspective. She believed that learning about AI would be helpful for her to advise her students. In the pre-survey, she said “Knowing more about the field can help me advise students about potential career paths.” She was also aware of the importance of integrating AI to support students' career paths. When she was thinking of her roles in this process, she was taking the responsibility of advising her students. Both teachers put emphasis on being able to communicate with their students to support their future career opportunities. They saw this as a benefit of participating in the workshop.

In conclusion, as teachers were thinking of integration of AI into their classrooms, they assessed how it could be benefiting their professional growth and teaching. They perceived these benefits in four main categories, staying up to date, acquiring new skills, taking leadership roles, and advising their students. From SCT perspective, Bandura (1978) explained outcome expectancy as a key component of behavioral change. According to the SCT, individuals' perceptions of outcome expectancies shape their decision-making process. Before and after the workshop, the teachers focused on outcome expectancies. These might help them to participate in the workshop and learn more about AI. Additionally, this might also affect their decisions to integrate AI topics into their classrooms.

Opportunities for My Students. When the teachers were sharing their views about the integration of AI into their classrooms, they indicated how this would be beneficial for their students. They perceived the opportunities for their students in three categories; improve ELA skills, gain new knowledge and skills, and seek careers. In the reflections, three teachers (Marsha, Amy, and Emma) explained that integrating the AI curriculum into their classrooms can boost their students' ELA skills. As an example, in the post-survey, Marsha explained how her students would benefit from learning about AI by saying: "they will benefit by understanding how a machine learns language in similar ways that they do and use it to improve their comprehension and writing skills." According to her reflection, she thought that her students' comprehension and writing skills can be improved while working with the AI activities. She described working with ML like peer teaching (i.e., teaching a subject to your peer). In this way, she believed her students' ELA skills might improve. Similarly, Amy saw benefits of integrating AI into her classroom to support her students' writing abilities. In the post-survey, she stated that "they (refers to her students) would be able to use it in their writing (to analyze and improve it), or to analyze works of literature for tone, mood, style, etc." After the PD, she saw a connection between the AI learning activities and ELA skills. Thus, she believed that her students could practice their writing skills while completing the AI activities.

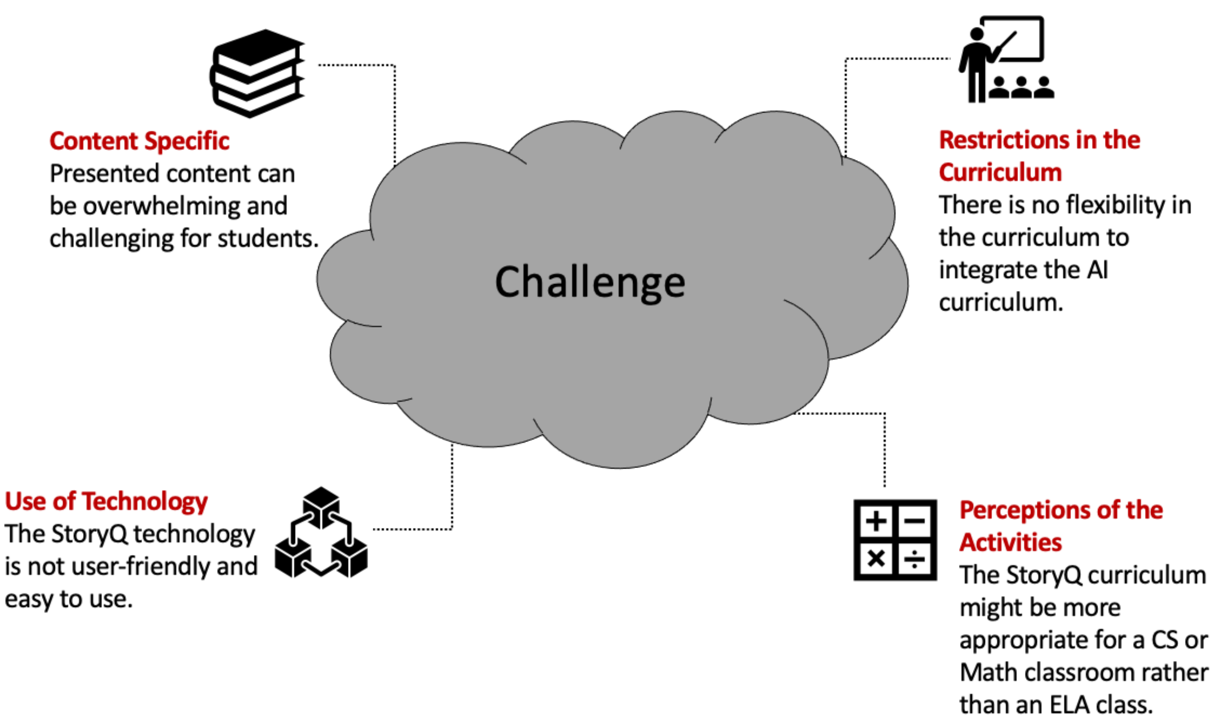
Additionally, the teachers noticed opportunities for their students to acquire new skills and knowledge. Two teachers (Marsha, Harper) reflected that integrating AI into their classroom might be beneficial for their students to gain new knowledge and skills. For instance, before the workshop, Marsha shared her thoughts related to how integrating AI would benefit to her students by saying: "I believe that a deeper understanding of AI would be useful to allow students to use these tools more efficiently across concent areas and grade levels in their education journey." She believed that her students could use their AI abilities in different disciplines throughout their education. After the PD, she built upon on her initial idea and stated that: "My students will benefit from learning about AI by gaining a greater understanding of how it impacts them and society." After experiencing the AI learning activities, she thought that her students could benefit from learning AI and how it impacts society.

Another opportunity that the teachers perceived for their students was getting familiar with AI-empowered careers. Two teachers (Heloise, Harper) explained that integrating AI into the classroom might be helpful for students to seek AI-empowered careers in their futures. For example, Heloise stated that: "I see my student's being intrigued by the technology and problem solving and seeking careers and workshops related to AI" while explaining how her students would benefit of integrating AI into her classroom. Like Heloise, Harper also described the importance of learning AI for her students' future careers. She stated that "AI is invisibly present in students' online worlds." After that she also explained that learning about AI would be a significant part of students' future careers. Both teachers acknowledge the importance of integrating AI into their classroom to support their students' future career paths. They saw opportunities for their students to seek AI-empowered jobs.

Overall, when the teachers were considering benefits of integrating AI into their classrooms, they came up with three main categories: improving students' ELA skills, acquiring new knowledge and abilities related to AI, and pursuing AI-empowered careers. By drawing upon SCT, the teachers were thinking of outcome expectancies for their students while sharing their views on integrating AI into their classrooms. Teachers' views related to possible opportunities might affect their decisions to incorporate AI into their classrooms.

Challenges. While thinking of the integration of AI, the teachers perceived a variety of challenges, including content-specific, restrictions in the curriculum, use of technology, and perception of the activities (see Figure 4.13). The most repeated challenges in the teachers' reflections were content-specific challenges. Seven out of eight teachers (Marsha, Amy, Douglas, Emma, Heloise, Maria, and Paola) brought up different challenges relevant to the presented content in the AI curriculum. Most of the teachers thought that the presented content could be overwhelming and challenging for their students. When they were thinking of the presented content, they mostly focused on advanced ML activities and concepts such as unigram, features, and weight. As an example, Marsha shared her experiences with understanding the "weight" concept. She explained that she got confused in understanding this concept and her students would also have similar experiences. She further detailed her concerns by saying: "I think students will ask about the equation and want to know why the denominator is 1 + e to a negative power. I will not know how to explain that." In her explanation, she demonstrated her confidence to explain this topic to her students. Since she did not understand the "weight" concept, she believed her students would have challenges and she might not help them. Additionally, when the teachers were mentioning the content-specific challenges, they brought up how overwhelming to complete the curriculum activities. For instance, Maria mentioned that the AI curriculum presented "too much information". She found this "very overwhelming". In particular, the teachers were referring to the advanced ML activities (e.g., Activity Six, Seven, and Eight).

Figure 4.13 *Perceived challenges in the integration of AI curriculum into K-12*



Moreover, while teachers were explaining their views on the integration of AI, they clarified the restrictions in their curriculum. Four teachers (Amy, Emma, Heloise, and Harper) pointed out that there was not enough space in their curriculum to integrate such innovations. For example, in the post-survey, Amy stated that:

> My curriculum is already very full. To add this would be interesting, but more of a challenge than I am willing got take on at this time. The pandemic has greatly increased my responsibilities for students and classes, and I barely have time to keep up with my job now. (Post-workshop Survey)

She was teaching Honor English for grades 9th and 10th. By referring to these classes, she explained that integrating AI into her Honors English classes would be challenging since there was not enough flexibility in the curriculum. Also, she pointed out her roles and responsibilities as a teacher. She might think that integrating AI would bring new responsibilities and tasks in the classes and this might be a hurdle for her. Similarly, Heloise was also teaching Honors English to 10th graders, and in the interview, she mentioned that integrating this curriculum might require "too much time investment". Instead of Honor English, she was thinking to integrate the curriculum into her Journalism classroom due to flexibility in the curriculum.

Another challenge that the teachers perceived was related to the use of technology. Three teachers (Amy, Emma, and Harper) claimed that the StoryQ learning environment was not user-friendly and easy to use. For instance, while completing the activities, Amy said that: "the program is just not very user-friendly for me". She also explained that learners need to focus so many points at the same time and it would "be overwhelming to some students". Especially, when she was working on building ML models, she pointed out the activity steps by saying: "Too many windows to manipulate-- I kept losing Selected Reviews box. I need to windows to be stationary so I don't have to explore to find what I need." In this activity, they were supposed to check multiple windows to understand their models' performance and errors. Yet, in her reflection, she described that managing all windows was not easy for her. Like Amy, Emma also shared her experiences in using the technology. While completing the activities, she said that: "As we add more information, it is more difficult to read the graphs and charts that pop up in the main window, and I don't want to close any, as I don't know which I'll need later on." She was also having challenges managing windows in the StoryQ learning environment. Also, she mentioned that many students use tablets and Chromebooks which might be an issue to view the StoryQ technology appropriately.

Lastly, two teachers (Amy and Maria) perceived certain AI learning activities as a part of a CS or Mathematics classroom rather than an ELA classroom. In the post-survey, Maria shared her concerns related to introducing advanced ML topics in the classrooms. By referring to the ML activities (e.g., unigram model), she stated that:

> I don't know that teaching the students how to program models is relevant in my classes. We need to remember that it is an ELA class, not a computer science class. While we do need to show the general premise behind the StoryQ, I don't know if we need to show the students knots and bolts of this software. (Post-workshop Survey)

In her reflection, she was thinking that introducing all concepts might not be relevant to ELA classrooms. Especially, she was perceiving building ML model activities as "knots and bolts of this software." These activities were one of the core activities in the AI curriculum. Yet, Maria perceived those activities as irrelevant to her ELA classrooms. Similarly, Amy reflected on the activities as: "We would be using it in English class, but I think it works better in a computer or math class. My role would be teaching it to my students for writing purposes." Amy was also sharing similar ideas with Maria. She was thinking that this curriculum might be more appropriate for a CS or Math classroom. After the PD, Amy explained that she did not feel confident to present all the topics in her classroom. Her experiences with the learning activities might push her to think in this way.

In general, the teachers viewed the challenges of integrating AI curriculum into their classrooms in four categories: (1) content specific, (2) restrictions in the curriculum, (3) use of technology, and (4) perceptions of the activities. While viewing the challenges, the teachers brought up their TPACK knowledge to predict the possible challenges that their students might face. Their learning experiences helped them to think about the possible challenges.

Summary of Phase One Findings

In phase one, the teachers' experiences in the AI professional development workshop were examined. Findings from research question one presented the changes in the teachers' confidence before and after they participated in the PD. The teachers' confidence was reported in three categories: (1) completing AI training, (2) presenting and explaining AI topics, and (3) facilitating and supporting students around AI concepts. The findings revealed that the teachers' confidence in completing AI training did not change significantly after they completed the PD workshop. Since the teachers were interested to learn about AI concepts before the PD workshop, their attitudes might not change after the PD. In other words, a teacher might start the PD program with high confidence in completing AI training, and then complete the PD workshop with a similar attitude. Therefore, we might not see a significant change.

On the other hand, the teachers became more confident in presenting and explaining AI topics to their students. Before the PD workshop, the teachers identified themselves as learners and did not feel confident in presenting and explaining AI concepts. After they experienced the AI learning activities in the curriculum, they felt more confident. In other words, their confidence increased significantly after the PD workshop. The teachers were most confident in presenting and explaining introductory AI topics such as the impact of AI, the introduction of text classification, and introduction of Machine Learning. Yet, the teachers felt less confident in presenting and explaining advanced ML topics like feature engineering. The teachers indicated that to feel more confident, they needed more time and scaffolding on advanced ML topics. Additionally, they mentioned that using the StoryQ technology was not easy for them to navigate advanced ML topics, and this affected their learning experiences. Moreover, a content analysis was employed for the teachers' mini-lesson artifacts to gain a more nuanced understanding of their confidence. The analysis revealed that teachers' mini-lessons reflected their confidence in presenting and explaining AI topics.

Regarding facilitating and supporting students around AI concepts, the findings demonstrated that teachers became more confident after the PD workshop. Most of the teachers started the PD session with "neutral" confidence in facilitating and supporting students related to AI topics. After the PD workshop, their confidence level significantly increased. Yet, two teachers did not demonstrate any increase in their confidence level. The analysis of their activity responses revealed that their learning experiences and challenges might have an impact on their confidence in facilitating and supporting students around AI concepts.

The findings of research question one highlighted the teachers' confidence before and after participating in the PD workshop. In the SCT, Bandura (1978) put emphasis on self-efficacy (i.e., an individual's belief in his/her abilities to succeed in a specific task) in determining behaviors. In the context of integrating AI into K-12 classrooms, the teachers' confidence in presenting and explaining AI topics and facilitating and supporting students around AI concepts might have an impact on their decisions to integrate an AI curriculum into their classrooms. As an example, a teacher with a high level of confidence in presenting and explaining AI topics might be more willing to integrate an AI curriculum into her classrooms than a teacher with a low level of confidence. Additionally, the TPACK framework identifies essential knowledge that teachers should have for successful educational technology integration. For the successful integration of an AI curriculum into K-12 classrooms, teachers need to have adequate TPACK knowledge. In this context, they should be equipped with adequate AI knowledge and feel confident about their knowledge. If they cannot feel confident, they might not facilitate their classroom implementations effectively.

Moreover, findings from research question two demonstrated the teachers' views on integrating an AI curriculum into their classrooms before and after they attended the PD workshop. When the teachers were thinking to integrate the AI curriculum into their classrooms, they considered several factors: including the relevancy of the topics, classroom implementation ideas, opportunities for their professional development and teaching, opportunities for their students, and possible challenges. Firstly, when the teachers were thinking to incorporate the AI learning activities, they were critically analyzing the relevance of the topics with their course objectives. In other words, regarding how much relevancy they perceived between the presented learning activities and their teaching goals, they were willing to integrate the AI activities into their classrooms. Secondly, when the teachers were considering the integration, they were acknowledging their learning challenges and suggesting new strategies to make their students' learning experiences better. In terms of classroom implementation ideas, they brought up four main ideas: explaining the terms clearly, making content simpler, employing more scaffolding and modeling, and allowing students to work in groups. The teachers believed these classroom ideas could help their students to understand the AI learning activities better. Thirdly, teachers also considered the opportunities for their professional development and teaching when they were sharing their views on the integration of the AI curriculum. Teachers perceived these opportunities as being up to date in their teaching, gaining new skills, being leaders who implement AI for the first time, and effectively communicating with their students.

Furthermore, teachers also acknowledged the perceived opportunities for their students. They believed integrating AI concepts into their classroom would benefit their students in improving their ELA skills, acquiring new knowledge and abilities, and seeking AI-empowered careers. Lastly, teachers mentioned possible challenges to integrating the AI curriculum into their classrooms. Those challenges were identified as content-specific, restrictions in the existing curricula, use of technology, and perception of the activities. When the teachers were thinking about their classroom implementation, they considered how their students might have challenges to understand specific content in the AI curriculum. In particular, they identified specific ML concepts (i.e., feature, weight, and unigram) as challenging concepts for their students. Also, teachers acknowledged the limitations of their existing curricula. Teachers mentioned that their existing curricula were not available to integrate additional activities due to a lack of flexibility. Especially, teachers brought up specific English courses (e.g., Honor English and AP English) to explain the lack of flexibility in their curricula.

As another challenge, teachers explained that the use of technology was not easy for them. When sharing their experiences, they explained that the StoryQ technology was not easy to navigate. They thought that their students might also have similar challenges when they were using the technology to complete the activities. Thus, they believed that this might affect their students' learning experiences. Lastly, a few teachers viewed specific AI learning activities as more appropriate for a CS or Mathematics class rather than an ELA class. In particular, teachers viewed ML activities as not relevant to an ELA class. This perception can be a barrier to integrating AI concepts into non-STEM classrooms.

Overall, the findings of research question two demonstrated the teachers' views on integrating the AI curriculum into their classrooms. As content experts, teachers brought their expertise to analyze possible outcomes of integrating the AI curriculum. From the SCT perspective, teachers focused on outcome expectancies to identify opportunities both for their career and their students. Additionally, from the TPACK framework perspective, teachers followed their TPACK knowledge to identify challenges and classroom implementation ideas to prevent these challenges.

Phase Two: Implementation

After the PD workshop, two ELA teachers (Marsha and Heloise) decided to implement the StoryQ AI curriculum in their classrooms. Heloise implemented the curriculum in her Journalism classroom for three weeks (i.e., 15 class days). The journalism classroom was an elective course for every grade level and consisted of twenty-eight students. The demographics of students varied by their grade level, gender, and race/ethnicity (see Table 3.1). For the classroom implementation, Heloise used their CS classroom to provide one desktop computer for each student to complete the activities. Marsha integrated the curriculum into her ESOL class for 10 days. This was a beginner class with four students: three 9th-graders and one 10th-grader. Each student had one Chromebook to complete the AI learning activities. While teachers were implementing the curriculum, they were supported through Zoom and Slack. Phase two presents these teachers' classroom implementation experiences.

Findings of Research Q3

This section presents the findings for research question three: What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms? To address this question, live coding was employed in the classroom implementation videos and audio recordings. Also, I followed open-coding strategies to analyze the teachers' self-reflections and transcripts of their semi-structured interviews. This process was held in three phases. In the first phase, the data were coded with open-coding strategies. After the initial codes, patterns and main categories were identified. This second phase helped to finalize the codebook. Lastly, in the final phase, the quotes of participants were used to draw conclusions and answer the research question. The analyses revealed three main categories: opportunities, challenges, and changes. The following section explains each category with details and evidence from the teachers' interviews and classroom implementations.

Opportunities. Teachers perceived specific opportunities to integrate AI into their classrooms. Both Heloise and Marsha mentioned how the curriculum could benefit their students. Heloise integrated the StoryQ AI curriculum into her Journalism classroom. She described the primary teaching goal as "to expose students to the skills and processes of creating journalism in a board." She was aiming to help her students to develop an interest in the Journalism field by equipping them with essential skills and abilities. When she was explaining her teaching goals, she also brought up the term "Digital Journalism". She believed that her students were consumers of "Digital Journalism" sources, yet she wanted them not only to be "consumers" but also to be "a responsible news producer". Thus, when she was thinking about the connection between her teaching goals and what the StoryQ AI curriculum can provide, she believed that the curriculum could support her students' "being a responsible news consumer".

Put differently, she saw an opportunity to support her students' critical thinking abilities to become a "responsible news consumer" by working on the StoryQ AI curriculum.

Specifically, in her interview, Heloise pointed out the similarities between "media bias" and "AI bias". In the Journalism class, they focused on the term "media bias" and discussed how publications carry a particular bias. She explained the importance of understanding "media bias" by saying "how can we be aware of Vice President in the news that we consume and how can we balance the news that we consume in order to be better informed." She believed that in order to become "responsible news consumers", students needed to understand the bias in media sources and be informed about this. She saw an opportunity in the StoryQ AI curriculum to help her students' understanding of "media bias". She stated that AI technologies use "someone's individual feed". Thus, she believed these technologies also carry biases like "media bias". In the interview, she stated:

> Understanding how systems algorithms and bias in fact information consuming produced equip yourself is responsible journalist and news consumers by learning balancing strategies, whether that's in what we write or read, and then the StoryQ was this third one, understand and investigate algorithms and machine learning principles from the inside out so like you know building that in order to use the tools start advantage, rather than put our lights back on. (Post-implementation Interview)

She thought that exploring these biases in the curriculum activities can support her students' critical thinking abilities in what they were reading and writing. She claimed that exploring biases in the algorithms and publications were similar. For this reason, she believed the StoryQ AI curriculum supports her teaching goals.

Another opportunity that Heloise mentioned was helping her students to envision a career in the AI-empowered world. She thought that integrating AI into her classroom helped her students to see different careers around AI. She perceived the Journalism class as an "exploratory class". She wanted her students to explore different careers in this class. In the interview, she described how she wanted her students to think about why they were here in this class, and then understand they were here to explore new areas. Specifically, she wanted them to "see if this *(refers to Journalism)* could be a career for me." By integrating the StoryQ AI curriculum into this class, she thought her students were able to explore new careers around AI. She mentioned the Activity, "Who Creates AI" and pointed out that she wanted to spend more time showing the career related to AI in Journalism. She wanted to show more examples in terms of how a person can use AI in her Journalism career. She also added that this part could be extended to other professions as well. She stated that she had so many students who were interested in sports. She thought it might be useful to show examples from the sports field. In this way, she believed that most of her students could see a career that they might be interested in their futures. Overall, she demonstrated that the StoryQ AI curriculum benefitted her students to explore different careers.

In addition to exposing careers, Heloise mentioned that integrating the AI curriculum gave opportunities for her students to have AI knowledge and understanding. She mentioned that while completing the learning activities, her students enjoyed learning about AI. Especially, she mentioned some of her students enjoyed "hands on manipulation of data." In her interview, she demonstrated her students' excitement and behaviors. She said:

> I can apply my kind of stem and engineering brain over here to this kind of field of data analysis and even machine learning… I think most people enjoyed it I don't think and maybe most people had a good time but whether they really found a curiosity and passion

there, or whether it was just something that they've done. (Post-Implementation Interview)

She thought that some of her students approached the data analysis activities by applying their STEM and engineering knowledge. She might believe that since her students had some prior knowledge in data analysis through other STEM courses, they might enjoy the activities and demonstrate passion. Also, she mentioned that some of the students might only approach these activities as a task and focus more on finishing them. However, she mentioned her students' AI knowledge increased whether the students "found a curiosity and passion there". To explore her students' AI understandings, she examined their pre-and post-survey responses. In the interview, she mentioned that she was looking at her students' responses to see whether they were able to use the terms correctly. She stated that "some students use it *(refers to the terms)* successfully some students you tried and we're less than successful some of the responses that I read, I was like okay you're almost say." Furthermore, she explained that she asked certain questions to check her students' understandings during the class. She said that hearing the students' responses to her questions showed their AI understanding. She mentioned that during the classroom discussions, she was able to understand how her students perceived the AI knowledge.

Like Heloise, Marsha also perceived opportunities for implementing the AI curriculum in her ESOL classroom. She explained her teaching goal in this classroom as helping the students to "gain English Language proficiency by modeling and supporting them in their native language as much scaffolding". She was helping beginner ESOL students to gain an adequate English language ability to understand the academic language at the school. In the interview, Marsha mentioned a perceived opportunity to integrate the StoryQ AI curriculum to support her students' language abilities in reading, writing, and listening. She saw a connection between the StoryQ AI curriculum and her teaching goals. In the interview, she emphasized how the StoryQ could support her students' language abilities by saying:

> This curriculum hit all four domains, because they had to really listen to the scenarios that we were discussing in class listen to each other when we were saying oh umm how would you tell somebody to turn the light off and we were talking about that, so they were listening and speaking, and then they were also reading and then writing their responses, so it was this curriculum really was hitting all of the four domains that we really work on in ESOL. (Post-Implementation Interview)

So, she believed that working on the AI learning activities created an opportunity for her students to practice their language skills in a different context. She also described that when the students were developing ML models, they were examining how ML models make decisions regarding words. She thought this was a practice of how her students learn different words and understand each word meaning in a sentence. She perceived this as an opportunity for her students to think about the power of words in their writings.

Moreover, she saw an opportunity for her students to learn more about "Computer Science and related tech field". She believed that the AI field would "be very important for students". Therefore, she wanted to integrate the AI curriculum into her classroom to expose AI knowledge to her students. She also mentioned that ESOL students could not interact with such innovations because of their language abilities. Marsha said:

> I often feel that those courses *(refers to CS and technology courses)* on either they don't seek them out, or they don't know that they exist or because they speak another language,

other educators don't think that they would be successful. (Post-Implementation Interview)

She believed that integrating AI into her classroom would give an opportunity for ESOL students to access AI education. She wanted her students to feel more inclusive in the current innovations. In her career, she was a middle school teacher, and she organized an after-school program, "CS for girls". She mentioned that the after-school program helped her students to wonder about CS and asked for additional courses. In the interview, she mentioned that "English Language Learners either not that it's purposefully exclusionary *(or)* it's just that." By drawing upon her previous experiences, she wanted to expose her ESOL students to AI education.

Additionally, she believed that integrating AI into the class provided an opportunity for the students to see different types of jobs for their future careers. She thought that these types of integrations were an opportunity for the students to get familiar with different jobs and seek careers. She thought these types of curriculum integrations could be a start for students to think about their future paths. In other words, she stated that students could start learning about "the language of coding" in one classroom and then develop an interest in these areas. After that, these students might seek additional courses. In this process, she thought her role would be to guide her students to receive other opportunities.

Overall, the teachers saw opportunities to get familiar with new careers, gain AI knowledge and understanding, improve their critical thinking abilities, practice their language skills, and create more inclusive education. From the perspective of SCT, teachers saw the value of integrating AI curriculum into their classroom regarding their own beliefs and teaching goals. When they were talking about the benefits of integrating AI into their classrooms, they were considering how the StoryQ AI curriculum took a place in their teaching goals. Thinking of that perspective helped the teachers to identify how the curriculum implementation helped their students practice their language skills and became more critical thinkers. Additionally, their classroom discussions and implementation experiences helped them to observe their students' learning processes and behaviors in the classes. In this way, they clarified how the StoryQ AI curriculum benefitted their students to gain AI knowledge and understanding.

Challenges. When the teachers were implementing the AI curriculum, they faced specific challenges. These challenges can be categorized into two groups: challenges for teachers and challenges for students. In Heloise's classroom implementation, she had to change her classroom setting. Instead of her own classroom, they had to use CS classroom to provide a computer for each student. In her interview, she mentioned that her students were getting distracted easily and it was hard for her to "micromanage". She explained that in the CS classroom, her students were sitting all around the class rather than being gathered around the center. Therefore, it was difficult for her to manage the classroom. She stated that:

> I don't know it's just a phenomenon that when students go to the computer lab, they just get more distracted more easily like... So that gives a little bit of you know excitement, and then I it's much harder for me to keep eyes on every single person. (Post-implementation Interview)

She believed that when her students got into a new environment, they became more excited and distracted. In terms of classroom management, she had difficulties managing her students in the CS classroom. Thus, she perceived this classroom setting change as a challenge. Also, she mentioned that the computers at the school were slow to complete the activities. Students were using Chromebook desktops and Heloise mentioned that those computers were not used frequently as they were slow. Additionally, when she was mentioning about the computers, she also stated that: “the Chromebooks are not well suited for that *Program (refers to the StoryQ)* because they’re never you know that’s not part of what they were designed to do the Chromebooks itself”. She further explained that it was difficult to see the windows in the StoryQ technology by using the Chromebooks screen. She mentioned that the screens were smaller to work on the StoryQ environment. Moreover, she brought up the technology glitches when students were working on the AI learning activities. On some of the students’ computers, they faced with technology glitches like not being able to see the table in the dataset or downloading the image in their curriculum questions. This might be related to their internet connection at the school.

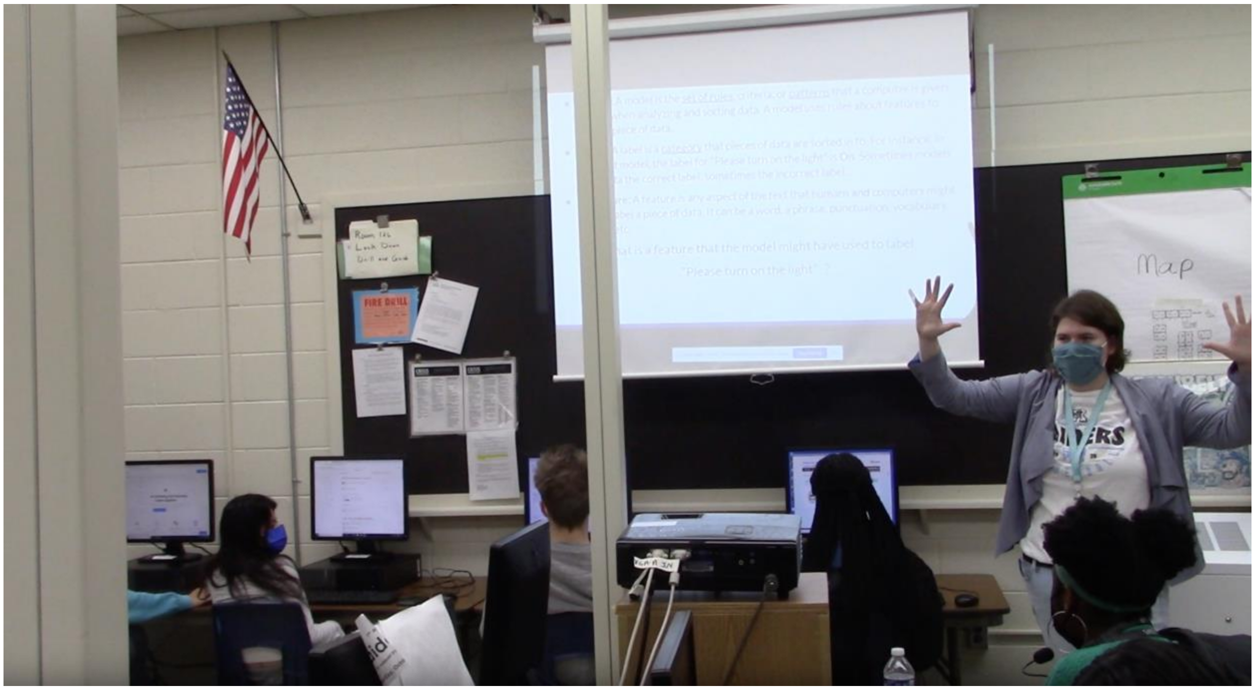
Another challenge that Heloise perceived related to technology was troubleshooting. In her interview, she was dedicating some of her class time to working with individual students to do troubleshooting. Yet, she said: “it's like it's downtime for because i'm over here troubleshooting.” She perceived this as “downtime” because she described that some students needed help while others were okay to go. Thus, students had to wait for each other, and this created “downtime” for students. She saw the troubleshooting part as a challenge while implementing the curriculum because of time constraints.

Moreover, Heloise talked about the content-specific challenges in the curriculum implementation. She specifically talked about the challenges in understanding the terminology. In the interview and the reflection notes, she mentioned that her students had difficulties understanding the terms. In her reflection notes, she stated that: “people are not familiar with the terms, usually people throw the terms and then they don’t give an explanation around that, which is a challenge to understand this things.” She explained that it is important to clear the terms to the audience. In her interview, she talked about how people use the term AI without providing a clear explanation of the terms. Thus, she decided to dedicate some of her class time to introducing the key terms at the beginning of the classroom. As an example, when she was introducing the Light on/off activity, she created “bite sized definitions” for the terms feature, label, and weight. She believed that her students needed a short definition of the terms to understand the concepts. As a teacher, she was applying her teaching style to teach AI concepts. In the interview, she said that:

> Like at the beginnings of class like em review and things like that yeah And, and I did a lot of rephrasing too so i'm a big fan of one word definitions and like very quick practical definitions it's like when I would students, when I teach students new vocabulary like that's what I tried to kind of distill things down. (Post-implementation Interview)

As a learner and as a teacher, she talked about her preferences to learn the definitions. Regarding that, she created “one word definitions” and “short phrases” for her students (see Figure 4. 14). As an example, the analysis of the classroom videos revealed that she created a phrase to define the term AI. While she was teaching the Activity One, page “Spot AI in our lives”, she brought up “imitates human behavior” phrase to define AI. Similarly, she also created a phrase for the term model. In the Activity Two, she introduced the term model as “a set of rules, criteria, or patterns that a computer is given to use when analyzing and sorting data”. During the classroom implementation, she was trying to support her students’ conceptual understandings through these phrases and definitions.

Figure 4.14 *A screenshot of a teacher's classroom implementation*



Note: On the board, she was representing the terms model, category, and feature.

In addition to the terminology, Heloise also acknowledged her students' challenges with the StoryQ technology as content-specific challenges. For example, while her students were working on the Activity Five, Heloise mentioned that "students struggled with wading through the large data set." Therefore, she had to work with the students one to one and provide help to them to understand how they could approach the dataset. While helping the students, she was carrying the camera with her to record her interactions with the students. In these one-to-one interactions, she was giving general tips for her students to understand the structure of the reviews. More specifically, some of her students were having difficulties observing the negative reviews in the dataset. She was explaining to scroll down in the dataset to see those reviews. In her reflection notes, she also mentioned that: "students will need to be coached on ways to interact with the large data set in a useful way. This includes guidance on how to navigate the program and what kinds of reviews will be most useful to them.” She emphasized the importance of guiding the students to understand the dataset to address the learning challenges.

Additionally, she also brought up her students’ difficulties to understand the graphs on the activities. In the reflection notes, Heather mentioned that “students struggled with finding the correct column of data to evaluate (weights of new features in particular) so we did a lot up front to help them click along and find the information they needed.” Specifically, while the students were working on Activity Six, page “Add features to your model”, they had problems to understand the “predicted versus actual sentiments” graph (classroom video analysis). Thus, Heloise had to work with her students one to one to explain this graph. Yet, when most students were asking similar questions about the same graph, she decided to give an explanation to the whole class.

Similar to Heloise, Marsha also shared the challenges in the implementation of the AI curriculum. In terms of challenges, she acknowledged the challenges to teach the AI curriculum for the first time in the ESOL classroom. As a teacher, she mentioned that the curriculum implementation took longer than she expected. During the curriculum implementation, she was doing whole-group discussions in her most of the class time (classroom observation notes). In the interview, she brought up this by saying: “We couldn't move through the curriculum as efficiently as I thought, because we had to really build a lot of background.” She believed that she needed to build a background to support her students’ conceptual understandings. After the curriculum implementation, she reflected on the duration of the implementation. She thought that this curriculum implementation should be “a semester course” instead of a three-week or ten-day-long implementation. She mentioned that the current implementation time would not be enough to build adequate background knowledge. Instead of this, she believed this curriculum could be taught as a semester-long elective course.

Additionally, in terms of whole-group discussion, she reflected on her own teaching. In the interview, she said that: “I guess I had that low expectation.” She was thinking of her students’ abilities to complete the learning activities. She thought that her students might have challenges completing the activities by themselves. Therefore, she decided to do whole-group discussions. When she was talking about her classroom dynamic, she stated that: “level or stage in their language journey so they're not really that willing to talk plus I think this is my first year i'm coming from middle school where i'm used to them.” As a teacher, she accepted having low expectations from her students. Also, she was teaching to middle school students before teaching at this high school. Therefore, she was not experienced to teach high-school students. She also believed that this might contribute to her perceptions of her students. In the interview, she talked about her own learning experiences in the PD workshop. She explained before doing the curriculum implementation, she was thinking to follow a similar structure to the PD workshop. She was planning to introduce the concepts at first and then provide time for her students to work by themselves and to have “their A-ha moments”. However, she said that:

> if it wasn't I didn't feel it getting there and I now that i'm talking about it out loud with you i'm just wondering was that because I didn't think they could get there, or I didn't allow them to get there because maybe they couldn't. (Post-implementation Interview)

During the curriculum implementation, she was not sure about what her students were capable of. Therefore, this perception affected her classroom implementation format. Moreover, in terms of classroom implementation, she also reflected on the classroom discussion. While completing Activity Three, “How do humans classify texts?”, she was explaining the term "clickbait" to her students and read a couple of clickbait headlines from the activity page. After reading the headline "We Can Tell What's Your Favorite Food Based On Your Zodiac Sign", she started a conversation about how Zodiacs were defined with the calendars in different cultures. One of her students joined the conversation and talked about how religions affected the calendars in specific cultures. This discussion lasted approximately 20 minutes out of 45 minutes of a class period (classroom observation notes). At the end of the day, Marsha reflected on the timing of this discussion by saying: "I made the mistake of talking about it for longer than needed probably when I could have shown some pictures and moved on". This was a challenge to integrate the curriculum for the first time. She could not make a prediction of the timing of her classroom implementation. For this reason, she might think this curriculum might need more time to implement.

In addition to her teaching reflections, she also shared the challenges that her students faced while completing the curriculum implementation. Like Heloise, she also brought up a technology challenge. In the interview and the reflection notes, she mentioned that her students had difficulties connecting to the Wi-Fi at the beginning of the classroom implementation. Connecting each computer to the internet took time for them. After they connected, they did not have any connection issues to complete the activities. As a learning challenge, Marsha also mentioned her students' familiarity with the Yelp reviews. She explained that some of her students were not familiar with the Yelp reviews. Therefore, she had to spend time explaining how people write reviews on Yelp to share their experiences. Since some of the students were coming from different countries, the Yelp review system might not be available in their countries. This might be a challenge for students to understand the review process and the dataset in the curriculum in the first place.

Lastly, Marsha acknowledged her students' vocabulary development as a challenge. In the interview, she explained that her students were not familiar with the technology terms in English. For this reason, she needed to dedicate her time to explaining the terms to support her students' conceptual understanding. In the interview, she reflected as:

> I felt like we had to really be all together and talk about the different vocabulary and do you know what this means and what is a sentiment and just all those different things, and do you have and I had. (Post-implementation Interview)

In her reflection, she claimed that her students might have challenges in understanding specific terms like "sentiment". Therefore, like Heloise, she also spent time explaining these types of terms to her students. In general, teachers explained challenges as classroom management, technology issues, time constraints, explanation of the terms, and understanding of concepts at the StoryQ technology. While reflecting on the challenges, teachers drew on their TPACK knowledge. From CK's and PCK's perspectives, they mentioned the challenges that their students faced in understanding concepts and how these concepts were introduced in the curriculum. From TK's perspective, they brought up the technological challenges in the classroom implementation including both connection and usability issues. From PK's perspective, one of the teachers explained the classroom management challenges during her curriculum implementation. Overall, the teachers' TPACK knowledge helped them to perceive challenges and find ways to address these challenges to support their students' learning experiences.

Changes. When the teachers mentioned the opportunities and challenges, they described the changes that they did during the classroom implementation. In the interviews, both teachers explained the PD workshop helped them to imagine their classroom implementation. Especially, Heloise stated:

> It was an interesting thing for me to like to have been part of the workshop in the fall, I kind of like think through as I went through the modules as a student I was also thinking it through as a teacher and, like the mini lessons etc. kind of directed me to do that as well, so I already kind of had an idea of ways, I wanted to like streamline. (Post-implementation Interview)

While she was working on the learning activities as a student in the PD workshop, she thought about how she would teach these activities. The PD helped her to create her classroom implementation plan by creating mini-lesson designs and assessing the activities as a learner. In her classroom implementation, the major change was to change the classroom setting. She had to move her class to the computer lab. She perceived this change as a major change since it affected her classroom management skills. Additionally, she made content-specific changes. As an example, she created presentations to introduce key concepts in the curriculum. At the beginning of the class, she decided to spend time working on the concepts as a whole group. She created a list of “phrases” and “one-word definitions” to help students to understand the key concepts. In her classroom reflection notes, she described the process of creating the definitions as:

> I am balancing how and where to include my own explanations and modifications with the module. Sometimes I will introduce explanations of my own that do not match the module exactly, so I have to spend time making those connections, sometimes at the cost of students’ focused time with the program. (Post-implementation Interview)

Furthermore, during these presentations, she had to make an introduction to show where the students were heading toward to make the content clearer for them. In the interview, she mentioned that she wanted to create a roadmap for her students to demonstrate what they would learn at the end of each learning activity. She believed that her students would be confused if they would not understand the learning objectives in the curriculum. Therefore, she made introductions to present what the students would learn at the end of the activities.

Another change she did during the curriculum implementation was to skip Activity Four, "Machine Learning with Alien Language". While she was explaining her reasons to skip the activity, she was mentioning her PD experiences. In her interview, she shared what she was thinking while completing this activity as a student in the PD. Her learning experiences led to her decisions during the classroom implementation. She explained how she perceived this activity by saying:

> In the English language, rather than an alien language, we had already like built vocabulary like feature and label with words and sentences. So, I didn't want us to then go over here to like shapes and symbols because and then returned back to words and sentences. (Post-implementation Interview)

During the classroom implementation, she did not want to work on the shapes to teach the features and labels, and then turned back to reviews to work with similar concepts. She believed their focus should be more on the words and sentences in an English Language classroom. For this reason, even though she believed that her students would enjoy the activity, she wanted to skip it to spend more time on the reviews. Moreover, she also did minor changes, including changing the order of the activity pages and bringing contextual discussions to support her students' understanding of the dataset. In the Activity Two, she changed the order of the pages to help students to understand the definitions of AI and ML before examining the current application of ML and AI. She believed this would be more helpful for her students. Also, in the

Activity Five, they were planning to explore the Yelp Frozen Dessert Dataset. Yet, her students were not familiar with the Yelp. Therefore, she decided to change the conversation to their school cafeteria. She asked students how they would write reviews about the foods in their cafeteria. She asked her students to write reviews and then discuss them as a whole group. In this way, she believed her students would develop a better understanding of writing reviews.

On the other side, in the Marsha's classroom implementation, she did not make any major changes in the curriculum. In her classroom, the biggest difference from the Heloise's class was being heavily relied on whole group discussions instead of including both independent and whole group work. In her interview, she mentioned what kind of changes she would like to make in her next classroom implementation. She wanted to include culture-specific examples from her students' hometowns. Before the classroom implementation, she wished to include some examples regarding to her students' backgrounds.

Overall, the teachers made changes based on their beliefs and values. While they were making decisions, they were trying to enrich their students' learning experiences. For this reason, one of the teachers created presentations, changed the order of the activities, skipped an activity, and brought up contextual discussions. From the SCT perspective, Bandura (1989) advocates that teachers' beliefs and values shape their instructional practices. These teachers' classroom implementation demonstrated how their beliefs about their students and the values in their classroom helped them to decide on the changes. While teachers were implementing the curriculum, they had opportunities to observe their students' learning processes. Their observations might help their decision-making processes. When they were experiencing the AI learning activities as learners, they might not have foreseen such changes. For example, as learners, they might not predict whether they would need to bring contextual discussions to introduce the reviews in the curriculum. However, one of the teachers recognized that her students were not familiar with the Yelp reviews. Therefore, she chose to bring a familiar context to discuss what kind of reviews people write. From a curriculum design perspective, the design of the AI curriculum provides flexibility for the teachers' classroom implementation. Through this flexibility, teachers can make changes and provide rich learning experiences for their students. Additionally, from the TPACK perspective, these teachers brought up their expertise in their content and pedagogy knowledge to decide the changes in the curriculum and support their students' learning. Their understanding of the AI content and observations of the students' learning helped them to make changes during their classroom implementation.

Findings of Research Q4

This section presents the findings for research question four: What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms? To address this question, teachers' semi-structured interviews were coded by following open-coding strategies (Strauss & Corbin, 1998). The analyses revealed the teachers' intention to teach the curriculum again and their recommendations to their colleagues.

Intentions. At the end of the classroom implementations, the teachers were asked to talk about their intentions to implement this curriculum again in the same class or another class. In the interviews, they shared their plans to implement the curriculum. Heloise was willing to implement the curriculum again. Yet, she mentioned that she would do more changes to the curriculum. Firstly, she criticized the number of questions that were asked to students to answer while working on the curriculum. In her next implementation, she wanted to "condense and streamline some of the introduction questions". She thought instead of asking students to complete these questions by themselves, she could ask some of the questions to hold a classroom discussion. She also mentioned that she might want to change the wording of the questions to make the questions clear for her students. She described her future implementation as “it would be me just like kind of trimming things there.” In terms of the class choice, she was preferring to teach again in the Journalism classroom. At the school, she was teaching Honors English and Journalism. However, she did not want to integrate the curriculum into her Honors English classroom. In her interview, she explained her reason as:

> Journalism I have a lot more freedom of like how I can spend our weeks, whereas 10 honors there are kind of particular more particular things that I need to kind of spend time spend time on and cover. (Post-implementation Interview)

She compared her classrooms based on the flexibility in their curriculum and decided not to implement the curriculum in the Honors English class. She further explained how she would use the flexibility in the Journalism classroom. She mentioned that she could extend or condense the activities based on her students’ interests in the Journalism class. Like Heloise, Marsha also mentioned how she would change her curriculum implementation for the next round. Her biggest concern about the curriculum implementation was time. She believed that instead of implementing whole curriculum activities, it would be easy to pick specific learning activities. She did not give details about which types of learning activities she would integrate again since she was more focused on time constraints. During her interview, she advocated presenting this curriculum as a semester-long course to help students to develop a deep understanding of AI.

On the other hand, she had a different attitude than Heloise in terms of integrating this curriculum into regular English Language Art classrooms. She thought that it would be possible to integrate the curriculum into a regular ELA class. In the interview, she stated:

> I think it would be appropriate if they wanted to add it and do maybe one or two days in a week. Like we were talking about how we would do the first 30 minutes as an intro so that students would learn that language learn the language of coding learn, because we do we put in our code, every year we put in the week of computer science week and try to highlight these different things to get them thinking about taking these courses. (Post-implementation Interview)

In her reflection, she explained that every year, at their school they were having CS week. In this week, the teachers were encouraged to talk about how CS was related to other disciplines such as history, mathematics, and reading. She thought this curriculum could be took a place in the regular ELA class during the CS week at their school. Yet, she was more thinking of the introductory level of implementation. In other words, she was imagining having 30 minutes of introductions of the concept one or two days a week.

In general, both teachers were indented to teach the AI curriculum activities again in their classrooms. When they were talking about their intentions, they shared their ideas to make changes in the implementation. Teachers' classroom implementation experiences helped them to gain expertise in delivering the AI curriculum. Regarding their experiences, they were willing to take responsibility to make changes. By drawing upon the SCT perspective, these teachers might become more confident in teaching AI learning activities. This confidence might help them to imagine their future iterations.

Recommendations. In addition to teachers' intentions, I also explored the teachers' recommendations for their colleagues. In the interview, the teachers explained why they preferred to integrate this curriculum into their classrooms and what kind of suggestions they would give to their colleagues if they wanted to integrate the curriculum into their classes.

Heloise explained her decision to integrate the curriculum by describing how she wanted to try something out of her comfort zone. In the interview, she mentioned that this was an exciting learning experience for her. By referring to her PD workshop days, she said:

> I was there with the other teachers. And a lot of them mentioned like oh this I want something that will push me out of my comfort zone, I want something that will be new and fresh and exciting and that's definitely what this was for me. (Post-implementation Interview)

As shown in her reflection, she was motivated to try new learning activities for her classroom. She got excited about the idea of teaching AI in her classroom. This interest helped her decide to integrate the curriculum. Additionally, as an educator, she wanted to "stretch" herself by bringing "something completely new to the table". She recommended to her colleagues push their comfort zone and try to integrate new learning activities.

Marsha had a different motivation to integrate the curriculum into her classroom. She explained her previous experiences related to helping to create an after-school program for middle school students. In the interview, she mentioned her beliefs to support underrepresented groups (i.e., girls and ESOL students) to be able to reach a CS education. She was motivated to integrate the AI curriculum into her classroom to provide an accessible CS education to her ESOL students. She wanted to share her effort on this with her colleagues. Also, she recommended integrating the curriculum by saying:

> um I would just tell them that it's it it's a nice curriculum that you can guide the students through it's got independent pieces it's got group work you get supported through the whole process there's training. And it really it will empower your students to you know take other you know take other coursework that will benefit them and. it's not difficult

you don't have to be a computer science major. To do it, you know. it's important you know, to help our students be well rounded and good problem solvers. (Post-implementation Interview)

She mentioned that the teachers did not need to have a CS background to teach this curriculum in their classrooms. She also explained the importance of integrating this curriculum to support their students' future and prepare them to become "good problem solvers". Overall, the teachers perceived different opportunities to boost their teaching and support their students. While they were considering recommendations, they mostly focused on their perceived outcome expectancies. In other words, they were making recommendations regarding how this integration would be helpful for teachers and students.

Summary of Phase Two Findings

In phase two, two teachers' classroom implementation experiences were presented. Findings from research question three demonstrated the opportunities, challenges, and changes that the teachers perceived and experienced during their implementations. During the classroom implementation, teachers perceived opportunities for supporting their students' career paths, improving their critical thinking skills, boosting their language abilities, and providing accessible education for them. Teachers explained that introducing AI-empowered careers in the AI curriculum helped their students to get familiar with different careers. Also, teachers observed their students' learning experiences while completing the AI curriculum activities. Teachers indicated that the curriculum supported their students' critical thinking and English Language abilities. In terms of critical thinking, Heloise mentioned that her students had an opportunity to discuss "media bias" and "AI bias" which helped them to approach digital publications with a critical lens. Additionally, Marsha brought up how the AI curriculum supported her ESOL students' reading, listening, and writing abilities. She believed the curriculum created an opportunity for her students to practice their language abilities. Another opportunity that one of the teachers mentioned was providing an accessible CS education for the students. She thought that her students were able to access an AI education in their ESOL classroom. She believed the integration of the AI curriculum helped them to experience AI learning activities with an interdisciplinary approach.

In addition to the opportunities, the teachers also talked about the challenges that they faced during classroom implementation. The teachers described challenges in two categories: the challenges for teachers and the challenges for students. As a teacher, Heloise brought challenges in classroom management since she had to use the computer lab during her classroom implementation. She explained her students were distracted in the computer lab and this affected Heloise's teaching. Therefore, she perceived classroom management in the computer lab as a challenge. Additionally, Marsha mentioned her perceptions of her students' abilities to complete activities. She had "low expectancies" from her students, and this impacted her decisions during the curriculum implementation. She dedicated most of her class time to do whole group discussions. When she was reflecting on her classroom implementation, she explained that this decision was costed more time than she expected. Thus, she perceived the duration of the curriculum implementation as a challenge due to her perception of her students' abilities and her decisions on how to implement the curriculum activities. In terms of the challenges for students, teachers brought up technology glitches and content-specific challenges. Both teachers talked about the technological challenges that their students had during the classroom implementation. Furthermore, students had challenges understanding the terminology (i.e., feature, category, and label) and concepts (i.e., reading graphs and findings errors) in the curriculum. For this reason, the teachers spent more time supporting their students' conceptual understandings.

Moreover, teachers talked about the changes that they employed in the curriculum implementation. The teachers mostly did modifications to support their students' understanding and address the challenges. They created presentations, change the order of the activities, skipped an activity, and brought up contextual discussions to support their students' learning experiences. Overall, the findings of the RQ3 presented opportunities, challenges, and changes. From the SCT perspective, the teachers recognized the advantages of incorporating AI curriculum into their classes regarding their own beliefs and teaching goals. As they discussed the benefits of integrating the StoryQ AI curriculum, they considered how it aligned with their teaching goals. This perspective helped them to realize how the curriculum integration supported their students' ELA abilities and critical thinking skills. In terms of the challenges, as the teachers encountered difficulties, they utilized their TPACK knowledge. Their CK and PCK helped them to recognize the challenges that their students faced in understanding the terminology and concepts. Also, their technology knowledge supported them to identify and solve technological challenges. By using their pedagogical content knowledge, teachers explained the challenges around classroom management. Overall, teachers' knowledge supported their classroom implementation to identify challenges and to decide the changes.

Additionally, the findings from research question four showed the teachers' intentions to implement the AI curriculum again and their recommendations to their colleagues if they would also want to integrate the curriculum into their classrooms. The findings demonstrated that both teachers were willing to implement the curriculum again in their classrooms. However, they mentioned making more changes for the next round. Especially, Heloise would like to make "a lot of trimming" to "condense" the curriculum. Also, they were asked to share the possibilities to integrate this curriculum into a regular ELA classroom. By thinking of Honors English, Heloise thought that it would be difficult to integrate the curriculum in such classrooms due to the lack of flexibility in the curriculum. On the other hand, Marsha claimed the possibility of integrating the curriculum into a general ELA course. Their schools were encouraging the teachers to talk about CS concepts in their classrooms during CS week. She thought integrating the AI curriculum into a regular ELA class during CS week would be a good fit. However, she was thinking that the teachers might integrate a 30-minute long-introductory course for one or two days a week.

Furthermore, the findings of the RQ4 revealed the teachers' recommendations for their colleagues. The teachers mentioned their motivation to implement the curriculum. Heloise's motivation was mostly related to her perception of an educator. She wished to experiment with something that was beyond her usual routine. She perceived integrating AI into her classroom as an exciting learning experience. For this reason, she suggested to her colleagues to have a similar approach. She suggested to her colleagues that they should step outside of their comfort zones and attempt to incorporate novel learning activities. On the other side, Marsha was motivated to provide an accessible education for her ESOL students. She believed that these students could not be able to reach CS education in their classrooms because of their language abilities. For this reason, she became motivated to integrate the AI curriculum into her ESOL classroom. Also, she elaborated on the significance of incorporating the AI curriculum to prepare students for their future careers and help them to equip with the skills to become proficient problem-solvers. She recommended her colleagues think about integration to support their students.

In general, teachers' classroom implementation experiences helped them to become more confident to make changes that they desired and intent to implement the curriculum again. SCT highlights the importance of individuals' self-efficacy and their prior experience in determining their behaviors. In this context, after teachers implemented the curriculum for the first time, they might feel more confident in their abilities to teach AI concepts. With this confidence, they might decide to implement the curriculum again. Also, their recommendations were mostly related to how they perceived the benefits of integrating this curriculum for teachers and students. Bandura (1978) emphasized the importance of outcome expectancy for a behavioral change. These teachers considered the outcome expectancies from their perspectives and provided recommendations to their colleagues. Additionally, by thinking of the TPACK perspective, the teachers' TCK might be improved after the classroom implementation. They might digest AI content knowledge while they were teaching their students. This might also help them to consider implementing the curriculum again.

CHAPTER 5: DISCUSSION

Introduction

This exploratory mixed method case study aimed to investigate English Language Arts (ELA) teachers' confidence and views in the integration of an AI curriculum into their classrooms. The dissertation included two different phases; Phase One: Professional Development Workshop and Phase Two: Classroom Implementation. Phase One examined the teachers' confidence and views before and after they participated in a curricular professional development program. Two research questions in Phase One were explored (1) What were ELA teachers' levels of confidence in integrating AI into their classrooms before and after participating in curricular professional development? and (2) What were ELA teachers' views of integrating AI into ELA classrooms after participating in curricular professional development? Thirteen ELA teachers participated in a one-month curricular professional development. The PD workshop was offered in a mixed format, including both synchronous and asynchronous days. Each week, teachers and researchers met through Zoom. During these meetings, the research team introduced the weekly activities and assignments in the StoryQ AI curriculum. In the Zoom meetings, teachers were assigned to breakout rooms randomly to explore their weekly assignments shortly and discuss their thoughts together. The purpose of these breakout rooms was to help teachers to check the learning activities quickly and discuss their questions with other teachers and researchers. After these Zoom meetings, the teachers completed their weekly assignments by themselves. During the asynchronous days, the research team supported the teachers through office hours and Slack. The teachers were encouraged to use the office hours and the Slack channel to ask their questions or share their concerns to complete the assignments. Each asynchronous week was followed by a synchronous Zoom meeting to discuss their completed assignments, give feedback, and learn about upcoming weekly assignments. In this curricular PD workshop, teachers were positioned in different roles, including co-designers, content experts, and learners. Throughout the workshop, they completed eight different AI learning activities, explored AI and ML concepts, and shared their insights. In Phase One, multiple sources of data were collected to address the research questions, including pre-and post-survey, semi-structured interviews, mini-lesson artifacts, video and audio recordings of synchronous sessions, asynchronous online interactions, field notes, and curriculum activity reports.

After the PD workshop, two teachers (Heloise and Marsha) decided to implement the StoryQ AI curriculum in their classrooms. Phase Two investigated their classroom implementation experiences. In this phase, two research questions were explored: (1) What challenges and opportunities do high school ELA teachers identify after they implement AI curricula in their classrooms? and (2) What recommendations do ELA teachers offer to their ELA colleagues for implementing AI curricula in their classrooms? Heloise integrated the curriculum into her Journalism classroom for three weeks. She recorded each classroom implementation with a camera and sent the recording to the research team. The research team supported her classroom implementation through Slack and office hours. When she had questions or issues, she was encouraged to meet with the research team. Marsha integrated the curriculum into her ESOL classroom for 10 days. In each class period, the research team connected to her classroom through Zoom to observe the classroom implementation and answer the questions when needed. To answer the research questions in this phase, multiple sources of data were collected, including video and audio recordings of the class periods, semi-structured interviews, self-reflections after each day, and field notes. This chapter demonstrates the summaries and discussions of each research question, implications of the findings, limitations, future directions, and conclusion.

Summary and Discussion of Research Question One

This section discusses the findings about the teachers' level of confidence in integrating AI into their classrooms before and after participating in a curricular professional development program. The teachers' level of confidence was examined in three categories: completing AI training, presenting and explaining AI topics to their students, and facilitating and supporting students around AI concepts. The analyses of the survey responses revealed that the teachers' confidence in completing AI training did not change significantly after the PD workshop. Teachers started the PD workshop with a high level of confidence in completing AI training (i.e., the mean of the pre-survey responses was 4.12). Since these teachers were motivated to learn about AI concepts and complete curricular training related to AI, the PD might not affect their attitudes and confidence in this manner. After the PD, they might keep a similar attitude toward completing AI training. For this reason, this might not create a significant change in their level of confidence in completing AI training.

Additionally, teachers' level of confidence in presenting and explaining AI topics to their students was examined before and after the PD workshop. The analysis showed that the teachers' level of confidence in presenting and explaining AI topics increased significantly after they completed the PD workshop. To gain a more nuanced understanding of their confidence in presenting and explaining AI topics, I investigated the topics that teachers felt confident in teaching. The analyses indicated that the teachers were most confident in teaching introductory-level of AI topics such as the definition of AI, the impact of AI, and the definition of ML. On the other hand, teachers felt less confident in teaching advanced ML topics like extracting and evaluating features. To gain a deep understanding, I analyzed the teachers' reflections on these advanced ML activities. This analysis revealed that teachers had usability challenges to complete the advanced ML activities. Also, some of the teachers indicated that they needed more training and background knowledge to feel more confident in teaching these advanced ML topics. Furthermore, teachers' mini-lesson artifacts were also analyzed to gain a deep understanding of their teaching perspectives during the PD workshop. The content analysis of the mini-lesson artifacts demonstrated that teachers' mini-lessons were a reflection on their confidence in teaching AI concepts. Teachers' choices of mini-lesson activities and their decisions to design and develop lessons might help them to develop confidence in presenting advanced ML topics.

Lastly, teachers' confidence in facilitating and supporting their students' learning around AI was examined. The analysis of the teachers' survey responses reported that teachers' level of confidence in facilitating and supporting students increased significantly after the PD workshop. The teachers started the PD workshop with either no confidence or slightly confident in facilitating and supporting students. Some of the teachers shared their prior experiences in integrating CS concepts into their classrooms before the workshop. Because of their earlier experiences, these teachers might feel slightly confident in facilitating and supporting their students' learning around AI. After the workshop, six out of eight teachers stayed or became confident in facilitating and supporting their students' learning around AI. To have a better understanding about the teachers, their responses to the learning activities were examined. The analyses of their responses revealed the learning challenges that the teachers encountered while completing the activities. Their learning challenges might affect their level of confidence in facilitating and supporting their students. Since they felt overwhelmed and did not feel understand the concepts, they might think that they cannot facilitate and support their students' learning.

The findings of research question one emphasized teachers' level of confidence before and after the PD workshop. In the Social Cognitive Theory (SCT), an individual's belief in his/her ability to succeed in a specific task is accepted as one of the core components. Bandura (1978) highlights the importance of examining individuals' self-efficacy to understand their behaviors. Similarly, many scholars (e.g., Ether & Ottenbreit-Leftwich, 2010; Ghavifekr & Rosdy, 2015) advocate the significance of teachers' self-efficacy in the integration of technology-enhanced curriculum into the classrooms. These scholars explained that even though teachers carry positive beliefs about the effectiveness of the integration, they might not be willing to integrate such curricula into their classrooms due to a lack of confidence. Therefore, it was critical to examine the teachers' level of confidence to foster the integration of AI curriculum into K-12 classrooms. On the other side, Trygstad (2013) highlighted that incorporating CS concepts into non-STEM classes can be a challenging experience for educators who do not have experience or training in the field of Computer Science (CS). By drawing upon the SCT framework, Bandura (1978) suggests that individuals' behaviors and decisions are shaped by their cognitive and social environment. In the context of teacher education, SCT advocates that teachers' beliefs on their own abilities can affect their instructional practices. In other words, teachers' confidence can play a critical role in their classroom practices. Several studies in the CS education literature examined the teachers' confidence in integrating CS into their teaching practices. As an example, Rahayu and Osman (2019) explored the pre-service teachers' self-efficacy and knowledge on the CT skills. Their study demonstrated that teacher candidates needed professional training to develop an understanding of CT skills and become confident in teaching CT concepts. From the SCT perspective, this study revealed that teachers' trainings are critical to develop confidence in integrating CS concepts into their classrooms. Also, this study highlighted the importance of teachers' confidence in their instructional practices.

Indeed, many scholars (e.g., Cabrera, 2019; Ray et al., 2019) revealed the importance of providing adequate training for teachers to support their curriculum integration experiences. Therefore, many scholars organized professional development workshops related to coding or programming to support teachers' knowledge and confidence in teaching these concepts in their classrooms. As an example, Ray et al. (2019) found that non-STEM teachers became more confident in teaching coding in their classrooms after they participated in the training. Similarly, Love et al. (2022) examined the changes in teachers' beliefs in the context of integrating CT to teach literacy and math concepts. Their study demonstrated that after teachers received four hours of professional development workshop related to how to use The Sphero Indi robot to support their students' CT abilities, their CT self-efficacy and teaching efficacy increased significantly. Furthermore, Lee and Perret (2022) revealed that high school teachers' AI knowledge and skills significantly increased after they participated in a PD workshop to learn about how to integrate AI methods into STEM classrooms. Overall, these studies demonstrated how PD workshops related to AI and CS concepts supported teachers' technology knowledge and helped them to gain confidence in teaching CS/AI concepts in their classrooms. The findings of research question one reflected similar findings in the literature by demonstrating how an AI PD workshop supported high school teachers' confidence in integrating AI into their classrooms. Furthermore, this research also demonstrated what contributed to increases in teachers' confidence. The findings revealed that providing flexibility for teachers to design their mini lessons by using the learning activities in the curriculum helped them to develop confidence. Moreover, the PD workshop positioned the teachers as co-designers, content experts, and learners. This design decision in the PD workshop might also be helpful for teachers to feel more comfortable and build upon their confidence. Also, as stated in the TPACK framework, for successful technology integration, teachers need to have adequate technology, pedagogy, and content knowledge. While teachers were working on the AI learning activities, they might develop an understanding of AI. This new knowledge and skills might also contribute to the increase in their confidence. This is also reflected in the many studies in the AI education literature. As an example, Sun et al. (2023) investigated the CS teachers' AI teaching competencies through a TPACK-based professional development approach. This study revealed that after the TPACK-based PD, teachers' AI knowledge, AI teaching skills, and AI teaching self-efficacy increased significantly. This study highlighted the impact of an TPACK-based PD workshop to support CS teachers' AI teaching skills and confidence. The findings of the research question one also revealed that teachers' confidence in teaching and facilitating AI concepts in their classroom increased after they participated in an AI PD workshop. In the workshop, their confidence might be increased as a result of an increase in their AI knowledge and skills. This study did not specifically investigate how the teachers' AI knowledge and skills improved after the PD workshop, but it assumes that their AI knowledge and skills might contribute the increase in their confidence.

Summary and Discussion of Research Question Two

This section discusses the findings about teachers' views of integrating AI into ELA classrooms after participating in a curricular professional development program. The analysis of the teachers' views presented in five categories: relevancy of the topics, classroom implementation, opportunities for my professional development and teaching, perceived opportunities for students, and challenges. When the teachers were thinking of the integration of an AI curriculum into ELA classrooms, they critically analyzed the relevancy of the topics. In other words, their views on the integration relied on how they perceived the connections between the AI curriculum modules and their ELA curriculum. The findings revealed that the teachers did not find Activities Two, Six, and Seven relevant to their classrooms. To gain more understanding of how teachers' perceptions of the relevancy of the topics shaped, I analyzed their learning processes in the curriculum activity reports and during the synchronous meetings. The analyses showed that for Activity two, teachers had difficulties in understanding the concepts of feature, probability, and weight. Their lack of understanding of the concepts might cause how they perceived the relevancy of Activity two in their classrooms. Also, the analyses of the synchronous meetings related to the Activity two demonstrated that the teachers were mostly focused on trial and error to understand how the ML model worked instead of understanding the concepts within the activity. This might also affect their learning process and then their perception of the activity. Like Activity two, the teachers also brought up difficulties in understanding feature engineering and unigram models in Activities six and seven. The difficulties in understanding the concepts might have an impact on their perceptions of the activities.

In addition to the relevancy of the topics, teachers also shared their views on how they would implement the AI curriculum into their classrooms and mentioned their plans. Their classroom implementation ideas were shaped around the challenges they faced or perceived while completing the activities. To address the challenges, teachers wanted to spend more time explaining terminology, making the content simpler, doing more scaffolding and modeling, and letting students work in groups. They believed that through these strategies their students might have better learning experiences. While completing the activities, most of the teachers had difficulties in understanding the concepts. Their learning experiences pushed them to think about how their students might have similar experiences and then find possible solutions. Moreover, as teachers were considering incorporating the AI curriculum into their classrooms, they were pondering the ways in which this could provide opportunities for their professional development and teaching. Teachers perceived these opportunities as keeping themselves up-to-date, acquiring new skills, being leaders in their schools, and effectively communicating with their students.

Furthermore, teachers explained how the integration would be beneficial for their students. They mentioned that integrating AI into their classrooms would be helpful for improving ELA skills, gaining new knowledge and abilities, and seeking careers. Regarding their own learning experiences in the AI curriculum, teachers thought these activities can help their students to practice the ELA skills and gain AI knowledge. Also, they indicated that students could get familiar with new careers and then they could consider these careers for their future. Additionally, when the teachers were thinking of the curriculum, they spoke about the perceived challenges, including content-specific, limitations in their curriculum, use of technology, and perception of the activities. Teachers thought the content of the activities might be overwhelming and challenging for their students. They mentioned that their students might have difficulties in understandings terms and mathematical concepts. Also, teachers talked about the lack of flexibility in their curriculum. Especially, some teachers talked about their Honor English class and how their curriculum was full. Put differently, they mentioned that their existing curriculum was packed and there was not any space to integrate such curricula into their classrooms. Another challenge that they perceived was related to the use of technology. After experiencing the StoryQ technology in the curriculum, teachers thought that the technology was not user-friendly and easy to use. Therefore, they believed this could be challenging for their students. Lastly, some of the teachers discussed the appropriateness of the curriculum for an ELA classroom. These teachers thought that the curriculum would be more appropriate for a math or CS classroom rather than an ELA class. Their perception of the curriculum can be accepted as a challenge in integrating of the curriculum into K-12 ELA classrooms.

The findings of research question two revealed the teachers' views on the integration of the AI curriculum into their classrooms. By drawing upon the SCT perspective, the teachers' views demonstrated their focus on outcome expectancies. Bandura (1978) explains outcome expectancy as an individual's belief or expectation about the results of their behaviors. In this context, teachers questioned what the integration of AI would bring to their lives. After they questioned this, they came up with perceived opportunities for themselves and their students. In the SCT, Bandura (1978) posits that an individual's outcome expectancies might be shaped by their experiences. Experiencing the learning activities throughout the PD might push the teachers to think about how this curriculum might be helpful for their students as well as for their professional development and teaching. Also, teachers brought up their content expertise to the table to discuss the relevancy of the topics, their classroom implementation ideas, and perceived challenges. Their content and pedagogy knowledge might play a significant role in determining the relevancy of the topics. When they were deciding the relevancy, they were considering the learning objectives and teaching goals in their classrooms. Regarding their classrooms, they shared their perceptions of the relevancy of the topics. Furthermore, in the SCT, Bandura (1978) highlights the role of mental processes in learning. Teachers can imagine their students' mental processes when they are working on the activities. In this way, they can predict the learning challenges that they might have while working on the learning activities. Their perceptions of their students' abilities and experiences in the PD workshop might also help them to think about their classroom implementation plans. Many scholars (i.e., Chen et al., 2012; Eley, 2006; Belbase, 2013; Mishra, 2000) put emphasis on how teachers' conceptions affect their teaching practices. The literature demonstrated a correlation between teachers' conceptions and their teaching practices. To understand the teachers' decisions on integrating an AI curriculum into their classroom, their views should be investigated. Their conceptions and views on integration can affect their decisions to implement the curriculum. For this reason, Lin and Brummelen (2021) explored K-12 teachers' views on integrating AI into their classrooms after a two-day co-design workshop. Their findings showed that teachers needed more scaffolding to integrate curriculum, but they perceived different opportunities for their students (e.g., supporting students' argumentation skills) and possible challenges (e.g., being prepared for students' questions) in the integration. The findings of research question two supported the findings in the literature by demonstrating how teachers perceived opportunities for their students as well as possible challenges in classroom implementation. Additionally, Sanusi et al. (2022) explored the high school CS teachers' preconceptions of teaching ML. Their study revealed three main concerns: student's focused (e.g., supporting students' technical knowledge, having knowledge of ML concepts), teacher's focused (e.g., focus on professional development practices, contextualizing teaching resources and materials), and society's focused (e.g., quality education, industry, innovation, and infrastructure, reduced inequality). This study also demonstrated that the CS teachers focused on the outcome expectancies when they were thinking of teaching ML concepts. Also, this study showed that teachers considered the relevancy of teaching ML, pedagogical approaches, and strategies for their classroom implementation. Similarly, Ayanwale et al. (2022) investigated high school teachers' readiness and intention to teach AI in schools. Their study showed that teachers' perceptions of the relevance of teaching AI has an impact on their readiness to teach AI. Both studies demonstrated the impact of the teachers' perceptions on how they perceive the relevancy of teaching AI/ML. The findings of the research question two shared similar findings in terms of the relevancy of the topics, the opportunities for teachers' professional development and their students. The findings also contribute to the literature by providing an understanding of ELA teachers' perceptions of the relevancy of AI learning activities, their classroom implementation plans, and perceived opportunities for their professional development and teaching. Moreover, in terms of the challenges, this study contributed the existing literature by demonstrating how high school ELA teachers perceived the challenges in the integration of AI concepts into their classrooms. Similar findings can be found in the CS education literature. For instance, Bers et al., (2022) investigated teachers' reflections related to integrating CT, robotics, and literacy in first and second grade. Their reflections revealed certain challenges in terms of lack of time to prepare learning materials and flexibility in their curricula. The findings of the research question two similar findings in terms of perceived challenges. Both CS and ELA teachers perceived the lack of flexibility in their curricula as a challenge to integrate CS/AI topics. In addition to curriculum-based challenges, this dissertation further contributed the literature by showing how teachers perceived learning challenges when they were completing the AI activities as learners in the PD workshop.

Summary and Discussion of Research Question Three

This section presents the findings of research question three: what challenges and opportunities high school ELA teachers identified after they implemented AI curricula in their classroom. The analyses of the teachers' classroom implementations revealed three categories:

opportunities, challenges, and changes. Firstly, teachers saw the benefits of integrating AI curriculum into their classrooms as introducing careers to their students, helping students to gain AI knowledge and understanding, supporting their students' critical thinking skills, providing opportunities for their students to practice their language skills, and creating more inclusive education. In terms of knowledge and skills, both teachers highlighted how the curriculum supported their students' AI understanding and knowledge. Also, in the Journalism classroom, Heloise mentioned that her students were able to discuss "AI bias" and "media bias" concepts. She believed these discussions supported her students' critical thinking abilities. In the ESOL classroom, Marsha approached the curriculum from another perspective. She claimed that the curriculum let her students practice their language abilities. She further explained that the curriculum supported her students' reading, writing, and listening abilities. For the ESOL class, Marsha also brought up providing an inclusive education for her students. In general, she highlighted the importance of providing accessible CS education for ESOL students. She thought many students could not have access to learn about CS concepts due to language barriers. Thus, she perceived integrating AI into her classroom as an opportunity for her students to access AI education.

Additionally, teachers encountered specific difficulties when they were implementing the curriculum. The teachers mostly identified challenges related to classroom management, technology issues, time constraints, explanations of the terms, and understanding of the concepts in the StoryQ technology. Regarding the opportunities and challenges, teachers described the changes that they did during the classroom implementation. The analyses of the teachers' interviews revealed that teachers' PD experiences helped them to plan their classroom implementations. Especially, Heloise described how she was thinking to implement the curriculum while completing the activities as learning during the PD workshop. This process helped her to think the possible challenges for her students and plan her classroom implementation accordingly. In terms of changes, Heloise skipped one of the activities as a major change. She did not find the activity relevant to her classroom. Therefore, she decided to skip the activity. In addition to this, she made minor changes such as changing the order of the activities and adding more contextual discussions. Heloise considered her students' challenges and decided to make changes to support her students' understanding. Similar to Heloise, Marsha also followed minor changes to enhance her students' learning experiences. The biggest difference between the two classroom implementations was how the teachers preferred to deliver the curriculum. Marsha mostly relied on whole group discussions while Heloise included both independent and whole group work. Even though the curriculum was designed to support students' independent work, Marsha did not want her students to work by themselves. In her interview, she reflected on how she perceived her students' abilities to complete the task. She believed that her students would need more scaffolding and modeling because of their language abilities. She also admitted that she had low expectations from her students. This impacted her decisions during the classroom implementation.

The findings of research question three demonstrated the opportunities, challenges, and changes in the teachers' classroom implementations. From the SCT perspective, these findings showed that teachers' past experiences, beliefs, and values shaped their teaching practices. When the teachers were sharing their thoughts related to the opportunities, they considered their values and teaching goals in their classrooms. Regarding this, they perceived the opportunities in terms of how the curriculum supported their students' learning in the context of English Language Arts. Additionally, as Bandura (1978) described the importance of an individual's past experiences in determining his/her behavior. In the context of the teachers' classroom implementation, the findings demonstrated that the teachers' PD experiences shaped their classroom implementations. Through their prior experiences in the curriculum, they imagined their classroom implementations and planned their instructions. Besides, teachers' beliefs about their students contributed to their decisions on how to deliver the content. Furthermore, from the TPACK perspective, teachers employed their expertise to identify the challenges that their students had in completing the learning activities. When teachers were reflecting on the technological challenges, they brought up their technology knowledge to identify these challenges and address them during the curriculum implementation. Also, teachers used their pedagogical content knowledge to address issues in classroom management and support their students' conceptual understanding by creating presentations to introduce the terms and concepts in the curriculum. On the other hand, teachers' classroom implementations were slightly different than the mini lessons that they designed in the PD workshop. Teachers did not apply their mini-lessons to their classroom implementation. This might be related to their students' performance during classroom implementation. In the PD workshop, Heloise created a lesson plan to introduce the ML model errors as an unplugged learning activity. During the classroom implementation, she might not think that a lesson plan would be essential for her students. While she was covering the same concepts in her mini lesson, she preferred to go over the concepts as a whole group and explain how her students need to approach the data and read the graphs. This might also be related to time issues. Teachers might think that creating new lesson activities would take a significant time to prepare and deliver. For these reasons, they might not be willing to create their own activities as they did in the PD workshop.

Additionally, the findings of research three echoed the earlier studies in the literature. Many scholars (i.e., Bauch, 1984; Raths, 2001; Vartuli, 2005; Anders & Evans, 2019) highlighted the roles of teachers' conceptions and values in their teaching practices. In this study, I demonstrated how teachers' beliefs and values shaped their integration of the AI curriculum into their classrooms. Also, the scholars (i.e., Beane, 1995; Tomar & Garg, 2020) advocated curriculum integration as a way of providing more accessible and equal education for marginalized students. The ESOL teacher perceived her students as a marginalized group and integrating the AI curriculum into her classroom as an opportunity to provide accessible education for her students. The findings of this study supported the idea of providing accessible education through curriculum integration in K-12 classrooms. The findings also demonstrated the teachers' perceptions of a social and cultural perspective of teaching AI. For instance, Lindner and Romeike (2019), conducted a survey study to explore high school teachers' perspectives of AI. They surveyed thirty-seven Computer Science teachers to explore their views. Their findings revealed that many teachers supported the idea of the integration of AI into the CS curriculum by providing diverse learning goals that include teaching social-cultural and technical aspects of AI. In this study, teachers perceived the opportunities with diverse learning goals. The Journalism classroom implementation showed that students had a chance to discuss media bias and AI bias while working on the AI learning activities. This illustrated that the curriculum integration not only supported students' diverse learnings but also helped them to gain critical thinking abilities. Also, this finding echoed in the Forsyth et al. (2021) study by demonstrating how AI curricula can foster students' understanding of bias. Similarly, Yau et al. (2022) explored secondary school CS teachers' conceptions of AI at Hong Kong after they implemented an AI curriculum. Their study illustrated that integrating AI raised their students' awareness about the AI technologies and developments, increased students' AI knowledge and skills, increased their interests to pursue an AI-empowered career, and built an understanding of AI ethics. The findings of the research question three have similarities with Yau et al. (2022)'s study. Even though the contexts of the studies were different than each other, the findings showed that both high school ELA teachers in the USA and secondary school CS teachers at Hong Kong perceived similar opportunities in integration of AI. Additionally, the findings of research question three contributed to the literature by providing new insights into the ELA teachers' classroom implementation experiences and what kinds of changes they followed to address challenges.

Summary and Discussion of Research Question Four

This section discusses the findings of research question four: what recommendations ELA teachers offered to their ELA colleagues for implementing AI curricula in their classrooms. The analysis of research question four demonstrated the teachers' intentions to implement the curriculum again and their recommendations for their colleagues. In terms of intentions, both teachers were willing to implement the curriculum again. For their future implementations, teachers brought up what kind of changes they would like to do. The Journalism classroom teacher argued the number of questions that were asked to students to complete in the curriculum. For the next iteration, she wanted to cut the number of questions and create a more condense curriculum for her students. In terms of the class choice, she wanted to implement this curriculum into her Journalism class again rather than implementing it in the Honors English class. She explained her reasons for the flexibility in the curriculum. She mentioned that the curriculum in Honors English does not have enough space to integrate the AI curriculum. Thus, she wanted to implement the curriculum again in the Journalism classroom. On the other side, the ESOL teachers believed the AI curriculum can be a standalone course instead of integrating into a class for 10 days. She thought that students could develop a deep understanding of AI if this curriculum was taught as a semester-long course. She was concerned about not having enough time for teaching AI with details. Therefore, she wished to offer this curriculum as a standalone course. Also, she shared her opinions on integrating this curriculum into a regular English Language Arts classroom. She believed the possibility of integrating the curriculum into a general ELA class. She talked about the CS week at their school. In this week, she said the school administration encouraged the teachers to discuss CS concepts in their domains. She believed that CS week would be fit to integrate the AI curriculum into a general ELA classroom for one or two days a week.

Additionally, teachers talked about their recommendations to other teachers if they would like to integrate the AI curriculum into their classrooms. The Journalism classroom teacher shared her ideas related to why she decided to implement the curriculum in her classroom. She wanted to try something new and out of her comfort zone. As an educator, she talked about how teachers create a comfort zone for themselves after teaching the same course over and over. She expressed her feelings when she was thinking of integrating an AI curriculum into her classroom. She recommended to her colleagues get out of their comfort zone and try new activities for themselves and for their students. On the other side, the ESOL teacher was motivated to incorporate the AI curriculum for a different reason. During the interview, she shared her past experiences related to offering an after-school program for middle school students. She also talked about her strong beliefs in supporting underrepresented groups, such as girls and ESOL students, to access a CS education. Her primary motivation for integrating the AI curriculum into her classroom was to provide inclusive and accessible CS education to her ESOL students. She suggested to other teachers integrate the AI curriculum into their classrooms to provide an accessible CS education. Furthermore, she explained that integrating the curriculum did not require any CS background information. She mentioned that her colleagues who have no CS background could integrate the curriculum into their classrooms to support their students' future and help them to become "good problem solvers".

The findings of research question four revealed the teachers' future plans to implement the AI curriculum and their recommendations for their colleagues. From the SCT perspective, the findings demonstrated that teachers' classroom implementation experiences affected their intentions to repeat the implementation. After teaching the curriculum for the first time, their self-efficacy might be increased, and this might also impact their decisions. Besides, from the TPACK perspective, after the classroom implementation, teachers' TPACK might be improved. Put differently, teachers' comprehension of AI concepts, as well as their ability to relate AI to their respective fields, teach these concepts effectively, and assist their students in developing their AI knowledge and skills, may improve once they experienced implementing the curriculum. As discussed in the literature, teachers' training, experiences, and preparedness play a critical role in the success and sustainability of integrating AI into K-12 classrooms (Lee et al., 2022). Many scholars demonstrated that after teachers received training related to AI, their knowledge and understanding of AI improved. For instance, Vazhayil and his colleagues (2019) organized an AI professional development workshop for Computer Science teachers for two days. Their study revealed that after teachers received PD training, they became knowledgeable about AI concepts and motivated to integrate these concepts into their classrooms. The findings of this dissertation reflected similar results in the literature. After the teachers received an AI PD training and implemented the curriculum, they started to think about what kinds of changes they would make for the next iterations. This means that teachers felt comfortable teaching AI concepts and developed ownership of the curriculum. Their beliefs in their abilities to make changes in the curriculum and implement again might reflect their AI knowledge and understanding. The findings of this research also contributed to the literature by demonstrating the teachers' motivation to integrate an AI curriculum into their classrooms.

Limitations

While this dissertation has provided significant contributions to the AI education literature, there are several limitations that need to be acknowledged in order to understand its implications. For Phase one, this dissertation examined the ELA teachers' experiences in the context of a one-month AI PD workshop. The participants of the workshop voluntarily attended from different schools and completed the activities. Since they were motivated to learn about AI, their perspectives might not reflect all populations. Additionally, Phase One reflected the findings from eight ELA teachers. Therefore, it is difficult to generalize the findings due to the small sample. In other words, the findings of Phase One might not reflect all ELA teachers' experiences in the integration of an AI curriculum into their classrooms. Also, since the number of participants was limited, findings cannot differentiate whether PD helped teachers to increase their confidence in integrating AI concepts into their classrooms or whether teachers' personal characteristics demonstrated a positive impact at the end of the PD. Future studies might target larger sample sizes to specifically examine the impact of PD designs on teachers' level of confidence in integrating AI concepts in their existing curricula as well as the impact of teachers' personal characteristics on their decision-making process in the context of integrating AI concepts into their classrooms. Besides, the findings cannot be applied to other contexts or settings. Furthermore, in the Quantitative part, a non-parametric test was employed. As a nature of non-parametric tests, the findings can be less powerful than a parametric test. Yet, since the sample size was not appropriate for a parametric test, a non-parametric test had been employed.

Moreover, the findings in Phase Two represented the two ELA teachers' classroom implementation experiences. Two out of eight teachers decided to implement the curriculum. In the context of classroom implementation, there are some limitations related to the data collection. In the Journalism classroom implementation, the teacher recorded each class and her interactions with her students. In the ESOL classroom implementation, I connected to the class through Zoom to observe the teacher's implementation. This might cause social desirability bias (Nederhof, 1985). During this data collection, the teachers and students might not feel comfortable sharing their sensitive thoughts or they might only reflect desirable outcomes. This might affect the interpretation of their experiences. Like Phase One, the findings of Phase Two cannot be generalizable since the curriculum was implemented in one ESOL and one Journalism classroom for a limited period.

Implications

The findings of this research have practical implications for curriculum developers, ELA teachers, and suggestions for educational researchers in the field of AI education. Earlier studies demonstrated the importance of integrating AI/ML concepts into K-12 classrooms to support students' future career paths (Zhang et al., 2022), increase awareness (Yau et al., 2022), and promote an understanding of AI ethics (Forsyth et al., 2021). At the same time, many studies revealed the challenges to integrate CS/AI curricula into existing curricula in the K-12 (e.g., Trygstad, 2013). For example, Cabrera (2019) found that integrating CS concepts into an existing K-12 curriculum can be a challenging experience for teachers without providing an adequate training and resources. This dissertation also reported what kind of challenges ELA teachers perceived and faced in the integration of an AI curriculum. The learned lessons can help curriculum developers who consider the develop similar curricula for K-12 students. Especially, teachers' perceptions of the relevancy of the AI learning modules provide insights for curriculum developers. Many scholars (e.g., Sanusi et al., 2022; Ayanwale et al., 2022) demonstrated the importance of teachers' perceptions on the relevancy of teaching AI/ML. This dissertation also revealed how ELA teachers assess the relevancy of each AI learning activity when they were thinking to integrate into their classrooms. Curriculum developer might think about ways to show the relevance of the activities in the context of an ELA class. They specifically work with ELA teachers while designing the curriculum activities to understand their beliefs and perceptions. This design method can help ELA teachers to perceive the relevancy of the AI learning activities effectively. Additionally, this research revealed how some of the ELA teachers perceived the AI curriculum as a part of a CS or math classroom. These kinds of perceptions might cause barriers to enhancing AI education in non-STEM classrooms. Curriculum developers can conduct participatory co-design workshops with non-STEM teachers to develop instructional methods to address teachers' concerns. Furthermore, this study provided an understanding related to teachers' approaches to teaching an AI curriculum. While teachers were designing their mini-lessons or implementing the curriculum, they came up with new ideas to support their students' learning experiences. Their insights into the curriculum can provide a roadmap for curriculum developers to understand teachers' values and find ways to address these values in their curriculum development process. This research also demonstrated the difficulties that students had during classroom implementation. As demonstrated in the previous research (e.g., Varma et al., 2008; Zalavra & Makri, 2022), technological challenges one of the main challenges during the technology-enhanced curriculum implementations. This dissertation demonstrated what kind of technological challenges K-12 teachers and students faced while completing the AI learning activities. Future curriculum designs can consider addressing these technology challenges. They can consider computer performance and screen size issues to provide effective usability experiences.

This dissertation provides implications for the educational researchers. This study demonstrated a mixed-method approach to investigate ELA teachers' confidence and views in the integration of an AI curriculum into their classroom. The findings of this study can inform educational researchers in terms of how ELA teachers develop the confidence to integrate AI concepts into their classrooms and what kind of approaches they followed during their classroom implementation. As stated in the previous studies in the CS education literature (e.g., Love et al., 2022) PD trainings help teachers to gain positive attitudes and confidence in the integration of CS concepts into their classrooms. Also, many scholars (e.g., Leonard et al., 2018; Ray et al., 2020) highlighted the importance of providing scaffolding opportunities for teachers to practice CS concepts firsthand before integrating these concepts into their classrooms. As an example, Leonard et al., (2018) found that exposing teachers to coding and robotics increased their self-efficacy and conceptual knowledge. This dissertation demonstrated an PD approach to help ELA teachers to experience AI learning activities as a learner. As they experienced the activities by themselves, teachers developed a conceptual understanding and demonstrated change in their level of confidence in teaching AI concepts in their classrooms. This would inform the educational researchers in terms of supporting non-STEM teachers' AI understanding and AI-efficacy to teach the concept through a PD workshop. Moreover, this study revealed that even though ELA teachers perceived opportunities to integrate AI topics into their classrooms, they were mostly considering elective courses instead of regular ELA classrooms because of a lack of flexibility in curricula. Many studies (e.g., Bers et al., 2022) illustrated similar findings in terms of integrating CS/AI concepts into their classrooms. Educational researchers can conduct more research to find effective ways of integrating AI concepts into these kinds of courses. Instead of 8 hours-long curriculum, educational researcher can explore teachers' perceptions on integrating AI concepts for a shorter time. This would help to change teachers' perceptions related to integrating AI concepts and might also increase the AI education in K-12. Furthermore, educational researchers can conduct additional research to provide a deep understanding of non-STEM teachers' concerns related to integrating AI concepts into core K-12 courses. Moreover, this study showed that after the PD and classroom implementation, teachers emphasized that bringing discussions around AI ethics would be beneficial for their students' critical thinking. Future research can focus on how to integrate AI ethics topics into existing curricula at the K-12 level. Educational researchers can examine high school teachers' perspectives on teaching AI ethics in their classrooms. Teachers can practice AI ethics learning activities before implementing them in their classrooms. In this way, they can provide insights related to learning activities. After practicing the activities, they can decide to implement learning activities and share their views on the practical impacts of teaching AI ethics in their classrooms. Also, this study demonstrated that how some teachers perceived the AI curriculum as a part of a CS or Math classroom. The researchers can investigate the reasons related to why non-STEM teachers perceive such curricula as a part of a CS or Math classroom rather than an ELA classroom. Their perceptions might affect their classroom implementations. Future research should focus on investigate teachers' perceptions on AI education from different disciplines.

Lastly, this dissertation offers practical implications for ELA teachers to integrate AI concepts into their classrooms. This study revealed ELA teachers' classroom implementation experiences and recommendations for other teachers. As Journalism and ESOL teachers recommended, other ELA teachers can look for ways to integrate AI concepts into their classrooms. These teachers were informed about current AI technologies and how these developments impact their students. Other teachers can investigate the impacts of AI for their students' future. They can also look for educational technologies to support their students' ELA skills and AI understanding. The StoryQ technology and curriculum demonstrated promising outcomes to support K-12 students (e.g., Jiang et al., 2022). Similarly, many studies (e.g., Dash & Kuddus, 2020; Mnasri & Habbash, 2021) demonstrated new educational approaches and technologies to support learners' English literature. ELA teachers can search for effective tools and technologies to bring AI-empowered learning opportunities for their students. For example, Mnasri and Habbash (2021) investigated how people can improve their English accent through a hybrid AI method. ESOL teachers can bring these technologies to support their students' English accent as a learning activity.

Conclusion

The purpose of this research was to investigate ELA teachers' level of confidence and views in the integration of an AI curriculum into their classrooms. The ubiquity of AI in our lives brought the necessity of AI education at the K-12 level. For this reason, many efforts have been established to develop policies and strategic plans to foster AI education in K-12 schools (Rodríguez-García et al., 2021; Pedró, 2019; Touretzky et al., 2019). Despite the efforts, AI education predominantly takes a place in STEM classrooms, particularly in CS classrooms (Wong et al., 2020; Nadi et al., 2022). This causes unequal access to AI education. To address this issue, teachers' perceptions and views should be investigated. Yet, the current literature is limited to providing insights about non-STEM teachers' level of confidence and how they perceive the integration of AI into their classrooms. This study provided significant insights into ELA teachers' level of confidence before and after they participated in a curricular professional development workshop. Many scholars (e.g., Koehler & Mishra, 2006) highlighted the importance of receiving an adequate training for teachers to integrate technology. This study demonstrated how teachers perceived integrating AI concepts after they participated in a one-month curriculum professional development. The findings of this study emphasized how teachers' level of confidence in integrating AI concepts into their classrooms changed before and after they received PD training. In the teacher education literature, this study provides an understanding of designing and developing a curriculum professional development to support non-STEM teachers' integration of AI concepts into their existing curriculum. Also, this study contributes to the AI education literature by demonstrating how teachers perceived the integration of AI concepts into their classrooms after they experienced the curriculum activities as learners. Current teacher education literature, specifically in the context of AI education is limited to explaining how professional development workshops support non-STEM teachers' readiness for teaching AI concepts in their classrooms. Overall, this study aims to fill the gaps in the literature in terms of providing insights related to an AI curriculum professional development workshop and ELA teachers' perspectives in integrating AI concepts into their classrooms.

Moreover, this study explored teachers' perspectives and experiences on the integration of an AI curriculum into their classrooms. Put differently, this study examined two high school ELA teachers' classroom implementation experiences. After the PD workshop, two teachers implemented the AI curriculum in their classrooms. The findings of this study provided a deep understanding related to perceived opportunities, challenges, and suggestions after teachers integrated AI concepts into their classrooms. In the AI education literature, scholars mostly focus on teachers' pre-conceptions of AI (e.g., Sanusi et al., 2022) or K-12 students' understandings of AI and ML (e.g., Forsyth et al., 2021). Current literature is limited to providing empirical insights about teachers' perspectives on teaching AI concepts in their classrooms (Lindner & Romeike, 2019). The findings of this study contribute to the AI education literature by providing an understanding related to ELA teachers' classroom implementation experiences after they received an AI curriculum training.

The findings of this study provided implications for curriculum developers who are interested in developing AI curricula and for educational researchers who conduct research on exploring non-STEM teachers' views on the integrating AI concepts into their classrooms. This study has specific limitations in terms of the generalization of the findings. Thus, future studies should be considering these limitations in their research design. Future studies can explore how teachers from different domains, particularly from different non-STEM disciplines perceive the integration of an AI curriculum into their classrooms.

REFERENCES

Alexander, B., Adams, S., & Cummins, M. (2016). *Digital literacy: An NMC Horizon project strategic brief* (pp. 1-16). The New Media Consortium. Retrieved from https://www.learntechlib.org/p/182085/

Alloghani, M., Al-Jumeily, D., Mustafina, J., Hussain, A., & Aljaaf, A. J. (2020). A systematic review on supervised and unsupervised machine learning algorithms for data science. *Supervised and unsupervised learning for data science,* 3-21.

Alzubi, J., Nayyar, A., & Kumar, A. (2018, November). Machine learning from theory to algorithms: an overview. In *Journal of physics: conference series* (Vol. 1142, No. 1, p. 012012). IOP Publishing.

Anders, P. L., & Evans, K. S. (2019). Relationship between teachers' beliefs and their instructional practice in reading. In *Beliefs about text and instruction with text* (pp. 137-153). Routledge.

Anderson, J., Rainie, L., & Luchsinger, A. (2018). Artificial intelligence and the future of humans. *Pew Research Center*, *10*. Retrieved from https://www.pewresearch.org/internet/2018/12/10/artificial-intelligence-and-the-future-of-humans/

Ashri, R. (2019). *The AI-Powered Workplace: How Artificial Intelligence, Data, and Messaging Platforms Are Defining the Future of Work*. Apress.

Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers and Education: Artificial Intelligence, 3,* 100099. https://doi.org/10.1016/j.caeai.2022.100099

Ayodele, T. O. (2010). Types of machine learning algorithms. *New advances in machine learning*, *3*, 19-48.

Bandura, A. (1961). Psychotherapy as a learning process. *Psychological Bulletin, 58*(2), 143. https://doi.org/10.1037/h0040672

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review*, *84*(2), 191. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1978). Reflections on self-efficacy. *Advances in behaviour research and therapy*, *1*(4), 237-269. https://doi.org/10.1016/0146-6402(78)90012-7

Bandura, A. (1983). Temporal dynamics and decomposition of reciprocal determinism: A reply to Phillips and Orton. *Psychological Review, 90*(2), 166–170. https://doi.org/10.1037/0033-295X.90.2.166

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, N.J.: Prentice-Hall

Bandura, A. (1989). Human agency in social cognitive theory. *American psychologist*, *44*(9), 1175. https://doi.org/10.1037/0003-066X.44.9.1175

Bandura, A. (2000). Self-efficacy: The foundation of agency. *Control of human behavior, mental processes, and consciousness: Essays in honor of the 60th birthday of August Flammer*, *16*.

Bandura, A. (2011). A social cognitive perspective on positive psychology. *Revista de Psicología Social*, *26*(1), 7-20. https://doi.org/10.1174/021347411794078444

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1). Prentice Hall: Englewood cliffs.

Bauch, P. A. (1984). The impact of teachers' instructional beliefs on their teaching: implications for research and practice. Paper presented at *the annual meeting of the American Educational Research Association*, New Orleans, LA.

Barretto, D., LaChance, J., Burton, E., & Liao, S. N. (2021, June). Exploring Why Underrepresented Students Are Less Likely to Study Machine Learning and Artificial Intelligence. In *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1* (pp. 457-463). https://doi.org/10.1145/3430665.3456332

Beane, J. A. (1995). Curriculum integration and the disciplines of knowledge. *The Phi Delta Kappan*, *76*(8), 616-622. Retrieved from https://www.jstor.org/stable/20405413

Belbase, S. (2013). Images, anxieties, and attitudes towards mathematics. *International Journal of Education in Mathematics, Science, and Technology, 1*(4). 230-237.

Bers, M. U., Govind, M., & Relkin, E. (2022). Coding as another language: computational thinking, robotics and literacy in first and second grade. In *Computational thinking in prek-5: empirical evidence for integration and future directions* (pp. 30-38). https://doi.org/10.1145/3507951.3519285

Berson, M. J., & Balyta, P. (2004). Technological thinking and practice in the social studies: Transcending the tumultuous adolescence of reform. *Journal of Computing in Teacher Education*, *20*(4), 141-150.

Bini, S. A. (2018). Artificial intelligence, machine learning, deep learning, and cognitive computing: what do these terms mean and how will they impact health care?. *The Journal of arthroplasty, 33*(8), 2358-2361.https://doi.org/10.1016/j.arth.2018.02.067

Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational psychologist*, *35*(3), 149-164. https://doi.org/10.1207/S15326985EP3503_2

Borg, S. (2017). Teachers' beliefs and classroom practices. In *The Routledge handbook of language awareness* (pp. 75-91). Routledge.

Boulden, D. M. C. (2020). *Building the capacity of in-service teachers to integrate and teach computational thinking*. North Carolina State University.

Cabrera, L. (2019). Teacher preconceptions of computational thinking: A systematic literature review. *Journal of Technology and Teacher Education*, *27*(3), 305-333. Retrieved from https://www.learntechlib.org/primary/p/210234/

Cantú-Ortiz, F. J., Galeano Sánchez, N., Garrido, L., Terashima-Marin, H., & Brena, R. F. (2020). An artificial intelligence educational strategy for the digital transformation. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *14*(4), 1195-1209. https://doi.org/10.1007/s12008-020-00702-8

Cetindamar, D., Kitto, K., Wu, M., Zhang, Y., Abedin, B., & Knight, S. (2022). Explicating AI literacy of employees at digital workplaces. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2021.3138503

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, *1*, 100002. https://doi.org/10.1016/j.caeai.2020.100002

Chui, M. (2017). Artificial intelligence the next digital frontier. *McKinsey and Company Global Institute*, *47*(3.6).

Code.org. (2021, November 3). *2021 state of CS Report shows half of U.S. high schools offer CS, but disparities still exist*. Medium. Retrieved August 30, 2022, from https://codeorg.medium.com/2021-state-of-cs-report-shows-half-of-u-s-high-schools-offer-cs-but-disparities-still-exist-890c20a724ad

Computer Science Teachers Association (2017). *CSTA K-12 Computer Science Standards*, Revised 2017. Retrieved from http://www.csteachers.org/standards.

Dash, A., & Kuddus, K. (2020). Leveraging the benefits of ICT usage in teaching of english language and literature. In *Smart Intelligent Computing and Applications: Proceedings of the Third International Conference on Smart Computing and Informatics, Volume 2* (pp. 225-232). Springer Singapore. https://doi.org/10.1007/978-981-32-9690-9_22

Deavours, C. A., & Reeds, J. (1977). The Enigma part I historical perspectives. *Cryptologia*, *1*(4), 381-391. https://doi.org/10.1080/0161-117791833183

Debarger, A. H., Choppin, J., Beauvineau, Y., & Moorthy, S. (2013). Designing for productive adaptations of curriculum interventions. *Teachers College Record*, *115*(14), 298-319. https://doi.org/10.1177/016146811311501407

de Freitas, A. A., & Weingart, T. B. (2021, March). I'm going to learn what?!? teaching artificial intelligence to freshmen in an introductory computer science course. In *Proceedings of the 52nd ACM technical symposium on computer science education* (pp. 198-204). https://doi.org/10.1145/3408877.3432530

Dokuchaev, V. A. (2020, October). Digital Transformation: New Drivers and New Risks. In *2020 International Conference on Engineering Management of Communication and Technology (EMCTECH)* (pp. 1-7). IEEE. https://doi.org/10.1109/EMCTECH49634.2020.9261544

Drake, S. M., & Burns, R. C. (2000). *Integrated curriculum*. Association for Supervision and Curriculum Development.

Druga, S. (2018). *Growing up with AI: Cognimates: from coding to teaching machines* (Doctoral dissertation, Massachusetts Institute of Technology). Retrieved from http://dspace.mit.edu/handle/1721.1/7582

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., … & Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *57*, 101994.

Eguchi, A., Okada, H., & Muto, Y. (2021). Contextualizing AI education for K-12 students to enhance their learning of AI literacy through culturally responsive approaches. *KI-Künstliche Intelligenz*, *35*(2), 153-161. https://doi.org/10.1007/s13218-021-00737-3

Eley, M. G. (2006). Teachers' conceptions of teaching, and the making of specific decisions in planning to teach. *Higher education*, *51*(2), 191-214. https://doi.org/10.1007/s10734-004-6382-9

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & education*, *59*(2), 423-435. https://doi.org/10.1016/j.compedu.2012.02.001

Everson, J., Kivuva, F. M., & Ko, A. J. (2022, February). " A Key to Reducing Inequities in Like, AI, is by Reducing Inequities Everywhere First" Emerging Critical Consciousness in a Co-Constructed Secondary CS Classroom. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 1* (pp. 209-215). https://doi.org/10.1145/3478431.3499395

Ferguson, D. L. (1995). The real challenge of inclusion: Confessions of a'rabid inclusionist'. *Phi delta kappan*, *77*(4), 281.

Forsyth, S., Dalton, B., Foster, E. H., Walsh, B., Smilack, J., & Yeh, T. (2021, May). Imagine a More Ethical AI: Using Stories to Develop Teens' Awareness and Understanding of Artificial Intelligence and its Societal Impacts. In *2021 Conference on Research in Equitable and Sustained Participation in Engineering, Computing, and Technology (RESPECT)* (pp. 1-2). IEEE. https://doi.org/10.1109/RESPECT51740.2021.9620549

Fives, H., & Gill, M. G. (Eds.). (2015). International handbook of research on teachers' beliefs. New York: Routledge, Taylor & Francis.

Fryling, M. J., Johnston, C., & Hayes, L. J. (2011). Understanding observational learning: An interbehavioral approach. *The Analysis of verbal behavior*, *27*, 191-203. https://doi.org/10.1007/BF03393102

Gallup (Firm) & Northeastern University (Boston, Ma.). (2019). Facing the future: US, UK and Canadian citizens call for a unified strategy for the AI age. Retrieved from http://hdl.voced.edu.au/10707/511441

Gardner-McCune, C., Touretzky, D., Martin, F., & Seehorn, D. (2019, February). AI for K-12: Making room for AI in K-12 CS curricula. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (pp. 1244-1244). https://doi.org/10.1145/3287324.3293729

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American educational research journal*, *38*(4), 915-945. https://doi.org/10.3102/00028312038004915

George, A., & Sanders, M. (2017). Evaluating the potential of teacher-designed technology-based tasks for meaningful learning: Identifying needs for professional development. *Education and Information Technologies*, *22*(6), 2871-2895. https://doi.org/10.1007/s10639-017-9609-y

Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International journal of research in education and science*, *1*(2), 175-191.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology, 76*(4), 569–582. https://doi.org/10.1037/0022-0663.76.4.569

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT press.

Google (2018). Teachable Machine. Retrieved from https://teachablemachine.withgoogle.com/v1/

Guven, I., & Gulbahar, Y. (2020). Integrating computational thinking into Social Studies. *The Social Studies*, *111*(5), 234-248. https://doi.org/10.1080/00377996.2020.1749017

Haenlein, M., & Kaplan, A. (2019). A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. *California management review*, *61*(4), 5-14. https://doi.org/10.1177/0008125619864925

Hernández-Orallo, J. (2020, June). AI safety landscape from short-term specific system engineering to long-term artificial general intelligence. In *2020 50th Annual IEEE/IFIP International Conference on Dependable Systems and Networks Workshops (DSN-W)* (pp. 72-73). IEEE. https://doi.org/10.1109/DSN-W50199.2020.00023

Hixon, E., & Buckenmeyer, J. (2009). Revisiting technology integration in schools: Implications for professional development. *Computers in the Schools*, *26*(2), 130-146. https://doi.org/10.1080/07380560902906070

Holzinger, A., Kieseberg, P., Weippl, E., & Tjoa, A. M. (2018, August). Current advances, trends and challenges of machine learning and knowledge extraction: from machine learning to explainable AI. In *International Cross-Domain Conference for Machine Learning and Knowledge Extraction* (pp. 1-8). Springer, Cham. https://doi.org/10.1007/978-3-319-99740-7_1

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. M. (2014). Teacher involvement in curriculum design: Need for support to enhance teachers' design expertise. *Journal of curriculum studies*, *46*(1), 33-57. https://doi.org/10.1080/00220272.2013.834077

Isele, D., Rahimi, R., Cosgun, A., Subramanian, K., & Fujimura, K. (2018, May). Navigating occluded intersections with autonomous vehicles using deep reinforcement learning. In *2018 IEEE International Conference on Robotics and Automation (ICRA)* (pp. 2034-2039). IEEE. https://doi.org/10.1109/ICRA.2018.8461233

Jaiswal, A., & Arun, C. J. (2021). Potential of Artificial Intelligence for Transformation of the Education System in India. *International Journal of Education and Development using Information and Communication Technology*, *17*(1), 142-158.

Jiang, S., Nocera, A., Tatar, C., Yoder, M. M., Chao, J., Wiedemann, K., Finzer, W., & Rosé, C. P. (2022). An empirical analysis of high school students' practices of modelling with unstructured data. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.13253

Johnston, J. R., & Heller, A. B. (1987). Effectiveness of a curriculum for preschool language intervention specialists. *Asha*, *29*(7), 39-43.

Jones, C. (2010). Interdisciplinary approach-advantages, disadvantages, and the future benefits of interdisciplinary studies. *Essai*, *7*(1), 26. Retrieved from http://dc.cod.edu/essai/vol7/iss1/26

Joshi, A. V. (2020). *Machine learning and artificial intelligence*. Springer International Publishing, Berlin. https://doi.org/10.1007/978-3-030-26622-6?

Judd, S. (2020, February). Activities for Building Understanding: How AI4ALL Teaches AI to Diverse High School Students. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education* (pp. 633-634). https://doi.org/10.1145/3328778.3366990

Kahn, K. (1977). Three interactions between AI and education. In E. Elcock, & D. Michie (Eds.), *Machine intelligence 8*: Machine representations of knowledge. Ellis Horwood Ltd. and John Wylie & Sons.

Khandkar, S. H. (2009). Open coding. *University of Calgary*, *23*, 2009.

Kandlhofer, M., Steinbauer, G., Hirschmugl-Gaisch, S., & Huber, P. (2016, October). Artificial intelligence and computer science in education: From kindergarten to university. In *2016 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE. https://doi.org/10.1109/FIE.2016.7757570

Karakoyun, F., & Lindberg, O. J. (2020). Preservice teachers' views about the twenty-first century skills: A qualitative survey study in Turkey and Sweden. *Education and Information Technologies*, *25*(4), 2353-2369. https://doi.org/10.1007/s10639-020-10148-w

Kaspersen, M. H., Bilstrup, K. E. K., & Petersen, M. G. (2021, February). The Machine Learning Machine: A Tangible User Interface for Teaching Machine Learning. In *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction* (pp. 1-12). https://doi.org/10.1145/3430524.3440638

Kim, J., Giroux, M., & Lee, J. C. (2021). When do you trust AI? The effect of number presentation detail on consumer trust and acceptance of AI recommendations. *Psychology & Marketing*, *38*(7), 1140-1155. https://doi.org/10.1002/mar.21498

Kim, J., Lee, H., & Cho, Y. H. (2022). Learning design to support student-AI collaboration: perspectives of leading teachers for AI in education. *Education and Information Technologies*, 1-36. https://doi.org/10.1007/s10639-021-10831-6

Knowles, T., & Brown, D. F. (2000). *What Every Middle School Teacher Should Know*. Heinemann, 88 Post Road West, PO Box 5007, Westport, CT 06881.

Koehler, M. J & Mishra, P. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, 108(6), 1017-1054.

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)?. *Contemporary issues in technology and teacher education*, *9*(1), 60-70. Retrieved from https://www.learntechlib.org/primary/p/29544/

Kubat, U. (2018). The Integration of STEM into Science Classes. *World Journal on Educational Technology: Current Issues, 10*(3), 165-173. Retrieved from https://eric.ed.gov/?id=EJ1185407

Lam, C. C., Alviar-Martin, T., Adler, S. A., & Sim, J. B. Y. (2013). Curriculum integration in Singapore: Teachers' perspectives and practice. *Teaching and Teacher Education*, *31*, 23-34. https://doi.org/10.1016/j.tate.2012.11.004

Lattuca, L. R., & Stark, J. S. (1994). Will disciplinary perspectives impede curricular reform?. *The Journal of Higher Education*, *65*(4), 401-426. https://doi.org/10.1080/00221546.1993.11778508

Lee, D., & Yoon, S. N. (2021). Application of artificial intelligence-based technologies in the healthcare industry: Opportunities and challenges. *International Journal of Environmental Research and Public Health*, *18*(1), 271. https://doi.org/10.3390/ijerph18010271

Lee, I., & Perret, B. (2022). Preparing High School Teachers to Integrate AI Methods into STEM Classrooms. In *Proceedings of the Association for the Advancement of Artificial Intelligence Conference.* https://doi.org/10.1609/aaai.v36i11.21557

Leonard, J., Mitchell, M., Barnes-Johnson, J., Unertl, A., Outka-Hill, J., Robinson, R., & Hester-Croff, C. (2018). Preparing teachers to engage rural students in computational thinking through robotics, game design, and culturally responsive teaching. *Journal of Teacher Education*, *69*(4), 386-407. https://doi.org/10.1177/0022487117732317

Lin, P. Y., Chai, C. S., & Jong, M. S. Y. (2021). A study of disposition, engagement, efficacy, and vitality of teachers in designing science, technology, engineering, and mathematics education. *Frontiers in Psychology*, *12*, 661631.

Lin, P., & Van Brummelen, J. (2021, May). Engaging teachers to Co-design integrated AI curriculum for K-12 classrooms. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-12). https://doi.org/10.1145/3411764.3445377

Lindner, A., & Romeike, R. (2019). Teachers' perspectives on artificial intelligence. In *12th International conference on informatics in schools,"Situation, evaluation and perspectives", ISSEP*.

Lindner, A., & Berges, M. (2020, October). Can you explain AI to me? Teachers' pre-concepts about Artificial Intelligence. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE. https://doi.org/10.1109/FIE44824.2020.9274136

Lindner, F., Mattmüller, R., & Nebel, B. (2020). Evaluation of the moral permissibility of action plans. *Artificial Intelligence*, *287*, 103350. https://doi.org/10.1016/j.artint.2020.103350

Littman, M. L., Ajunwa, I., Berger, G., Boutilier, C., Currie, M., Doshi-Velez, F., Hadfield, G., Horowitz, M. C., Isbell, C., Kitano, H., Levy, K., Lyons, T., Mitchell, M., Shah, J., Sloman, S., Vallor, S., & Walsh, T. (2021, September). *Gathering strength, gathering storms: The one-hundred-year study on Artificial Intelligence (AI100) 2021 Study Panel Report*. Stanford University. Retrieved from http://ai100.stanford.edu/2021-report

Love, T. S., Bartholomew, S. R., & Yauney, J. (2022). Examining changes in teachers' beliefs toward integrating computational thinking to teach literacy and math concepts in grades K-2. *Journal for STEM Education Research*, *5*(3), 380-401. https://doi.org/10.1007/s41979-022-00077-3

Luszczynska, A., & Schwarzer, R. (2015). Social cognitive theory. *Fac Health Sci Publ*, 225-51.

Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*, *90*, 46-60. https://doi.org/10.1016/j.futures.2017.03.006

Manyika, J., Lund, S., Chui, M., Bughin, J., Woetzel, J., Batra, P., Ko, R & Sanghvi, S. (2017). Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages. McKinsey & Company. Retrieved from https://apo.org.au/node/199751

Marques, L. S., Gresse von Wangenheim, C., & Hauck, J. C. (2020). Teaching machine learning in school: A systematic mapping of the state of the art. *Informatics in Education*, *19*(2), 283-321. https://doi.org/10.15388/infedu.2020.14

Marr, B. (2019). *Artificial intelligence in practice: how 50 successful companies used AI and machine learning to solve problems*. John Wiley & Sons.

Mason, T. C. (1996). Integrated curricula: Potential and problems. *Journal of teacher education*, *47*(4), 263-270.

McCarthy, J. (2004). What is artificial intelligence? Retrieved from http://www-formal.stanford.edu/jmc/whatisai/whatisai.html

McCarthy, J. (2007). From here to human-level AI. *Artificial Intelligence*, *171*(18), 1174-1182. https://doi.org/10.1016/j.artint.2007.10.009

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). A proposal for the dartmouth summer research project on artificial intelligence, august 31, 1955. *AI magazine*, *27*(4), 12-12. https://doi.org/10.1609/aimag.v27i4.1904

McGiboney, G. W. (2016). *The psychology of school climate*. Cambridge Scholars Publishing.

McPhail, G. (2018). Curriculum integration in the senior secondary school: A case study in a national assessment context. *Journal of Curriculum Studies*, *50*(1), 56-76. https://doi.org/10.1080/00220272.2017.1386234

Miao, F., & Holmes, W. (2022). *International Forum on AI and Education: Ensuring AI as a Common Good to Transform Education*, 7-8 December; synthesis report. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000381226

Mike, K., & Rosenberg-Kima, R. B. (2021, March). Teaching Machine Learning to Computer Science Preservice Teachers: Human vs. Machine Learning. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 1368-1368). https://doi.org/10.1145/3408877.3439550

Mishra, L. (2020). Conception and misconception in teaching arithmetic at primary level. *Journal of Critical Reviews*, *7*(5), 936-939. http://dx.doi.org/10.31838/jcr.07.05.192?

Mitchell, T. M. (1997). Does machine learning really work?. *AI magazine*, *18*(3), 11-11. https://doi.org/10.1609/aimag.v18i3.1303

Mnasri, S., & Habbash, M. (2021). Study of the influence of Arabic mother tongue on the English language using a hybrid artificial intelligence method. *Interactive Learning Environments*, 1-14. https://doi.org/10.1080/10494820.2021.2012809

Nadi, A. H., Hossain, S. F. A., Safin, M. A., Sofin, M. R., & Akhter, R. (2022). Discovering the Role of Artificial Intelligence in K12: The Future of Online Platforms. In *Designing Effective Distance and Blended Learning Environments in K-12* (pp. 314-326). IGI Global.

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital Innovation Management: Reinventing innovation management research in a digital world. *MIS quarterly, 41*(1).

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. National Academies Press.

Naylor, C. D. (2018). On the prospects for a (deep) learning health care system. *Jama*, *320*(11), 1099-1100. https://doi.org/10.1001/jama.2018.11103.

Nederhof, A. J. (1985). Methods of coping with social desirability bias: A review. European journal of social psychology, 15(3), 263-280. https://doi.org/10.1002/ejsp.2420150303

Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence*, *2*, 100041. https://doi.org/10.1016/j.caeai.2021.100041

Ng, D. T. K., Luo, W., Chan, H. M. Y., & Chu, S. K. W. (2022). Using digital story writing as a pedagogy to develop AI literacy among primary students. *Computers and Education: Artificial Intelligence, 3*, 100054. https://doi.org/10.1016/j.caeai.2022.100054

Nickerson, C. (2022, May 05). *Social Cognitive Theory: How We Learn From the Behavior of Others*. Simply Psychology. www.simplypsychology.org/social-cognitive-theory.html

Oliver, K., & Houchins, J. (2019, June). Preparing Teachers to Capture and Assess Evidence of Computational Thinking. In *EdMedia+ Innovate Learning* (pp. 370-375). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/210029/

Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & education, 55*(3), 1321-1335.

Papert, S., Solomon, C., Soloway, E., & Spohrer, J. C. (1971). Twenty things to do with a computer. *Studying the novice programmer*, 3-28.

Parameswaran, U. D., Ozawa-Kirk, J. L., & Latendresse, G. (2020). To live (code) or to not: A new method for coding in qualitative research. *Qualitative social work, 19*(4), 630-644. https://doi.org/10.1177/1473325019840394

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. SAGE Publications, inc.

Pedró, F., Subosa, M., Rivas, A., & Valverde, P. (2019). *Artificial intelligence in education: Challenges and opportunities for sustainable development.* Paris: UNESCO. Retrieved from http://repositorio.minedu.gob.pe/handle/MINEDU/6533

Rahayu, T., & Osman, K. (2019). Knowledge level and self-confidence on the computational thinking skills among science teacher candidates. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *8*(1), 117-126. https://doi.org/10.24042/jipfalbiruni.v8i1.4450

Raths, J. (2001). Teachers' Beliefs and Teaching Beliefs. *Early Childhood Research and Practice*, 3(1). Retrieved from http://ecrp.uiuc.edu/v3nl/raths.html

Ray, B. B., Rogers, R. R., & Hocutt, M. M. (2020). Perceptions of non-STEM discipline teachers on coding as a teaching and learning tool: What are the possibilities?. *Journal of Digital Learning in Teacher Education*, *36*(1), 19-31. https://doi.org/10.1080/21532974.2019.1646170

Reis, J., Amorim, M., Melão, N., & Matos, P. (2018, March). Digital transformation: a literature review and guidelines for future research. In *World conference on information systems and technologies* (pp. 411-421). Springer, Cham. https://doi.org/10.1007/978-3-319-77703-0_41

Rigg, K. (2022, November 29). *Where are all the women in AI?* Health Tech World. Retrieved March 22, 2023, from https://www.htworld.co.uk/news/where-are-all-the-women-in-ai/#:~:text=The%20vast%20majority%20(78%25),in%20science%20is%20nothing%20new.

Rodríguez-García, J. D., Moreno-León, J., Román-González, M., & Robles, G. (2021, March). Evaluation of an online intervention to teach artificial intelligence with learningml to 10-16-year-old students. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 177-183). https://doi.org/10.1145/3408877.3432393

Roehrig, G. H., Dare, E. A., Ellis, J. A., & Ring-Whalen, E. (2021). Beyond the basics: a detailed conceptual framework of integrated STEM. *Disciplinary and Interdisciplinary Science Education Research*, *3*(1), 1-18. https://doi.org/10.1186/s43031-021-00041-y

Rouhiainen, L. (2018). *Artificial Intelligence: 101 things you must know today about our future*. Lasse Rouhiainen.

Sabuncuoglu, A. (2020, June). Designing one year curriculum to teach artificial intelligence for middle school. In *Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education* (pp. 96-102). https://doi.org/10.1145/3341525.3387364

Sakulkueakulsuk, B., Witoon, S., Ngarmkajornwiwat, P., Pataranutaporn, P., Surareungchai, W., Pataranutaporn, P., & Subsoontorn, P. (2018, December). Kids making AI: Integrating machine learning, gamification, and social context in STEM education. In *2018 IEEE international conference on teaching, assessment, and learning for engineering (TALE)* (pp. 1005-1010). IEEE. https://doi.org/10.1109/TALE.2018.8615249

Sanusi, I. T., Oyelere, S. S., & Omidiora, J. O. (2022). Exploring teachers' preconceptions of teaching machine learning in high school: A preliminary insight from Africa. *Computers and Education Open*, *3*, 100072. https://doi.org/10.1016/j.caeo.2021.100072

Schrum, L. (1999). Technology professional development for teachers. *Educational technology research and development*, *47*(4), 83-90. https://doi.org/10.1007/BF02299599

Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.), *APA educational psychology handbook, Vol. 1. Theories, constructs, and critical issues* (pp. 101–123). American Psychological Association. https://doi.org/10.1037/13273-005

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *International Journal of STEM Education*, *4*(1), 1-16. https://doi.org/10.1186/s40594-017-0068-1

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, 15(2), 4-14.

Siebel, T. M. (2019). *Digital transformation: survive and thrive in an era of mass extinction*. RosettaBooks.

Steinbauer, G., Kandlhofer, M., Chklovski, T., Heintz, F., & Koenig, S. (2021). Education in Artificial Intelligence K-12. *KI-Künstliche Intelligenz*, *35*(2), 127-129. https://doi.org/10.1007/s13218-021-00734-6

Stray, J. (2019). Making artificial intelligence work for investigative journalism. *Digital Journalism*, *7*(8), 1076-1097. https://doi.org/10.1080/21670811.2019.1630289

Strauss, A., & Corbin, J. (1998). Basics of qualitative research techniques (2nd ed.). Newbury Park, CA: Sage.

Sulmont, E., Patitsas, E., & Cooperstock, J. R. (2019, February). Can You Teach Me To Machine Learn?. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (pp. 948-954). https://doi.org/10.1145/3287324.3287392

Sun, J., Ma, H., Zeng, Y., Han, D., & Jin, Y. (2023). Promoting the AI teaching competency of K-12 computer science teachers: A TPACK-based professional development approach. *Education and Information Technologies*, *28*(2), 1509-1533. https://doi.org/10.1007/s10639-022-11256-5

Sutton, R. S. (1992). A special issue of machine learning on reinforcement learning. *Machine learning*, *8*.

Tatar, C., Yoder, M. M., Coven, M., Wiedemann, K., Chao, J., Finzer, W., Jiang, S., & Rosé, C. P. (2021). Modeling Unstructured Data: Teachers as Learners and Designers of Technology-enhanced Artificial Intelligence Curriculum. In *Proceedings of the 15th International Conference of the Learning Sciences-ICLS 2021*. International Society of the Learning Sciences. https://doi.dx.org/10.22318/icls2021.617

Tegmark, M. (2017). *Life 3.0: Being human in the age of artificial intelligence*. Vintage.

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de P., Dehaene, W., Deprez, J., DeCock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van, P., Peter, D., & Depaepe, F. (2018). Integrated STEM education: A systematic review of instructional practices in secondary education. *European Journal of STEM Education*, *3*(1), 2. https://doi.org/10.20897/ejsteme/85525

Tomar, G., & Garg, V. (2020). Making STEAM Accessible for Inclusive Classroom. *Global Journal of Enterprise Information System*, *12*(4).

Torrey, L., Johnson, K., Sondergard, S., Ponce, P., & Desmond, L. (2016, March). The turing test in the classroom. In *Proceedings of the AAAI Conference on Artificial Intelligence* (Vol. 30, No. 1). https://doi.org/10.1609/aaai.v30i1.9853

Touretzky, D., Gardner-McCune, C., Martin, F., & Seehorn, D. (2019, July). Envisioning AI for K-12: What should every child know about AI?. In *Proceedings of the AAAI conference on artificial intelligence* (Vol. 33, No. 01, pp. 9795-9799). https://doi.org/10.1609/aaai.v33i01.33019795

Trygstad, P. J. (2013). 2012 National Survey of Science and Mathematics Education: Status of Elementary School Science. *Horizon Research, Inc.*

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and teacher education*, *17*(7), 783-805.

Turing, A. M. (2012). Computing machinery and intelligence (1950). *The Essential Turing: the Ideas That Gave Birth to the Computer Age*, 433-464.

Van Brummelen, J. (2019). Conversational agents to democratize artificial intelligence. In *2019 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC)* (pp. 239-240). IEEE. https://doi.org/10.1109/VLHCC.2019.8818805

Van Veldhoven, Z., & Vanthienen, J. (2022). Consolidating Academic and Practical Guidelines for Digital Transformation. In *International Conference on Business Information Systems* (pp. 279-290). Springer, Cham. https://doi.org/10.1007/978-3-031-04216-4_25

Vandenberg, J., Rachmatullah, A., Lynch, C., Boyer, K. E., & Wiebe, E. (2021, June). The Relationship of CS Attitudes, Perceptions of Collaboration, and Pair Programming Strategies on Upper Elementary Students' CS Learning. In *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1* (pp. 46-52). https://doi.org/10.1145/3430665.3456347

Varma, K., Husic, F., & Linn, M. C. (2008). Targeted support for using technology-enhanced science inquiry modules. *Journal of Science Education and Technology*, *17,* 341-356. https://doi.org/10.1007/s10956-008-9104-8

Vartuli, S. (2005). Beliefs: The heart of teaching. *YC Young Children*, *60*(5), 76. Retrieved from https://proxying.lib.ncsu.edu/index.php/login?url=https://www.proquest.com/scholarly-journals/beliefs-heart-teaching/docview/197696272/se-2

Vazhayil, A., Shetty, R., Bhavani, R. R., & Akshay, N. (2019, December). Focusing on teacher education to introduce AI in schools: Perspectives and illustrative findings. In *2019 IEEE tenth international conference on Technology for Education (T4E)* (pp. 71-77). IEEE. https://doi.org/10.1109/T4E.2019.00021

Wan, X., Zhou, X., Ye, Z., Mortensen, C. K., & Bai, Z. (2020, June). SmileyCluster: supporting accessible machine learning in K-12 scientific discovery. In *Proceedings of the Interaction Design and Children Conference* (pp. 23-35). https://doi.org/10.1145/3392063.3394440

Wang, P. (2019). On defining artificial intelligence. *Journal of Artificial General Intelligence*, *10*(2), 1-37. https://doi.org/10.2478/jagi-2019-0002

Wallace, S. A., McCartney, R., & Russell, I. (2010). Games and machine learning: a powerful combination in an artificial intelligence course. *Computer Science Education*, *20*(1), 17-36. https://doi.org/10.1080/08993400903525099

Way, T., Cassel, L., Matuszek, P., Papalaskari, M. A., Bonagiri, D., & Gaddam, A. (2016, July). Broader and earlier access to machine learning. In *Proceedings of the 2016 ACM Conference on Innovation and Technology in Computer Science Education* (pp. 362-362). https://doi.org/10.1145/2899415.2925485

Way, T., Papalaskari, M. A., Cassel, L., Matuszek, P., Weiss, C., & Tella, Y. P. (2017, June). Machine learning modules for all disciplines. In *Proceedings of the 2017 ACM conference on innovation and technology in computer science education* (pp. 84-85). https://doi.org/10.1145/3059009.3072979

Wollowski, M., Selkowitz, R., Brown, L., Goel, A., Luger, G., Marshall, J., ... & Norvig, P. (2016, March). A survey of current practice and teaching of AI. In *Proceedings of the*

AAAI Conference on Artificial Intelligence (Vol. 30, No. 1). https://doi.org/10.1609/aaai.v30i1.9857

Wong, G. K., Ma, X., Dillenbourg, P., & Huan, J. (2020). Broadening artificial intelligence education in K-12: where to start?. *ACM Inroads*, *11*(1), 20-29. https://doi.org/10.1145/3381884

Williams, R. (2021, March). How to train your robot: Project-based ai and ethics education for middle school classrooms. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 1382-1382). https://doi.org/10.1145/3408877.3439690

Williams, R., Kaputsos, S. P., & Breazeal, C. (2021, May). Teacher Perspectives on How To Train Your Robot: A Middle School AI and Ethics Curriculum. In *Proceedings of the AAAI Conference on Artificial Intelligence* (Vol. 35, No. 17, pp. 15678-15686). https://doi.org/10.1609/aaai.v35i17.17847

Yamada, A. (2018). Developing global competencies through interdisciplinary studies: why collaboration is important between STEM and Non-STEM students. In *New Directions of STEM Research and Learning in the World Ranking Movement* (pp. 79-96). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-98666-1_6

Yang, X. (2019). Accelerated move for AI education in China. *ECNU Review of Education*, *2*(3), 347-352. https://doi.org/10.1177/2096531119878590

Yau, K. W., Chai, C. S., Chiu, T. K., Meng, H., King, I., & Yam, Y. (2023). A phenomenographic approach on teacher conceptions of teaching artificial intelligence (AI) in K-12 schools. *Education and Information Technologies*, *28*(1), 1041-1064. https://doi.org/10.1007/s10639-022-11161-x

Zhang, H., Lee, I., Ali, S., DiPaola, D., Cheng, Y., & Breazeal, C. (2022). Integrating Ethics and Career Futures with Technical Learning to Promote AI Literacy for Middle School Students: An Exploratory Study. *International Journal of Artificial Intelligence in Education*, 1-35. https://doi.org/10.1007/s40593-022-00293-3

Zimmermann-Niefield, A., Turner, M., Murphy, B., Kane, S. K., & Shapiro, R. B. (2019, June). Youth learning machine learning through building models of athletic moves. In *Proceedings of the 18th ACM international conference on interaction design and children* (pp. 121-132). https://doi.org/10.1145/3311927.3323139

Zimmerman, M. (2018). *Teaching AI: exploring new frontiers for learning*. International Society for Technology in Education.

APPENDICES

Appendix A: AI Professional Development Workshop Pre-Survey

1. I am interested in learning about AI. (Strongly agree to Strongly disagree)

2. I feel confident in completing this PD workshop and mastering the fundamental AI concepts. (Strongly agree to Strongly disagree)

3. I feel confident in completing a semester-long introduction to AI course that does not require programming. (Strongly agree to Strongly disagree)

4. I am interested in incorporating AI topics in my classroom. (Strongly agree to Strongly disagree)

5. I believe that my students would benefit from learning about AI. (Strongly agree to Strongly disagree)

6. Please explain your answer to the previous question.

7. I feel confident in presenting AI topics and explaining AI concepts to my students. (Strongly agree to Strongly disagree)

8. Please explain what kinds of topics or concepts you feel confident about:

9. I feel confident in facilitating and supporting my students' learning or discussions about AI. (Strongly agree to Strongly disagree)

10. Please identify a topic and explain how you would support students' learning or discussions:

11. What percentage of teaching time would you spend on introducing AI topics? [percentage scale]

12. In what ways do you think learning about AI would benefit your own career development?

13. In what ways do you think your school should bring AI education to ALL students? What roles and responsibilities do you see yourself taking on in this school-wide effort that you are envisioning?

Appendix B: AI Professional Development Workshop Post-Survey

About the workshop format

1. The workshop activities and content were spread over three weeks, with real-time meetings and offline activities. How did that format work for you?

[ ]

How well did these activities you participated in during the group meetings on Fridays help you learn the content? Please rate from 0 for "it didn't help at all" to 5 for "it helped very much."

2. Debriefing with the whole group.

▢ 0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5

3. Can you please explain your rate to "Debriefing with the whole group?"

[ ]

4. Lesson preparation in breakout rooms.

▢ 0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5

5. Can you please explain your rate to "Lesson preparation in breakout rooms?

[ ]

6. Samplers of new activities.

▢ 0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5

7. Can you please explain your rate to "Samplers of new activities?"

[ ]

8. Analyzing students' data.

▢ 0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5

9. Can you please explain your rate to "Analyzing students' data?"

10. How well did the scheduled office hours work for you?

11. How well did access to instant messaging (Slack) work for you?

12. How did preparing the mini-lessons offline help you better understand the content?

13. From your experience in other PD workshops, what kind of design or approach would you like to have seen in the StoryQ workshop?

About the activities

14. Drag and drop to order the 3 most challenging activities in the module:

1st most challenging	2nd most challenging	3rd most challenging

15. What did you find was the most challenging in each of these three activities?

16. Please share any suggestions you think would make them run more smoothly for your students.

17. How did the access to the Teacher Edition for each activity help you understand the content and envision how the lesson would play out in the classroom?

How useful did you find the following teacher edition features (Use 0 to “not useful at all” to 5 “extremely useful.”):

18. Exemplar answers to questions

19. Teacher tips on questions and interactives

20 Lesson suggestion bubbles (Theory and Background/Discussion Points/Framing the lesson)

18. How did the timing of the release of the Teacher Editions work for you? (Check all that apply)

- I would like to have worked directly on them since the beginning.
- I would like to have them released along with the student version we used.
- I would like to have them as separate material.
- The timing of the release (after we used the student version) worked well for me.
- I would prefer to have them all released at the end of the workshop.
- None of these.

19. Can you please explain your answer to the question above? Please share any suggestions you may have.

20. How much time, on average, would you say you spent every week in the workshop offline activities?

- Less than 1 hour.
- Between 1 and 2 hours.
- Between 2 and 3 hours.
- More than 3 hours.

21. Please explain (optional):

22. How was the overall pacing of this workshop?

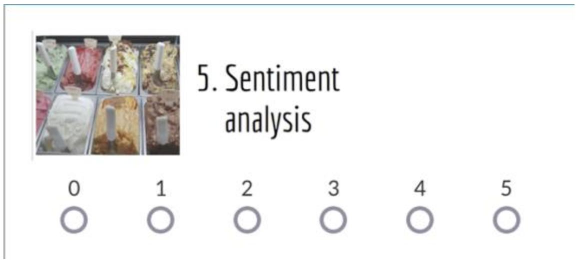
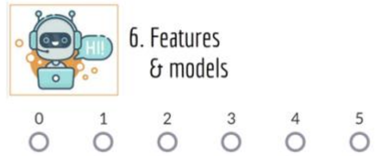
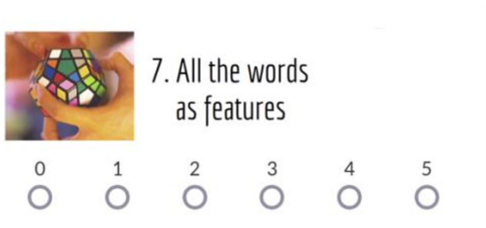
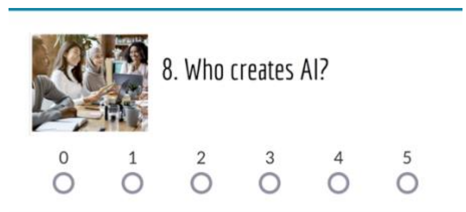
- The pacing worked fine.
- I prefer this format to 2-3 day-long sessions.
- I prefer 2-3 day-long sessions to this virtual format.
- None of these.

23. Please explain (optional):

About relevancy

Please rate each activity in terms of relevancy for your students, from 0 being completely irrelevant to 5 being the most relevant.

 1. Introduction to Artificial Intelligence 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 24.	 2. How to model natural languages? 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 25.
 3. How do humans classify text? 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 26.	 4. Machine learning with Alien language 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 27.

28. 	29. 
30. 	31. 

32. If you rated any (or some) of the activities as being irrelevant to your students, could you please explain? That would help us enormously in future designs.

33. How do you think the module would work in your classroom? (Check all that apply)

- It would work nicely, as is.
- It would work nicely, but not all activities.
- I would have to tweak the activities a little to use the whole module in my classroom.
- I would have to tweak the activities a lot to use the whole module.
- It would work if I use them in a different order (e.g., activity 4 first, then 1, then 5…)
- These activities would not work in my classroom.
- None of these.

34. Please explain your answer to the previous question:

Interests

35. Participating in the workshop increased my interest in learning about AI.
☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

36. I feel confident that I mastered the fundamental AI concepts in this PD workshop.
☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

37. Please list three concepts that you feel confident about (e.g., models learn patterns in training data, the difference between *human decision making* and *model decision making*):

38. Please list three concepts that you feel <u>less</u> confident about:

39. The workshop increased my confidence in facilitating and supporting my students' learning and/or discussions about AI.

▢ Strongly agree ▢ Agree ▢ Neutral ▢ Disagree ▢ Strongly Disagree

40. (If you *agree* or *strongly agree*) Please identify a topic and explain how you would support students' learning or discussions:

41. (If you are *neutral*, *disagree*, or *strongly disagree*) Please identify a topic and explain what kinds of support you would need to support students' learning or discussions:

42. The workshop increased my confidence in completing a semester-long introduction to AI course that does not require programming.

▢ Strongly agree ▢ Agree ▢ Neutral ▢ Disagree ▢ Strongly Disagree

43. (If you are *neutral*, *disagree*, or *strongly disagree*): Please explain what kinds of topics or concepts that you do <u>not</u> feel confident about.

44. (If you *agree* or *strongly agree*): Please explain in which ways your confidence in completing a semester-long introduction to AI course increased after the workshop.

45. Did the workshop change your perception of the ways in which AI would benefit your own career development? Please explain.

46. The workshop increased my interest in incorporating AI topics in my classroom.

▢ Strongly agree ▢ Agree ▢ Neutral ▢ Disagree ▢ Strongly Disagree

47. Did the workshop change your perception of the ways in which your students would benefit from learning about AI? Please explain.

48. Did the workshop change your perception towards the ways you think your school should bring AI education to ALL students? Please explain.

49. Did the workshop change your perception towards roles and responsibilities you see yourself taking on in this school-wide effort that you were envisioning in the previous question? Please explain.

50. Now that you have attended the workshop, what percentage of teaching time do you think you would spend on introducing AI topics?

▢ 0% ▢ 10% ▢ 20% ▢ 30% ▢ 40% ▢ 50% ▢ 60% ▢ 70% ▢ 80% ▢ 90% ▢ 100%

51. Is there anything else you would like to share?

Appendix C – Interview Questions After the Professional Development Workshop

1. In which of your classes do you plan to pilot the curriculum module? (See the interviewee's background)

2. Could you please tell me more about the class that you plan to pilot the module?
    a. How many periods/blocks are there?
    b. How many students are there in each period/block?
    c. What are the students' grade levels?
    d. How many female/male students are there?
    e. Are the ethnic backgrounds of the students representative of the school?
    f. What are these students' academic aspirations?
    g. What are students' comfort levels using computers and new software?
    h. What are the major learning goals of this class?

3. What is the schedule of the class that you intend to use the module?
    a. How long is each class meeting?
    b. On which day of the week does class meet?
    c. When does the class meet?
    d. If there are multiple class periods/blocks, please provide a screenshot of the class schedule.

4. Do you plan to pilot the whole module?

5. If not, which activities do you plan to pilot? Why do you choose these activities?

6. Which of your ELA units will you connect to the module or particular activities?

7. Do you need to get approval from your department for the pilot? If yes, what is the process?

8. If the pilot is successful or at least promising, do you intend to repeat it in the future and make it an official part of your curriculum? What indicators are you looking for to call it successful or promising?

9. When do you plan to pilot?

10. How much time do you plan to spend on this module or the selected activities?

11. How would you like the project team to support you? We can offer the following supports:
    - Create additional curriculum materials per your requests;
    - Prep meetings;
    - Presenting to your class via Zoom on selected topics;
    - Joining your class via Zoom and standing by for any help you need;

- Staying on Slack for instant communication during your class;
- Debrief meetings on a daily basis or on your preferred schedule;
- Others:________________________________

12. What kinds of computers do students use?

13. Do you need to get permission from the IT department to use our learning platform (learn.concord.org)?

Appendix D – Interview Questions After the Classroom Implementation

[teachers' expectancy, value, belief, goal, teaching philosophy]

- Could you share your three major teaching goals for this course? How did you realize these goals in your teaching?
    - In the context of the previous teaching
    - In the context of teaching this AI unit

[teacher agency, teacher decision-making process]

- What are the major changes you made? Why did you make these changes?
    - A prepared list of changes (3 open-ended changes, 2 can come from our list)
    - Not just sth skipped, but also sth expanded
    - If she refers to PD experience, we can talk more about how her experiences in the professional development workshop directed her to make these changes. (Does not necessarily need to be related PD)
    - Tie back to teaching goals.

[teachers' perception of students' learning outcomes]

- What do you think your students learned or what are their big takeaways from the unit?
    - How could you tell students you learned xxx?
        - What kinds of conversations have you had with your students or have you heard from student discussions?
            - If you have engaged in the conversations, what did you say, how did you respond, why did you decide to intervene, how did you guide students to some directions, etc.
    - Tie back to teaching goals.

[Ending questions]

- Repeating the module in your ELA class
    - If you will teach this curriculum by yourself again next semester, what kinds of changes would you like to make? Anything we can do to help you make such changes?
    - Is there anything that you would like to share?
- Potentially implementing it in your regular English classes
    - Do you think this curriculum is appropriate for your regular English class?
    - What are your primary teaching goals in that class?
    - If so or maybe, how would you implement/adapt the module or some activities in your regular class?
    - Could you explain your adaptation ideas?

Optional questions

- If your colleagues or ELA teachers from another school ask you why you taught this module in an English class, what would you say to them? Would you recommend them to try it? Why or why not?
- If your colleagues or ELA teachers from another school are considering implementing this module, what advice would you give them?