URLiteracy: Analyzing the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts

ACCEPTANCE

This dissertation, URLITERACY: ANALYZING THE K-2 GEORGIA STANDARDS OF EXCELLENCE IN COMPUTER SCIENCE AND ENGLISH LANGUAGE ARTS, by LAUREN COLEMAN, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chairperson, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty.

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URLITERACY: ANALYZING THE K-2 GEORGIA STANDARDS OF EXCELLENCE IN COMPUTER SCIENCE AND ENGLISH LANGUAGE ARTS

by

LAUREN COLEMAN

Under the Direction of Laura May, PhD

ABSTRACT

As technology and digital media occupy an increasingly prominent place in the daily lives of American citizens, education must adapt to better develop students' literacy skills using a variety of media. The metaliteracy framework provides a pedagogical structure toward this end, but few studies have examined metaliteracy from an elementary perspective. Also, it is not yet known to what extent state instructional standards align with the body of research on metaliteracy and digital literacies. The purpose of this dissertation was to examine the Georgia Standards of Excellence (GSE) in K-2 Computer Science and English Language Arts concerning a) their alignment with concepts of metaliteracy and b) the processes and practices they most commonly demand of students through a mixed-methods convergent design employing directed content analysis and data-driven qualitative content analysis. A literature review was first conducted to report the relevant technology and literacy education research. The directed content analysis used a simulation of hypothesis testing procedure to determine the degree of presence for 25 concepts of metaliteracy and found support for eight concepts in the standards: the Author, Communicator, Participant, and Producer Learner Roles; the Participatory and Productive Learner Characteristics; and the Behavioral and Cognitive Learning Domains. The qualitative content analysis produced a novel coding frame with five main categories: Collaborative Communicator, Acquisition Toward Analysis, Employing Toward Innovation, Reflecting and Revising, and Meaning and Belonging. Finally, the dissertation provides implications for research, policy, and practice.

INDEX WORDS: Digital literacy, Educational technology, Elementary literacy, Early technology skills, New literacies, Metaliteracy

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Lauren Coleman

A Dissertation

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DEDICATION

Mom: You were my first teacher, and you are my best friend.

Dad: I promised I would make you proud.

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

GSE: Georgia Standards of Excellence

CS: Computer Science

ELA: English Language Arts

MLC: Metaliteracy Concept

VP: Variable Presence

LR: Learner Role

LC: Learner Characteristic

LD: Learning Domain

LG: Learning Goal

> If our schools continue to limit the literacy curriculum to reading and writing traditional, alphabetic, printed texts, then our children will be well-prepared for 1950 but ill-prepared for 2050. (Baker et al., 2010, p. 2)

1 THE PROBLEM

As technology and digital media occupy an increasingly prominent place in the daily lives of American citizens, the nation's educational directives must adapt to prepare students to be literate in the variety of multimedia they encounter. As of 2021, internet use is practically universal among young adults in America; 75% of all Americans have broadband internet at home (Pew, 2021). In addition, the majority of families with school-aged children use computers at home for both educational and leisure activities, and even preschool students are often well-acquainted with digital devices such as smartphones and tablets (Furman et al., 2019; Kafai & Sutton, 1999; Kjällander & Moinian, 2014; Yilmaz Genc & Fidan, 2017). Today, technology plays an integral role in the lives of many individuals; therefore, students must be able to use and create digital content effectively.

The interactive, digital, multimodal literacy landscape that students interact with today fundamentally differs from the pen-and-paper society of just thirty years ago and before the Information Age. Henry Jenkins (2008, 2009) coined the terms "participatory culture" and "convergence culture" to describe the modern young person's relationship with technology. No longer passive audiences, individuals now interact with media dynamically, producing original content in response to and incorporating the messages they encounter (Jenkins, 2008). This participatory culture consists of social media networks, viral meme-sharing, fandom community discourses, massively multiplayer online role-playing games (MMORPGs), comments sections on news articles, and still other, as-yet-unanticipated methods of communication (Jenkins, 2009). In the years since convergence culture became a topic of theoretical discussion, factors such as social media, generative AI, the rise of "fake news," and more have all complicated the individual's relationship with the Internet and, by extension, the world. Today, digital skills affect students' social interactions, political lives, and career trajectories. A 2000 examination of over 600,000 job openings found that more than 450,000 focused on computer knowledge and technology in some capacity (May, 2000). In 2023, worldwide spending on Information Technology (IT) services, including data center systems, software, devices, digital communications services, and other IT services, is projected to exceed $4.3 trillion (DeLisi & Howley, 2023).

To respond to the technology sector's growth, districts nationwide have poured increasing amounts of money into technology education. In Georgia specifically, the government has spent millions on increased technology budgets in the classroom; in addition, the U.S. Department of Education has cited technology as a fundamental skill to accompany reading, writing, and arithmetic (Georgia. Dept. of Audits and Accounts, 2004; U.S. Department of Education, 2017). However, research suggests that technology should not be taught *alongside* or *in addition to* core subjects like literacy; digital media are part and parcel of today's literate world, and ideas about schooling must shift to accommodate this (Knobel & Lankshear, 2014; Tyner, 1998). Unfortunately, spending more tax dollars on technology without a deep understanding of its role in the curriculum may be ineffective.

Trying to keep up to date with endless iterations of new apps, platforms, and technological devices can lead to exhausted, unprepared teachers, directionless curricula, and students who lack the more profound conceptual knowledge and thinking practices, or literacies, necessary to be successful as a critical consumer and producer of content (Johnson et al., 2016; Warschauer et al., 2004). Rather than a mere technological development or new device to master, participatory culture represents a “shift in cultural logic:” an entirely new way of thinking about and interacting with media and society (Jenkins, 2006, p. 5). There is not one literacy that students need to learn to interact with the world around them; there are multiple (Gee, 2005; Harste, 2014; Knobel & Lankshear, 2014; Street, 1997, 2003). Moreover, modern humans do not communicate solely with oral and written language; they communicate multimodally, fluently moving among and between many literacies (Kalantzis et al., 2010; Kress, 1996, 2001; O’Halloran, 2011; Unsworth, 2006).

Within this framing, technology is not simply a tool to help understand literacy; technology *is* literacy (and vice versa). This cultural shift necessitates a shift in conceptual understandings and classroom practices (Street, 2003). The metaliteracy model, defined by its founders as “an overarching model for connecting related literacies with an emphasis on emerging technologies… in collaborative learning environments,” represents one means for moving forward with this reimagination and expansion of literacy (Mackey & Jacobson, 2014, pp. 14–15). While many states have developed computer science standards in response to the technology boom of the past two decades, there has been little investigation into how computer science standards might interplay with preexisting conceptualizations of literacy in other sets of standards, nor how these standards align with the interdisciplinary concepts advocated for by new literacies and metaliteracy.

Problem

Sociocultural theories of literacy suggest that learning to read and write is an essentially social phenomenon (Chaiklin, 2003; Gee, 2010; Holland & Lachicotte, 2007; Lewis et al., 2007; Vygotsky & Cole, 1978). Scholars advocate for the incorporation of students' life experiences and home competencies, interweaving home life and school life by using students' funds of knowledge in a process that ultimately makes school more relevant to real life (Esteban-Guitart & Moll, 2014; Gonzalez et al., 2006; Moll et al., 1992). Students of all ages are doubtlessly interacting with technology in their extracurricular lives, making its inclusion in even early elementary classrooms vital. Critical literacy theorists also advocate for teaching students to read and write both the "word" and the "world," tying the instruction and practice of literacy in the classroom to relevant social action and impact (Freire, 1972; Freire & Macedo, 2005). Modern students' voices are amplified to far greater degrees if they can critically evaluate and harness the power of digital media; some have described the development of modern technology, like the internet, computers, and smartphones, as a revolution equivalent to that of the switch from oral to written modes of language (Tyner, 1998). Therefore, computer science skills must not be taught as an add-on but rather interwoven throughout the general education classroom's literacy activities and the development of critical thinking about literacy.

Numerous research frameworks have been created to address the rising influence of technology and digital media as forms of literacy and communication in their own right. "New literacies" refer to the variety of skills, media formats, sources, processes, and tools that individuals must fluently navigate between in modern literacy environments beyond standard printed text (Baker, 2010; Cervetti et al., 2006; Gee, 2010; Leu, 2006). However, just as digital media are expansive and varied, so are the various frameworks that attempt to explain them. Disparate yet overlapping fields such as new literacies, digital literacy, information literacy, media literacy, visual literacy, critical digital literacies, computational literacy, and more have all attempted to encapsulate this issue. This issue of simultaneous oversaturation and lack of consensus has been noted in scholarly works from as early as the 1990s. In the words of Kathleen Tyner (1998):

> There is much cohesion between information literacy, visual literacy, and media literacy, and the fields have the potential to go the distance beyond access to address the productive uses of information technologies for teaching and learning. The fact that these three fields of study do not join forces to link their research and findings is of significant interest. Perhaps a synthesis, under a different name, will come about in the future (p.6).

In the future, the study of these issues will only become more relevant. The need for a cohesive, intentional, and integrated approach deepens as technology's reach expands and multiplies throughout society. This paper approaches the issue from the perspective of the metaliteracy framework, a pedagogical model for digital information literacy informed by sociocultural theory, new literacies, and elements of critical theory (Freire & Macedo, 2005; Gee, 2010; Jacobson & Mackey, 2022; Leu, 2010; Street, 2003).

Theoretical Framework

Sociocultural Theory of Literacy

Because online social interaction is taking place increasingly and in new ways, the present study necessitates a framework that accommodates the sharing and collaborative learning in digital classroom spaces. Therefore, the project works from the perspective of sociocultural theory, wherein literacy is seen as a product of culture. Literacy is inherently tied to the experiences and interactions of the individual; it is situated in historical, cultural, social, and political contexts. While there are variations in how various scholars from particular schools of thought might explicate sociocultural theory, they generally "share a view of human action as mediated by language and other symbol systems within particular cultural contexts" (Lewis et al., 2007, p. 5). One commonly cited definition of the sociocultural theory of literacy comes from Barton and Hamilton (2000), explaining:

> 1. Literacy is best understood as a set of social practices; these can be inferred from events which are mediated by written texts;
> 2. There are different literacies associated with different domains of life;
> 3. Literacy practices are patterned by social institutions and power relationships, and some literacies are more dominant, visible, and influential than others;
> 4. Literacy practices are purposeful and embedded in broader social goals and cultural practices;
> 5. Literacy is historically situated; and
> 6. Literacy practices change and new ones are frequently acquired through processes of informal learning and sense making. (p.8)

Therefore, literacy adapts, evolves, and *looks different* as culture varies or changes across space and time. As other skills became more relevant to citizens' needs and daily lives, they became part of our practical definition of literacy. The development of print language, rivaling the preexisting predominance of oral language traditions, marked one early, significant shift in society's conceptualization of literacy. Recently, the evolution of digital media, now vying with the traditional printed word, has been compared to this revolutionary development (Tyner, 1998). In addition, projects such as Heath (1983)'s examination of literacy in Appalachian communities and Scribner and Cole (1978)'s ethnographic study of the Vai people indicate that literacy beliefs and practices, as well as the skills necessary to be "literate" within a specific community, change according to their unique needs and values.

Similarly, much research underscores the importance of aligning classroom curricula and daily tasks with students' home lives, interests, experiences, and knowledge bases. Moll et al. (1992) introduced the concept of "funds of knowledge" in the classroom to unify these two worlds for student gain. In their words, "By capitalizing on household and other community resources, we can organize classroom instruction that far exceeds in quality the rote-like instruction… children commonly encounter in schools" (Moll et al., 1992, p. 132). If our communities regularly draw on digital environments and technological skills to communicate, our curricular understandings of what comprises literacy instruction must adapt accordingly.

Some argue that popular forms of technology and media, such as gaming and social networking, can be viewed as funds of knowledge for children, even at an early age (Gee, 2010; Marsh, 2010). Similarly, technology is necessary for many modern cultural practices and workplaces. Considering these two ideas–one, that literacy changes as culture changes and, two, that what matters in students' extracurricular lives ought to matter in the classroom–, there is a clear case for technology as literacy (or multiple relevant *literacies*) and literacy as technology. The field of new literacies examines the variety of skills and competencies students must use to navigate the modern world and learn to participate effectively in a digital, rapidly-evolving, information-heavy environment (Cervetti et al., 2006; Gee, 2010; Kalantzis et al., 2010; Knobel & Lankshear, 2014; Leu, 2010; Marsh, 2010; Street, 2003). These include, but are not limited to, issues of multimodal literacy, visual literacy, information literacy, media literacy, and digital literacy (Leu, 2010; Street, 2003).

While theoretical research in this area continues to grow, new literacies remain understudied in certain practical applications, such as analyzing educational standards. In

"What's 'new' in New Literacy Studies?", Brian Street (2003) stresses the importance of continued and ongoing evaluation of the practical manifestations of new literacies in the classroom, as both the experiences of the learner and the technological landscape are dynamic phenomena, constantly changing and evolving. We can no longer ignore the digital space in our classrooms if we want students to be able to read, write, think, communicate, and enact change in a digitally connected world.

The digital age has fundamentally changed how humans interact with the world around them; digital devices and platforms can also be viewed as tools through which humans interact and make meaning. The internet exists simultaneously outside, within, and between our physical reality. Often, we retreat to digital communities and social media to relax after a hard day's work. At the same time, digital tools and interactive media are integral to accomplishing many of our daily tasks. Activities that could exist solely "in real life" often use the digital as interloper, from checking a restaurant's Google reviews (instead of asking a friend) to checking the weather on your phone in the morning (instead of, well, "touching grass"). While the more recent development of this digital context impacts the individual's relationship with the tools in their environment, this interaction has been studied in education for decades through the lens of activity theory.

Activity theory emphasizes the connections between humans, their goals, the tools they utilize, and the sociocultural context in which they are situated. Vygotsky(1978) popularized the concept of "mediated action." Within this theory, humans' *tools* and *signs* mediate interactions between subject and object, fundamentally altering the nature of said exchange. Vygotsky argued that these could be mastered by humans in order to elevate our innate capacities and extend the domain of one's impact. Engeström and Cole (2021) built upon Vygotsky's mediated action concept by grouping tools and signs into the broader "artifacts," which can be used to communicate, learn, and create. Additionally, this later conceptualization of activity theory views interactions as not only mediated by artifacts but also as existing within larger systems that they both influence and are influenced by (Engeström, 1999; Leont'ev, 1978).

It is clear that these artifacts are becoming increasingly digitized; therefore, human activity and thought are progressively more mediated by technology. While in activity theory, subjects traditionally act upon objects, we see now that these relationships are changing–just as in the tenets of convergence culture, these relationships are less fixed. The object and subject now interplay dynamically. Karanasios et al. (2021) state, "Digital technology has the potential to magnify mediation, but can also be disruptive, leading to new forms of labor and expansive objects – some of which might yield societal damage… while others might produce societal benefits" (p.244). Students must become adept at using tools to mediate their experiences, but they also must remain critical and reflexive when considering how these tools alter their perceptions.

The present study relates to these understandings in a couple of ways. Educational standards, which provide guidelines for what students should learn and be able to accomplish, can be seen as a) a mediating factor influencing the interactions of districts, schools, teachers, and students, b) part of the sociocultural context relevant to the activity system of the school, and c) factors causing tensions in the activity system (Barrett-Tatum, 2015; Engeström & Cole, 2021; Leont'ev, 1978). Additionally, several scholars have studied the intersection of activity theory, new literacies, and digital literacy (Abdallah, 2013; Kaptelinin & Nardi, 2006; Li et al., 2021).

Technology and its myriad manifestations can be viewed as tools interacting with the educational process to enhance learning outcomes. However, in order to observe how technology interacts with learning standards and the educational system, it is essential to employ a practical framework with observable characteristics of new literacies – not only the technical know-how needed to navigate current hardware systems but also the cognitive processes and behaviors that abet individuals in adapting to and integrating with the constantly-changing digital world. Metaliteracy serves as a helpful structure.

Conceptual Framework: Metaliteracy

The researcher utilized the metaliteracy framework to guide this study, which aims to provide “a comprehensive framework for information literacy that unifies related literacies to advance critical thinking and metacognitive learning” (Mackey & Jacobson, 2014, p. 1). While it originates in information literacy, metaliteracy also infuses elements of digital literacy, media literacy, and other related disciplines. Metaliteracy requires that students become fluent in determining, accessing, locating, understanding, producing, and using information; it also encourages the collaboration on, production of, and sharing of new content in participatory digital media environments (Mackey & Jacobson, 2014). The founders of metaliteracy have published several books and articles to elucidate the framework and its applications (Jacobson & Mackey, 2013, 2017; Mackey & Jacobson, 2014, 2017). However, recognizing the tendency towards rapid obsolescence of frameworks that are too closely tied to specific ephemera of the digital age, the creators maintain an online portal at Metaliteracy.org, where the framework is continually updated (Mackey & Jacobson, 2022).

The basis of metaliteracy can be found primarily in social construction theory, metacognitive theory, and elements of Freireian critical theory. The social construction theory of learning emphasizes the dynamic nature of the learning process; here, students learn through engagement with material and the construction of meaning rather than the passive acquisition of knowledge (Piaget et al., 1969). Flavell (1963) builds upon Piaget's theories of learning as a constructive process by emphasizing the importance of reflecting on one's perception to understand a wider variety of perspectives. Collaborating in online communities and being self-aware about one's interaction with the digital world is critical to being able to "read the word and the world" in the Information Age (Freire & Macedo, 2005; Jacobson & Mackey, 2022).

Metaliteracy also incorporates elements of critical theory, including the process of critical self-reflection and an orientation toward social action. Freire (1972) envisioned a liberatory educative process wherein learners play active and reflexive roles in learning rather than teachers "banking" information into students' brains. This model necessitates that education has a transformative effect, wherein learning is directly tied to the alteration of power relations and tangible changes in social institutions in the learner's reality (Freire, 1972; Freire & Macedo, 2005; Glass, 2001). According to the creators of metaliteracy, "the metaliterate learner as producer is similarly an ongoing praxis when individuals are reflective and active in creating new knowledge while transforming themselves and their world" (Jacobson & Mackey, 2022, p. 12). Educational standards must incorporate these participatory and transformative aims if they are to be reflective of metaliteracy.

Learning Domains and Goals. Metaliteracy divides student learning into four domains: behavioral, cognitive, affective, and metacognitive (Mackey & Jacobson, 2019). These learning domains are heavily influenced by Flavell (1979)'s theory of metacognition and cognitive monitoring. The *affective* domain concerns adapting the individual's attitudes and beliefs in technology-mediated environments, which alter the typical nonverbal cues in physical and social settings, such as facial expression or body language (Jacobson & Mackey, 2022). For example, individuals must learn to be mindful of their affective responses when engaging with information shared across social networks; they also must be skilled at analyzing information regarding authorship, trustworthiness, authenticity, and validity of online content (Jacobson & Mackey, 2022). The *behavioral* domain emphasizes the skills and competencies individuals must develop fluency in to participate in online environments. Learners must become proficient in specific technologies that aid in producing, sharing, communicating, and comprehending information. These skills are nested. For example, to create content online, users draw upon various reading and writing processes in conjunction with technical skills such as web browsing (Jacobson & Mackey, 2022).

Next, the *cognitive* domain refers to higher-order thinking processes, such as evaluation, analysis, problem-solving, and creation, which are needed when using technology. Metaliterate individuals may do this by discerning source types, analyzing an author's expertise, evaluating the context of information found in online social settings, parsing their preconceptions involved in interacting with particular media, and ethically creating new content (Jacobson & Mackey, 2022). Finally, the fourth learning domain of metaliteracy is the *metacognitive*. This domain also incorporates elements of the affective, behavioral, and cognitive domains; however, it emphasizes self-regulation and awareness of one's thinking (Flavell, 1979; Jacobson & Mackey, 2022). Metacognition in the context of early childhood education refers to young children's ability to understand, monitor, and regulate their cognitive processes, thereby demonstrating mindfulness around their thinking, learning, and problem-solving skills (Flavell, 1979). By developing metacognitive skills, children can become more aware of their thinking processes, better regulate their learning strategies, and make informed decisions about their learning experiences (Ceylan & Harputlu, 2015; Ozturk, 2015; Ruan, 2005). In addition, the reflexive nature of this domain works to promote the longevity of the metaliteracy framework as technology adapts and evolves beyond what is currently available to users.

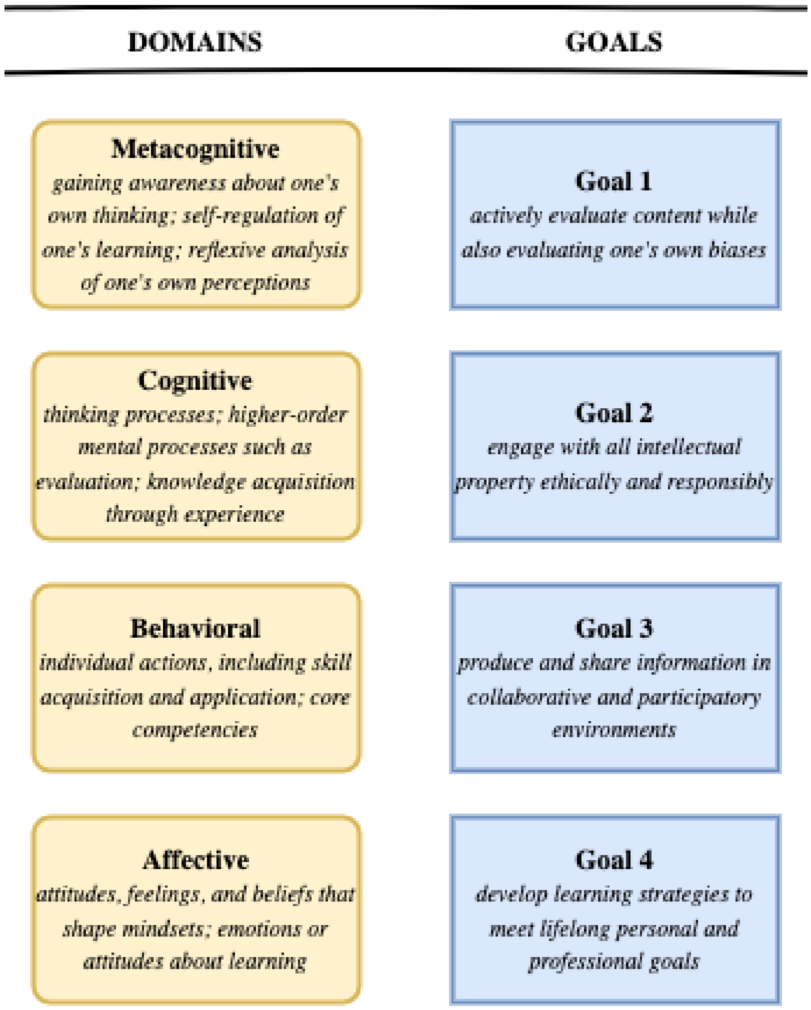
Metaliteracy also organizes its goals and standards across four broad goals, under which each learning objective is assigned to one of the above domains. The goals of metaliteracy are as follows:

1. "Actively evaluate content while also evaluating one's own biases
2. Engage with all intellectual property ethically and responsibly
3. Produce and share information in collaborative and participatory environments
4. Develop learning strategies to meet lifelong personal and professional goals" (Mackey & Jacobson, 2019)

Brief definitions of these domains and goals are described in Figure 1.

Figure 1

Metaliteracy Domains and Goals

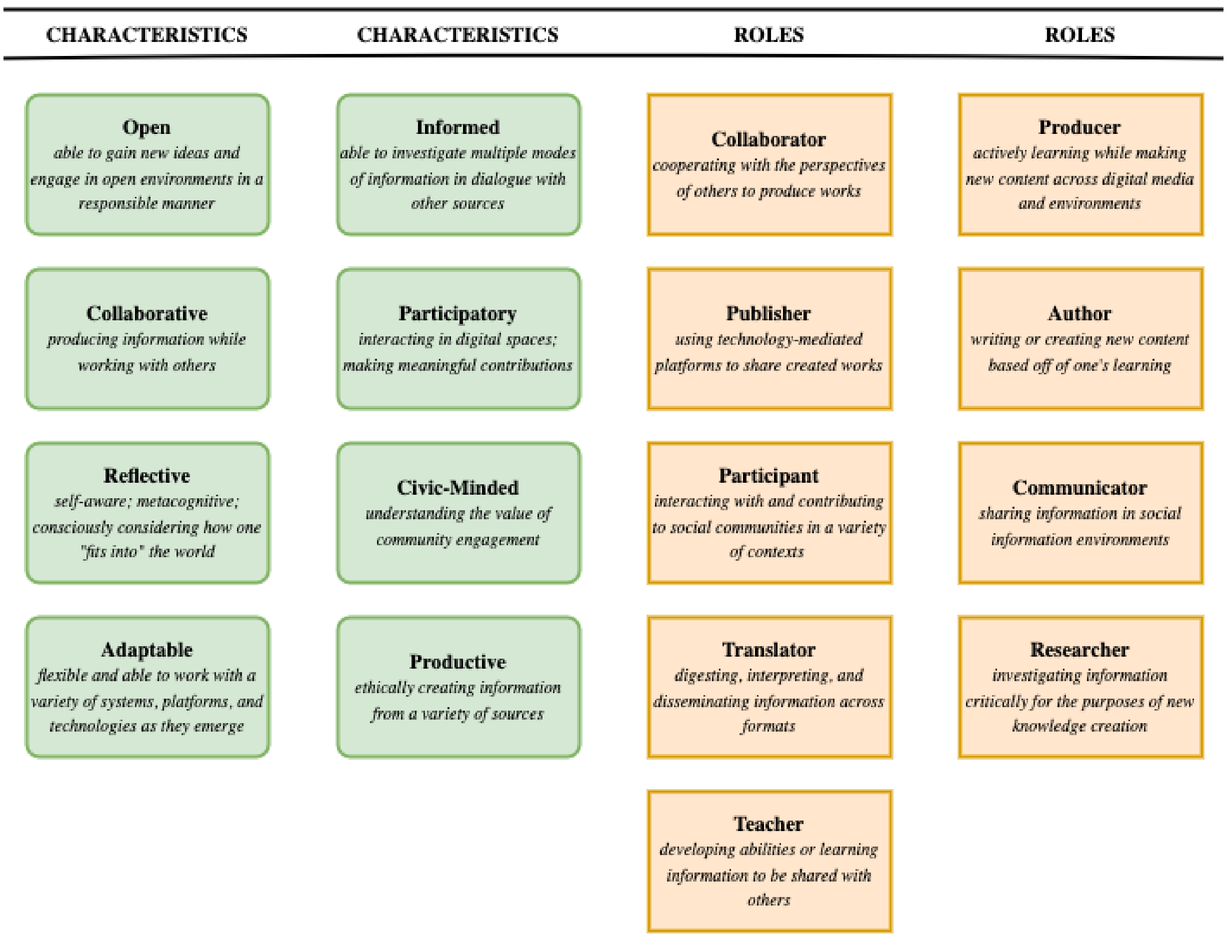


(Jacobson & Mackey, 2022)

Learner Characteristics and Roles. Aside from the four domains of metaliterate learning, the metaliterate learner also develops eight characteristics. The metaliterate learner is civic-minded, adaptable, open, productive, informed, collaborative, participatory, and reflective (Jacobson & Mackey, 2022). By developing these eight characteristics, metaliterate learners can embody nine roles: teacher, collaborator, producer, publisher, researcher, participant, communicator, translator, and author (Jacobson & Mackey, 2022). Definitions of these roles and characteristics can be found in Figure 2.

Figure 2

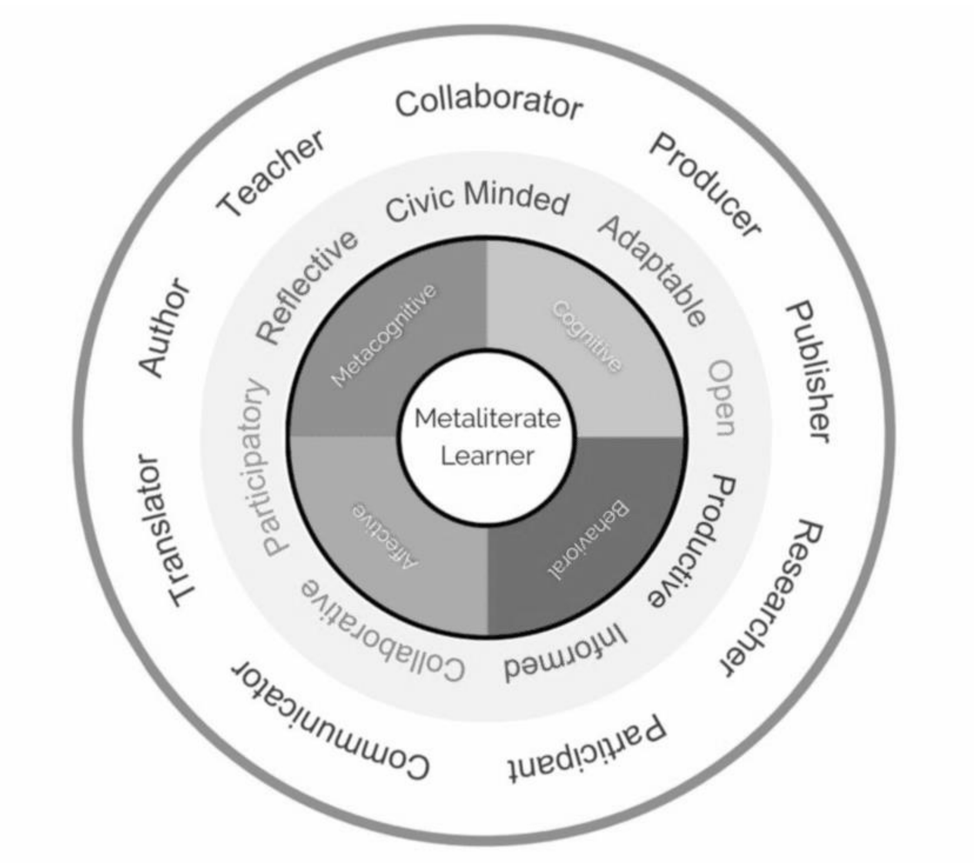
Metaliterate Learner Characteristics and Roles



The domains, characteristics, roles, and goals of metaliteracy were created in alignment with well-established theories of learning that are commonly used in elementary pedagogy, such as Vygotsky's Zone of Proximal Development (ZPD) and Bloom's Taxonomy (B. S. Bloom, 1994; Jacobson & Mackey, 2022; Vygotsky & Cole, 1978). These domains, characteristics, and roles work together to empower students in the digital space as consumers and contributors. A visual representation of this model can be seen in Figure 3.

Figure 3

Metaliterate Learner Figure



(Jacobson & Mackey, 2022, p. 23)

It is essential to understand that metaliteracy functions not as a new theory but as a synthesis of many preexisting models for digital learning. It emphasizes the technical skills needed to access digital content, which can quickly be rendered obsolete as technology evolves, along with the underlying concepts of critical thinking, discernment, and reflection that remain necessary digital literacy skills regardless of specific format. A literacy instructional framework that promotes content comprehension and production, metaliteracy focuses on critical thinking, self-directed learning, and metacognition (Jacobson & Mackey, 2022). In this manner, metaliteracy is a digital learning framework that can and should be integrated into the general elementary literacy classroom.

Despite its potential, metaliteracy has yet to be applied to an elementary context. Since metaliteracy was developed out of information literacy, many scholars focusing on metaliteracy are involved in library science. Research has been conducted to apply metaliteracy to an undergraduate learning context, and results have been promising so far (Al-Aufi et al., 2017; Jacobson & Mackey, 2017; Mackey et al., 2018; Mitchel, 2007; Sales, 2022; Stewart & Broussard, 2016). However, there needs to be more research on elementary metaliteracy, and the learning objectives provided by the creators of metaliteracy are not grade-level specific. In other words, metaliteracy addresses a theoretical gap in preexisting educational technology and literacy frameworks; however, there remains a research gap in the application of metaliteracy within the early elementary grades. Therefore, a study that attempts to evaluate the alignment between preexisting standards of elementary computer science and metaliteracy's learning objectives could be highly fruitful as a first step towards integrating metaliteracy into elementary instruction and promoting greater computational literacy among young learners.

Purpose

The proposed study aims to determine the alignment between state educational standards in literacy and computer science and the principles of metaliteracy for K-2 students. This study uses mixed-methods content analysis informed by Neuendorf (2017) and Krippendorff (2013) to examine the Georgia Standards of Excellence (GSE) in both Computer Science (CS) and English

Language Arts (ELA) for the K-2 grade band to determine their alignment with the metaliteracy framework. As metaliteracy synthesizes elements of traditional literacy with computational competencies against the backdrop of the digital sphere, both CS and ELA standards are observed in this study.

Research Questions

The following questions guide the research design and methodology for this study:

1. To what extent are the learning goals, learning domains, learner roles, and learner characteristics of metaliteracy (metaliteracy concepts) evident in the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts?
    a. How do metaliteracy concepts differ in prevalence between the CS and ELA corpora of standards?
    b. How do metaliteracy concepts differ between grade levels, considering both CS and ELA standards together?
2. What are the prevailing themes related to processes and practices in the K-2 Georgia Standards of Excellence for Computer Science and English Language Arts?

Significance of the Study

Currently, there is no adaptation of the metaliteracy framework for the K-2 age range. The metaliteracy framework's components are not differentiated according to grade level bands, and the framework has primarily been applied to secondary or higher education students. However, the goals that metaliteracy espouses–like creating and sharing content via digital platforms, evaluating the reputability of sources, and being reflective about one's own identity as mediated by social technologies–are essential to begin instructing in a developmentally appropriate manner at an early age, as literacy is now inextricable from the online world. Therefore, the findings from the present study pave the way for merging the current relevant K-2 GSE standards with the concepts present in metaliteracy to create an early elementary metaliteracy model.

Metaliteracy has yet to be widely studied, as it is a newer framework. A ProQuest search of Georgia State University Dissertations and Theses revealed zero dissertations referencing metaliteracy and very few studying new literacies or digital literacy. Furthermore, technology advances rapidly, and studies from just a few years ago can quickly be rendered outdated due to new technological innovations. Computational literacy, in general, is also more commonly studied among the middle and secondary grades. While this is a fast-growing field, early childhood or elementary-level studies are underrepresented. Much research focuses strictly on computational literacy and programming skills or reading comprehension and critical thinking skills. However, metaliteracy serves to integrate these skill sets, as learners draw on these components simultaneously as they navigate digital environments.

This study is also relevant to both teacher development and student experience. State standards should provide a “road map” for teachers' instructional design. If said road map gives “faulty directions,” students will not arrive at the desired destination. In other words, if the standards do not effectively incorporate metaliterate principles, then students and teachers may not have an adequate understanding of or competencies regarding the relationship between literacy and technology. Evaluating the current state of the standards is the first step towards this content reframing. Teachers may be able to shift their practices towards promoting student voice and identity development in the digital space while also helping students become more discerning about and more skilled in engaging with multimedia and online content. If schools shift towards virtual learning on a wide scale again, as occurred during the COVID-19 pandemic, teachers could be much better prepared to provide high-quality, thoughtful instruction online if the standards are well-aligned with metaliteracy. Improving metaliteracy instruction in schools may work toward closing the digital divide by increasing equity in awareness about these skills and cognitive practices. One way to begin this process is to examine the standards used to guide instruction for young children.

Students with more knowledge of metaliteracy will be able to engage with the online world in a more productive, more informed, and safer manner. Long-term, students with higher metaliteracy knowledge will have an easier time adjusting to the increased digital demands of high school and college; they will also be equipped to succeed in high-paying industries that rely on technical prowess, multimedia research skills, and digital communication aptitude. Students who have received instruction in metaliteracy from an early age will have more success as they navigate the complexities of the digital world in their later school years and even adulthood. If we accept metaliteracy skills as fundamentally important endeavors in this modern world of new literacies, we must ensure that standards effectively accommodate these new literacies.

To this end, this study may provide a rationale for policymakers to broaden the spectrum of texts included in current curricula (Hartman et al., 2010). In addition, shifting from a skills-based to a utility and outcome definition of digital literacy in curriculum and policy would ideally lead teachers to reorient their approach to technology in the classroom (Helsper, 2016). The findings of this paper could also be used to inform funding decisions regarding allocating resources to schools for updated technology and professional development regarding digital devices in the classroom. Overall, the paper addresses a gap in the research regarding content analysis of computer science standards, elementary computer science research, and a literacy-focused, integrated view of computer literacy, or metaliteracy skills, at the elementary level.

Assumptions

There are certain assumptions to acknowledge before proceeding with the study.

1. State standards are influential in guiding teachers' lesson planning and instructional activities.
2. Modifying state standards is influential towards classroom practices.
3. States maintain up-to-date websites with their current educational standards.
4. The most recent Metaliteracy learning goals, learner roles, and learner characteristics, as per the Metaliteracy.org website, are updated and accurate.
5. Content analysis is a valuable and appropriate framework for examining educational standards.
6. The sample size included in the content analysis will be sufficiently large enough to draw conclusions about themes in the data.
7. The current GSE for K-2 are developmentally appropriate for that age range.

Definition of Terms

It is essential, moving forward, to provide concise and consistent definitions for the terms and phrases that will be repeatedly used throughout the subsequent portions of the study. Accordingly, these terms and their relevant definitions are provided below.

1. Standards: the intended learning objectives, goals, and content programming that comprises a given subject at school (A. C. Porter & Smithson, 2001)
2. Literacy: a "situated–sociocultural" phenomenon wherein individuals engage in social and cultural practices, such as oral language, reading, writing, and using digital media, to act, interact, and achieve goals depending on their particular historical, social, cultural, and institutional contexts (Gee, 2010)
3. Metaliteracy: a lifelong learning framework comprised of learning objectives, learning domains, learner roles, and learner characteristics that serve to create individuals who are capable of understanding, analyzing, and producing content in a variety of modalities among collaborative, dynamic, internet-integrated communities (Jacobson & Mackey, 2022)
4. Multiliteracies: theory of literacy that recognizes the many diverse forms of language and multimodal forms of representation and expression that individuals draw upon to make meaning of their everyday lives within increasingly globalized, digital societies in the era of media convergence (Kalantzis et al., 2010)
5. Digital Literacy: Can include the functional or instrumental "survival skills" of navigating digital devices and the internet, or may move towards understandings about how to evaluate and use digital texts critically, with attention to representation, language, production, and audience (Buckingham, 2015; Gilster, 2006)

6. Technology Integration: A means of adding to the learning environment by infusing digital devices such as computers or tablets, as well as a variety of software programs, into the daily learning curriculum and the achievement of learning objectives (Antifaiff, 2000)
7. Digital Media: a variety of tools used for communication that involve the use of digital devices, computers, software programs, internet networks, online communities, and interaction (Howard & Hussain, 2013)
8. Information Literacy: the processes involved in identifying, gathering, comprehending, evaluating, analyzing, and using information to achieve a goal (Bent & Stubbings, 2011)
9. General Education: the primary classroom space for grades K-2 that is generally non-departmentalized, where the instruction of the core curricular subjects occurs with the entire class of students
10. Computational Thinking: manners of thinking needed by individuals engaging in problem-solving and systems design as enacted by technological devices or information processing agents (Wing, 2006)
11. Computer Science: the study of computers and the use of computational systems (Brookshear et al., 2009)

Conclusion

This chapter has provided the rationale for the present study, which seeks to understand the degree to which current educational standards reflect best practices in technology integration in the early elementary classroom, as viewed from a literacy perspective. The chapter discussed the importance of digital literacy in modern society and the rationale for viewing digital literacy as a form of literacy to be incorporated into the general education classroom. It also introduced the metaliteracy conceptual framework and the relevant theoretical frameworks.

The purpose of this study is to analyze what is currently being thematically emphasized by the body of standards as a whole, as well as within each subject and grade level. The study is particularly interested in how the standards incorporate ideas of metaliteracy, reflecting the shifting definition of modern literacy as inherently necessitating fluency with the consumption and production of digital media. This project adds to the current body of knowledge on elementary digital literacy and the new field of metaliteracy. This study's findings could inform future studies regarding metaliteracy, policy directives on computer science and literacy standards, and teacher practice concerning technology integration into the general education classroom.

Chapter 2 follows with a review of the relevant literature concerning issues such as prior research on the effects of technology integration in elementary classrooms and the history of standards-based reform in American public education. Chapter 3 then describes the study’s research goals and delineates the study’s methodology, including the rationale for the choices made regarding data selection, research design, and data analysis for each portion of the mixed-methods triangulation design. Chapter 4 presents the findings from both research questions’ analyses. Finally, Chapter 5 synthesizes and interprets the findings and provides implications for research, policy, and practice.

2 REVIEW OF THE LITERATURE

The literature review for this dissertation sought to understand the prior research regarding several relevant concepts, including the history of elementary literacy education, the development of metaliteracy as it converges with other digital literacy frameworks, and the importance of state standards in elementary education. A better understanding of these phenomena contextualizes this project and provides a rationale for its aims, illuminating a gap in the current research.

Aims

This literature review has several main aims, as represented by the following guiding questions:

1. How is the current landscape of literacy education vis-à-vis digitally mediated environments informed by the broader history of social literacy practices?
2. What is the extant literature on elementary metaliteracy among early elementary learners, including the relationship between child development and technology?
3. What prior research exists regarding content analysis of educational standards, and how does this inform the current project?

Search Procedures

I used multiple electronic databases to locate the studies in this review, including JSTOR, ERIC, SAGEPub, and Wiley Online. I also used Google Scholar and my university's library catalog to find information. Each literature review question was approached using a slightly different method. For the first question, I used several predefined sources to inform my research, namely: Tyner (1998)'s *Literacy in a Digital World*, M.T. Clanchy (2012)'s *From Memory to*

Written Record, Digital Literacies For Learning, edited by Allan Martin and Dan Madigan (2006), and *The New Literacies: Multiple Perspectives on Research and Practice* (Leu, 2010). Theoretical work on convergence culture, mentioned in Chapter 1, also informed this line of thinking, including more recent publications on this subject (Jenkins, 2008, 2013; Jenkins et al., 2020). These sources, which I came across during my early readings on digital literacy, provide historical overviews of literacy to contextualize the current Information Age and how it demonstrates a marked shift in our society's understandings of technology, comparable to other major historical events such as the development of the printing press and even the shift from oral to written language (Tyner, 1998). Evolutions of the internet age, including the rise of social media and generative AI, are also discussed, with a speculative nod towards the future.

Finding the responses to the subsequent questions for the literature review followed a more traditional search procedure. For questions 2 and 3, I used the following search terms:

- "literacy," and/or "reading," "writing," "learning," and "literary."
- "technology," "digital," "online," and/or search terms representing the many frameworks previously used to organize such research, such as: "digital literacy," "information literacy," "educational technology," "media literacy," "visual literacy," "information and communication technology," "new literacies," "multiliteracies," and "computational literacy."
- and "elementary," and/or "kindergarten," "early learning," "early childhood," "early elementary," "young learners," and "first grade."

For the final research question, I used search terms such as "content analysis" and "educational standards," with related synonyms including "text analysis," "state standards," "literacy standards," and "common core standards." I also communicated with other education scholars with similar interests over the phone and via e-mail to broaden the scope of my search and include any additional perspectives they recommended that fit my search criteria.

The included pieces of literature for research questions 2-4 had to meet several criteria. First, they had to come from the field of educational studies. Secondly, I looked for works published in 2000 or later. This decision springs from the rapidly changing nature of digital technology, making findings quickly outdated. Furthermore, I primarily allowed empirical journal articles and book chapters to comprise the review, and both qualitative and quantitative studies were permitted, seeing as the present study takes a mixed-methods approach.

After conducting these preliminary searches, I organized the review findings in Google Sheets, with separate tabs for each research question. I created tables that included the citational data for each article, the abstracts of the articles, and my notes on the relevance of the articles to this paper. I also consulted with two peers when I ran into questions or concerns about whether a given study would fit the parameters of the review.

Literacy and the Digital World

Technology has, in fact, always existed within literacy instruction and literate knowledge; it has simply evolved over the past centuries of reading and writing, much like the evolution of language itself. In other words, technology and literacy have never been separate. Literacy scholar Seth Lerer charts the evolution of reading, reading technology, and the English language. For example, in early Greek and Roman civilizations, the written word was preserved on scrolls, and notes were taken using wax-covered wood and a stylus; the codex and the bound papyrus book followed thereafter (Lerer, 2013).

With the development of the bound book, comprehension strategies and necessary competencies also developed. Bound books were smaller and more portable; they also provided the ability to skim, scan, and save one's place more easily. The cultural practices associated with reading changed, as individuals were able to bookmark pages, open to passages at random, and, well, "curl up with a good book." The development of new literacy technology necessitates the development of new social literacy practices and, in turn, the adaption of instructional techniques and pedagogical mindsets. With the advent of screens and devices as a widespread form of taking in the written word, more significant shifts in the cultural experience of literacy processes have occurred. Some view innovations such as email and text messaging as sorts of ever-changing code, which individuals master through different discourses depending on their cultural backgrounds (Lerer, 2000; Lerer & Dane, 1996). In this way, while the advent of digital media does connotate a marked departure from the pen-and-paper methods of the past, it also follows a tradition of successive technological breakthroughs that have iterated since the beginnings of communication. Our current digital media landscape is both unlike anything that came before it and the next logical descendant of a long literary tradition.

We are now in what is known as the Information Age (Castells, 1997). The developments of the late-20th century have conspired to create a more interconnected society than ever before. As a result, the old tools of print reading and writing no longer suffice to create empowered citizens. One element of the Information Age is what Castells calls "the culture of real virtuality" (Castells, 1997, p. 10). This concept refers to the "flexible, diverse hypertext" of the online world and the myriad of diverse digital media messages every individual now encounters (Castells, 1997, p. 11). As a result, many have called for a reconceptualization of literacy that accommodates how individuals currently encounter and produce new information (Gee, 2010; Gilster, 2006; Jacobson & Mackey, 2013; Leu, 2010).

Even in the years since *Convergence Culture*'s original publication, the digital and interactive nature of content has diversified in ways that were previously beyond imagination. For example, Jenkins (2008) used *Survivor* fandom to illustrate the blurred lines between content creators and consumers; the audience's interaction with the show's content eventually became so integral to the show itself that their sleuthing for spoilers and inferences about contestants ended up impacting the storytelling of the show itself. These days, that fandom has expanded so much that fans now run their *own* digital *Survivor* games on Minecraft (including a 280-page fan-run wiki), with many online players ending up as real-world show contestants (Minecraft Survivor Wikia, 2023). Carolyn, one of the final three players on Season 44, won a season of Discord *Survivor* prior to her time on the show (colealoupe, 2023). Her ally, Carson, favored Roblox *Survivor* games; he prepared at home by 3D printing miniature replicas of each puzzle from previous seasons (Garrett, 2023). While this study aims to understand elementary literacy practices (not reality TV fandoms), this example underscores how digital communication, and the active role of the consumer in producing content and shaping discourse, can no longer be ignored. Minecraft, Roblox, Discord, Instagram, Reddit, and even 3D printers are all parts of students' literacy practices, yet their inclusion in the classroom setting is far less common.

While we certainly interact with the digital world in our collective leisure activities, it also deeply impacts modern politics and society. Two major recent events, the 2016 United States presidential election and the global COVID-19 pandemic, add nuance to how we might now conceptualize digital participatory culture. While the internet had been around for several presidential campaigns already, the 2016 election invoked the online sphere in novel ways thanks to the rapid proliferation of social media platforms, making it arguably the first election wherein the influence of digital participatory environments had usurped that of traditional print media (Mims, 2016). As an example, users of the Pro-Trump subreddit r/The_Donald were so disproportionally active that their posts disproportionately dominated the r/all subreddit, ultimately forcing Reddit to alter their algorithm (Shepherd, 2020). A specific group of extremely active, "chronically online" users made it their mission to warp, kaleidoscope-like, the perception of every user on the site, distorting what was supposed to be an equal reflection of the most popular and relevant posts across all subreddits.

If an inaccurate rendering is presented to the public with all the trappings of reality, does it eventually become so? This anecdote is only the tip of a *Titanic*-sized, house-of-mirrors iceberg. Misinformation, "fake news," and social media played unprecedented roles at every stage of the election (Patterson, 2017; Bode et al., 2020). Foreign actors spread propaganda disguised as memes (cite). Internet echo chambers of yes-men self-radicalized, turning conspiracy theories into coups (cite). Through it all, social media platforms like Facebook and Twitter scrambled to shift their algorithms and create content warnings, serving as Band-Aids on a much larger wound—the collective lack of literacy understandings needed to navigate the world of new media. With regards to the importance of digital literacy understandings in the general elementary literacy classroom, the election serves as a turning point to demonstrate how necessary metaliteracy instruction is to fully engage and empower students.

The advent of the COVID-19 pandemic also provided the catalyst for a paradigm shift in how teachers and students, across all grades, interact with technology in the classroom. By shifting traditional classroom practices to fully digital ones virtually (no pun intended) overnight, the pandemic accelerated and highlighted the preexisting disparities in preparation, access, and technological knowledge of teachers and students. Emerging research indicates that teachers' varying levels of digital competencies entering the pandemic impacted students' experiences with virtual learning (Joia & Lorenzo, 2021). Additionally, many teachers indicated during the pandemic that they did not feel adequately prepared to teach in a digital environment (Middleton, 2020). Novel research into post-COVID teacher perspectives concerning digital learning also highlights the numerous technical issues teachers encountered during the pandemic, such as a lack of experience with e-learning content and platforms and a lack of knowledge regarding how to deliver content, assess, and provide feedback to students in a strictly digital environment (Korkmaz & Toraman, 2020)**.**

While research on this recent phenomenon is still developing, it is also clear that COVID-19 impacted schools' relationships with technology in more ways than simply the conduction of virtual instruction. While most students returned to their buildings in 2021, many adoptions, like the increased use of Google Classroom and other virtual learning platforms, persisted. Additionally, students' futures online were clearly shaped by this unprecedented phenomenon. Although remote work is no longer imperative for the health and safety of our communities, working from home is still markedly more common than it was pre-pandemic, and early reports suggest that this shift is here to say, with some even deeming this shift the "remote work revolution" (Popovici & Popovici, 2020; Van Nieuwerburgh, 2023). 2022 Gallup poll data indicated that the amount of workers working entirely in person decreased from 60% in 2019 to 23% in mid-2022, with 94% of survey respondents preferring either fully remote or hybrid work settings (Wigert & Agrawal, 2022). As students' digital lives and futures become more inseparable from their off-screen identities, the instruction of metaliteracy concepts–including awareness about one's own identity online, being informed about the reputability of online sources, and producing content in various digital formats–becomes even more pressing.

Even more recently, advancements in artificial intelligence (AI) and machine learning (ML) have led to innovations and expanded possibilities in almost every field, from consulting and business to medicine to the arts (Baig et al., 2023). Using a large-scale language model called Generative Pre-Trained Transformer 4 (GPT-4, originally GPT-3.5 when introduced), OpenAI's ChatGPT chatbot reached over 100 million users just two months after it was debuted to the public in November 2022 (Lim et al., 2023). Google released Bard shortly after ChatGPT, and Khan Academy debuted their adaptation of GPT-4, called Khanmigo, in April 2023 (Khan, 2023; Pichai, 2023).

The ubiquity of these language models illustrates the inevitability of technological progress and the inescapable influence of technology on human existence; however, they also illuminate the importance of being digitally literate, mindful, and discerning when interacting with technology. The chatbot, which can write essays, provide feedback on assignments, and even pass the Bar Exam–to skim the surface of its capabilities–, opens both a treasure trove of opportunities and a can of worms (Ryznar, 2023). At time of writing, this technology is so recent that peer-reviewed articles on its impact are practically nonexistent; however, novel research has already investigated ChatGPT's ethical quandaries, including its tendency to hallucinate academic references (Athaluri et al., 2023; Baidoo-Anu & Owusu Ansah, 2023; Ray, 2023). While generative language models are the latest fad to take hold of public consciousness, it is only a matter of time before the next innovation takes the world by storm. Regardless of format, students must develop the discernment, critical thinking, and mindsets needed to navigate digital developments ethically, responsibly, and productively.

Metaliteracy and Adjacent Frameworks

Many studies emphasize the importance of high-quality technological integration into literacy classrooms at the early elementary level. However, because metaliteracy is a newer concept and was first introduced at the higher education level, more research is needed using metaliteracy specifically. While there are yet to be state standards that intentionally and directly employ metaliteracy, the fields of computer science, computational thinking, digital literacy, and literacy are the most relevant. Therefore, studies using a variety of these frameworks have been included in this section of the review. Table 1 provides the studies evaluated for this review portion, with relevant metadata.

Table 1

Studies Investigating the Effects of Technology Integration

Authors	Theoretical Framework	Methods	Focus
Akayoglu et al., 2020	digital literacy	qualitative: interviews, essay questions	elementary PSTs
Anisimova, 2020	digital literacies	survey; statistical analysis	PSTs
Aslan, 2021	digital literacy	descriptive surveys, ANOVA	K-12 PSTs
Atkinson, 2020	metaliteracy	quantitative, pretest-posttest	higher ed
Bers, 2018	computational thinking	descriptive statistics	early childhood
Çam & Kiyici, 2017	digital literacy; information literacy; visual literacy	quant. instrument (dig. lit. scale)	preschool PSTs
Carpenter & Harvey, 2019	social ecological model	interviews	teachers
Casillas Martin et al., 2020	digital competence	surveys; descriptive statistics	ECE teachers
Castellví et al., 2020	critical digital literacy	online questionnaire	PSTs
Chang & Peterson, 2018	computational thinking	case study	PSTs
Chen & Chang, 2006	educational technology integration	quantitative analysis	pre-K teachers
Coady et al., 2019	metaliteracy; sociocultural theory	writing prompts, interviews, qual. analysis	4th grade

Authors	Theoretical Framework	Methods	Focus
Dewi et al., 2021	digital literacy competency	likert-scale questionnaire; descriptive statistics	higher education
Dore & Dynia, 2020	classroom technology integration	surveys; latent class analysis	preschool teachers
Erdem & Eristi, 2018	media literacy	mixed-methods, semi-structured interviews	PSTs
Furman et al., 2019	information communication technologies (ICT)	quasi-experimental, pretest-posttest, interviews	preschool
Garcia et al., 2020	Black feminist theory; critical digital literacy	qual. essay analysis	secondary
Godbey, 2018	information literacy	hierarchical linear modeling	higher ed
Herman & Ciampa, 2019	digital literacy	mixed-methods: quiz scores, interviews	first grade
Horn et al., 2013	computational literacy	observations, transcriptions, descriptive statistics	
Hsu et al., 2019	digital literacy	surveys, interviews, observations, artifacts; statistical analysis	elementary students
Hur and Brush, 2009	social learning theory	reconstructive analysis	K-12 teachers
Kaya et al., 2019	computational thinking	pretest-posttest, paired sample t-tests	PSTs

Authors	Theoretical Framework	Methods	Focus
Kjällander & Moinian, 2014	ICT, designs for learning, multimodal learning	multimodal analysis of video material; Learning Design Sequence analysis	preschool children
Lauricella et al., 2020	digital citizenship; media literacy	surveys; descriptive statistics; chi square	K-5 teachers
Lee & Soep, 2016	critical computational literacy	field notes, artifacts, discussions, interviews; grounded theory	high school and college
Lestari et al., 2020	digital literacy	descriptive, qualitative	elementary teachers
List et al., 2020	digital literacy	open-ended surveys; coding	PSTs
List, 2019	digital literacy	descriptive, qualitative	PSTs
Liza & Andriyanti, 2020	digital literacy	mixed-methods, questionnaires, interviews	higher education
Michelot et al., 2022	metaliteracy	quantitative; sequential mixed	PSTs
Olur & Ocak, 2021	digital literacy	scale development	4th grade
Pandya & Pagdilao, 2015	critical digital literacies	multimodal content analysis	elementary
Sadaf & Johnson, 2017	digital literacy; theory of planned behavior	surveys, interviews	teachers
Stockham & Collins, 2017	information literacy	surveys	PSTs and school media specialists
Trujillo Torres et al., 2020	information literacy	descriptive and inferential quantitative analysis	ECE teachers

Given the myriad options available for analyzing and understanding digital media in education, a justification must be made for why metaliteracy provides a unique lens through which to not only view these issues but also address them within the classroom space. Therefore, before diving into the results of this review, there necessitates a brief explanation of the strengths and weaknesses of these interrelated frameworks compared to metaliteracy.

Where information literacy focuses on many of the same core skills, such as analyzing, evaluating, and using information sources, metaliteracy uniquely focuses on digital sources rather than traditional print texts (American Library Association, 2006; Bent & Stubbings, 2011; Jacobson & Mackey, 2013). On the other hand, media literacy, visual literacy, and computational literacy focus on *components* of metaliteracy. However, they share a common problem of being too narrowly focused for use across various contexts, digital media platforms, and formats (K. Bloom & Johnston, 2010; diSessa, 2018; McTigue & Flowers, 2011).

Digital literacy can accomplish many of the same goals as metaliteracy. Several papers have conceptualized it in a similar fashion (Dewi et al., 2021; List et al., 2020; Tyner, 1998). However, this multitude of definitions for digital literacy means there is no consensus on its singular definition or codification, making it difficult to operationalize as a framework for content analysis (Buckingham, 2015; Labbo & Ryan, 2010; Tyner, 1998). It also provides less utility to teachers because it lacks standards and learning directives. On the other hand, documents such as ISTE's educational technology standards provide direction for teachers and administrators but do not have utility as an academic research framework (Crompton, 2017a).

Like digital literacy, new literacies studies can also give researchers a helpful theoretical jumping-off point. “New literacies” refer to the variety of sources and tools individuals navigate through in modern society beyond just printed text; digital literacy, media literacy, and literacy within pop culture artifacts are sometimes interwoven here (Gee, 2010). New literacies studies are also important for their framing of literacy as a social project, wherein individuals make use of texts and literacy practices to achieve their own goals in each moment (Gee, 2010). However, while many current studies using new literacies focus on technology and the digital realm, these do not form the confines of the new literacies space, nor are new literacies guaranteed to be viewed in terms of digital media in coming years (Knobel & Lankshear, 2014). Compared with these adjacent frameworks, metaliteracy has many applications for theory and practice while melding traditional print with multimodal sources and the digital world.

Another concept that sets metaliteracy apart from other frameworks is its emphasis on students as creators of digital media rather than passive readers (Jacobson & Mackey, 2017). As students analytically digest, then thoughtfully create content, they are encouraged to examine the relationship between information, technology, and power; there is an underlying goal that through producing digital media, students will become empowered as agents of social and political change (Jacobson & Mackey, 2017; Lewison et al., 2002; Morrell, 2015). Metaliteracy also argues that due to the ever-evolving nature of the digital space, learners must constantly reflect and re-evaluate their understandings of online communication; this is reminiscent of the critical reflection-action cycle found in critical literacy (Freire & Macedo, 2005). While these ideas and projects are often applied to higher grades, evidence suggests that elementary-aged students can and should be given opportunities to produce content with a social message (Bennett, 2012; Comber et al., 2001; Creighton, 1997; Demoiny & Ferraras-Stone, 2018).

One common area of examination is that of elementary teachers' digital awareness levels and technical capacities. Some evidence suggests that teachers lack a nuanced understanding of digital literacy, especially concerning the critical evaluation of sources (Avila & Pandya, 2013; Castellví et al., 2020; Garcia et al., 2020; Golden, 2017; Hauck, 2019; Pandya & Pagdilao, 2015). Studies that report teachers have at least a medium-level understanding of media and digital literacies often use self-reporting measures in their instruments, and the researchers recommend continued professional development in this area (e.g., Aslan, 2021; Erdem & Eristi, 2018). Other studies aim to measure elementary teachers' digital literacy knowledge by developing instruments such as the Digital Literacy Self-Efficacy scale (Akayoglu et al., 2020; Olur & Ocak, 2021). However, this does not extend to teachers' knowledge of the standards that they are directed to use for instruction.

It has also been suggested that American teachers are likely to see digital literacy in more of a goal-oriented fashion, viewing technology as another tool in one's toolkit rather than developing a critical-use view of the integrated nature of technology and literacy (List et al., 2020). A study by Trujillo Torres et al. (2020) corroborates this finding; their quantitative analysis revealed that teachers had "adequate" knowledge of digital literacy skills, with comparative weaknesses in areas such as evaluating the trustworthiness and accuracy of digital sources.

Studies of preservice teachers' digital literacy skills are inconclusive. Promisingly, studies focusing on preservice teachers sometimes reveal higher levels of digital literacy readiness, as in Liza and Andriyanti (2020)'s mixed-methods study. Furthermore, increased professional development at the university level has been shown to be effective in increasing teachers' digital literacy knowledge and their willingness to use digital tools in the classroom (Anisimova, 2020). In another examination, education students self-reported difficulty with information literacy concepts, including accessing and interpreting reliable information from various sources (Stockham & Collins, 2017).

However, an educator's understanding of digital literacy in her personal life does not necessarily translate to finesse in transferring these concepts to her students—particularly if she is unfamiliar with or lacks understanding of the state standards designed to guide the instruction of these concepts. For example, Lee et al. (2012)'s study revealed that preservice teachers perceived technology as a nice "add-on" or "bonus" to have in the classroom, but one that was primarily to be taught by librarians or technology teachers rather than integrated into the classroom. Similarly, Branch (2003)'s work on information literacy pedagogy among preservice teachers indicated that most preservice teachers had not considered metaliteracy skills to be within their instructional scope (Branch, 2003).

It remains challenging to evaluate the digital literacy knowledge of very young learners for many of the same reasons that other qualitative survey data with young subjects (e.g., kindergarteners) is complex. Most of the studies located in this review that did involve an early elementary-aged sample did not revolve around concepts of critical thinking as related to digital literacy but rather were skill-based, focusing on the potential benefits of using very specific technologies, apps, or new devices in the classroom (e.g., Bers, 2018; J.-Q. Chen & Chang, 2006; Dore & Dynia, 2020; Furman et al., 2019; Herman & Ciampa, 2019; Kjällander & Moinian, 2014; Yilmaz Genc & Fidan, 2017).

Child Development and Metaliteracy

The present study argues that the digital world is inextricable from literacy and, therefore, that it is imperative to instruct students in concepts of metaliteracy in order to adequately prepare them to live, grow, learn, and contribute to and in the world around them. Furthermore, the study highlights the juxtaposition of the prevalence of technology in the lives of young children with the lack of thoughtful classroom instruction regarding how to engage with said technology. In order to move forward with this study, it is also essential to understand how early elementary-aged children might engage with metaliteracy and technology on a developmental level.

For children ages 0 through 2, the American Academy of Pediatrics recommends against screen time of any form; this recommendation increases to two hours or less per day for children ages 2 through 5 (Guram & Heinz, 2018). While excess screen time in young children can induce adverse effects such as "irregular sleep patterns, behavioral issues, focus and attention problems, decreased academic performance, negative impact on socialization and language development, and the increase in the amount of time young children are spending in front of screens" (NAEYC, 2012, p. 3), it is crucial to consider the quality and nature of the digital content with which children are engaging, rather than merely the amount of time they spend on devices. Not all "screen time" is created equal.

The National Association for the Education of Young Children (NAEYC)'s 2012 position statement concerning the use of technology in the education of children from birth through age eight encourages the use of thoughtfully designed digital experiences to enhance young students' learning (NAEYC & Fred Rogers Center, 2012). Noting the ever-growing prevalence of digital tools in modern society, they write, "The shift to new media literacies and the need for digital literacy that encompasses both technology and media literacy will continue to shape the world in which young children are developing and learning" (NAEYC & Fred Rogers Center, 2012, p. 2).

While "screen time" can be defined as the number of minutes and hours a child spends interacting with any digital device in any format (Konca, 2021), the NAEYC statement, along with other literature within this discipline, draws into focus the difference between interactive and non-interactive media content. Many professionals particularly warn against the adverse effects of non-interactive media, like the passive viewing of television programs, videos, or movies, on the development of young children's brains (Guram & Heinz, 2018; Strasburger et al., 2010). However, interactive media, where students actively engage with a digital device towards some learning goal or goals, is more encouraged as a potential means of improving learning outcomes (Donohue & Schomburg, 2017).

The importance of play-based learning at the early childhood and elementary level is well-documented (Anderson-McNamee & Bailey, 2010; Pellegrini & Smith, 1998; Pyle & Danniels, 2017; P. K. Smith, 2009), but the concepts of *play* and *technology* are not often viewed as compatible. Recent research has explored how children engage in open-ended, creative play in virtual worlds (Du et al., 2021; Livingstone & Pothong, 2022; Marsh, 2010; Marsh et al., 2005). The development of touchscreen devices, such as smartphones and tablets, has made these virtual worlds even more accessible to young children (Furman et al., 2019; Yilmaz Genc & Fidan, 2017). Therefore, when incorporated in an accessible way that aligns with research on instructional best practices at this age range, engagement with virtual worlds can help children learn, develop their identities, and build skills in communication, creativity, and self-expression while also developing their fluency with technical skills (Jackson et al., 2014; Marsh et al., 2005).

As students engage in interactive digital technology, they learn the fundamental skills necessary for modern life. For example, just as educators of young children instruct concepts about print, such as how to turn a page and read left-to-right, so must they now instruct "technology-handling" skills, such as how to use a mouse and scroll through a website. According to the International Society for Technology, this is recommended as an instructional objective by age 5 (Crompton, 2017a; Trust, 2018). Therefore, technology experiences should be intentionally and thoughtfully designed by teachers. Similarly to how a skilled educator would not read directly from the curriculum guide verbatim without adapting it to her particular students, digital curricula that park students in front of a screen while they "teach at" them are ineffective and potentially damaging. Although they ostensibly incorporate "modern innovations" such as cutting-edge devices and software, these approaches ironically bear more similarities to the "banking model of education" as maligned by Freire (1972) half a century ago.

Also related to childhood development is the development of cognitive processes associated with metacognition, a significant component of metaliteracy. Concepts such as the Metacognitive Domain, the Researcher Role, the Informed Characteristic, and the Reflective Role require learners to think metacognitively about their learning processes and critically evaluate information for their research needs. While early research once indicated that young learners' brains were not advanced enough to think metacognitively, more recent research suggests that students as young as three years old engage in processes related to the regulation of their thinking (S. Chen & McDunn, 2022; Escolano-Pérez et al., 2019; Resendes et al., 2021; Whitebread et al., 2009). Students' verbal abilities and capacities for abstract thinking are still developing from three to seven years of age, impacting their capacities for deeper metacognition and the evaluation of said processes by external researchers (Papaleontiou-Louca & Thoma, 2014). However, research on hands-on tasks requiring metacognitive processes, such as pre-planning and evaluating, has indicated that young children draw upon metacognitive repertoires as they move through the world (Whitebread et al., 2009).

Overall, research demonstrates that when incorporated in a developmentally appropriate and thoughtful manner consistent with educational best practices, concepts of metaliteracy can enhance the elementary classroom and even improve individual student learning outcomes (Avila & Pandya, 2013; NAEYC & Fred Rogers Center, 2012; Tyner, 1998). There is overwhelming evidence to support the developmental need for young children to engage in real-world activities, such as exploration, creative play, and social interaction, due to a variety of mental and physical benefits (Anderson-McNamee & Bailey, 2010; Pellegrini & Smith, 1998; Pyle & Danniels, 2017; P. K. Smith, 2009). This should undoubtedly remain a mainstay of the elementary classroom. However, when considering the sociocultural context of students' lives outside the school building and beyond, digital literacy instruction is becoming an ever-growing necessity that can enrich students' school experiences.

Educational Standards

In the wake of large-scale national reform efforts such as the Improving America's Schools Act (IASA) of 1994 and No Child Left Behind (NCLB) in 2001, standards-based reform

(SBR) has become a commonly-seen means of changing education policy and practice across the United States. Hamilton et al. (2008), in their report on the history of SBR in the United States, write that most examples of SBR include some or all of the following:

> academic expectations for students (the standards are often described as indicating 'what students should know and be able to do)' alignment of the key elements of the educational system to promote attainment of these expectations, the use of assessments of student achievement to monitor performance, decentralization of responsibility for decisions relating to curriculum and instruction to schools, support and technical assistance to foster improvement of educational services, and accountability provisions that reward or sanction schools or students on the basis of measured performance. (p.4)

Standards-based reform (SBR) has existed in common educational discourse since the 1990s, around the time of the passage of the Improving America's Schools Act of 1994 (H.R.6 - 103rd Congress (1993-1994), 1994). Many attribute the origins of modern SBR to an essay entitled "Systemic School Reform" (M. S. Smith & O'Day, 1990). In the essay, Smith and O'Day (1990) emphasize the importance of alignment among all elements of instruction. Their theory of change for SBR suggests that by first designing solid standards for all academic subjects across grade levels, along with measurable goals for each, teachers' instructional practices will adapt accordingly, and students' learning potentials will increase (M. S. Smith & O'Day, 1990). Clune (2001)'s "Toward a Theory of Standards-based Reform: The Case of Nine NSF Statewide Systemic Initiatives" further elucidates the main concepts behind SBR. In his words, "Creating greater cohesion (or alignment) of instructional guidance policies (those affecting the content and quality of instruction in schools) is the only way to create large numbers of effective schools (schools producing desirably high levels of student achievement)" (Clune, 2001, pp. 13–14).

Proponents of statewide standards believe in their capacity to improve practice by enforcing stricter rules or codes (Ravitch, 1995). The ideas behind SBR were codified into law with the passage of No Child Left Behind (NCLB) in 2002, which was succeeded by the Every Student Succeeds Act (ESSA) in 2015 (Text - S.1177 - 114th Congress (2015-2016), 2015; Boehner, 2002). In order to gain insight as to what is currently known about the effects of SBR, the researcher conducted a literature review according to the previously mentioned search procedures; a summary of the articles included in this section of the review may be found in Table 2.

Table 2

Studies Investigating the Effects of Standards-Based Reform

Citation	Methods	Sample	Focus
Ardito, 2022	close reading; text analysis		NYS CS standards
Beach, 2011	content analysis		ELA CCSS
Carnoy & Loeb, 2002	regression analysis		4th-8th grade NAEP mathematics scores
Dee & Jacob, 2011	regression analysis	220-249 students	NAEP scores, 4th/8th grade
Hagge & Waltman, 2007	surveys	1,338 teachers	K-12
Hamilton & Berends, 2006	case study, survey	2,840 teachers	elementary & middle
Pedulla et al., 2003	surveys	4,195 teachers	K-12

Citation	Methods	Sample	Focus
Polikoff, 2015	content analysis	7 textbooks	textbooks as aligned to standards
Porter et al., 2011	content analysis	27 states' standards	alignment between state standards and CCSS
Smith & Kovacs, 2011	surveys	488 teachers	K-8 teachers
Stecher et al., 2004	surveys	400 teachers	4th grade, 7th grade
Stillman, 2009	case study	3 teachers	upper elementary
Tortorelli et al., 2022	content analysis	458 standards	grades 3-5 writing standards
Wright & Domke, 2019	content analysis	1,300+ sentences	

Since the passage of these laws, numerous studies have attempted to measure SBR's effects on students and teachers, with many of them reporting at least some significant effects on instruction and achievement (e.g., Betts et al., 2000; Carnoy & Loeb, 2002; Close et al., 2018; Cook-Harvey et al., 2016; Dee & Jacob, 2011; Stecher et al., 2004). These studies have been both qualitative and quantitative and have used a variety of methods, though forms of quantitative analysis and content analysis are common (Beach, 2011; Carnoy & Loeb, 2002; Dee & Jacob, 2011; Polikoff, 2015; A. C. Porter & Smithson, 2001; Tortorelli et al., 2022). It must be noted, however, that the methodology of content analysis itself needs clarification and greater consistency among the social sciences. For example, a 2006 review of 31 content analysis papers found that almost a third of them (n = 9) failed to define their units of analysis; they also frequently had inconsistent segmenting procedures and unclear definitions of codes (Strijbos et al., 2006). To conduct a reliable and valid content analysis, it is essential to learn from these mistakes and have clearly-defined methods, units, and coding procedures.

Just as content analysis as a method has had its detractors, SBR has also faced a great deal of criticism in the roughly two decades since its rise. Of primary concern have been states' varying measures of "proficiency" concerning standards instruction and the lack of consistency or uniformity within and across standards (Cronin et al., 2007; Rothstein et al., 2006). Critics deem this approach overly top-down and restrictive, limiting teacher autonomy; some argue that over a decade of implementing SBR, they have not yet had a meaningful positive impact (Loveless, 2021). Other naysayers cite increased stress and dissatisfaction among teachers as one negative impact of SBR (J. M. Smith & Kovacs, 2011).

While less common, a few studies in this review conducted a content or other textual analysis of a given set of standards (Beach, 2011; Polikoff, 2015; A. Porter et al., 2011; Wright & Domke, 2019). Some studies found that the standards articulated lower-level goals more clearly than those requiring higher-order thinking skills (Ardito, 2022). Others find that standards may need more alignment and focus, leading to issues when teachers and students attempt to translate the standards into classroom practice (Beach, 2011). Before adapting tests and classroom resources to be better aligned with the standards, education professionals must ensure that the standards effectively measure relevant concepts.

The present study is not necessarily concerned with arguing for or against the *existence* of standards. Instead, it operates from the understanding that educational standards will continue to exist and guide policy and practice, at least in the short term. If the standards are meant to shape classroom instructional plans, they should reflect best practices related to literacy instruction, which, as this chapter has also emphasized, now inherently involves digital literacies and metaliteracy. Since there does not yet exist an interdisciplinary metaliteracy model for elementary education enacted via state standards, one might logically start with the standards for the most relevant area(s) of instruction area: Computer Science and English Language Arts.

Emergent Elementary Computer Science Standards

In recent years, various teams of education professionals have attempted to create guiding standards for the instruction of computational literacy, digital literacy, and computer science. For this study, it is helpful to briefly review the history of the development of the Georgia Standards of Excellence, which were used in the study, and the ISTE standards, which are closely related. The Georgia Standards of Excellence (GSE) were used as the basis for the study's sample. This section provides a rationale for the decision to use the GSE, including background regarding how the GSE fit into the national context for K-12 computer science instruction. To do this, I will begin with the ISTE standards and the K-12 Computer Science Framework, which provided much of the inspiration for the GSE.

K-12 Computer Science Framework

Another national inspiration for the Georgia Standards of Excellence in Computer Science is the K-12 Computer Science Framework (K12CS), which was developed in 2016 under the K-12 Computer Science Framework Steering Committee, comprised of delegates from the Association for Computing Machinery, CODE, CSTeachers.Org, Cyber Innovation Center, and the National Math & Science Initiative (Committee, 2016). The framework is organized according to grade bands, concepts, and practices.

The K-12 Computer Science Framework includes the following seven practices:

- Fostering an Inclusive Computing Culture
- Collaborating Around Computing
- Recognizing and Defining Computational Problems
- Developing and Using Abstractions
- Creating Computational Artifacts
- Testing and Refining Computational Artifacts
- Communicating About Computing (K12CS, 2016).

Whereas the ISTE standards relate to the digital world more broadly, including its utility for amplifying student voice and driving learning, the K-12 CS Framework is more domain-specific to computer science technical knowledge capacities. The subject matter of the framework is organized into the following concepts across all grade bands: Computing Systems, Networks and the Internet, Data and Analysis, Algorithms and Programming, and Impacts of Computing (K12CS, 2016). The framework represents the skills and mindsets needed to build strong computer science students, but it does not involve sociocultural theories of literacy.

ISTE Standards

The International Society for Technology in Education, or ISTE, is a nonprofit organization dedicated to improving technology practices and digital literacy instruction in schools worldwide. In 2017, ISTE revised and redeveloped their preexisting standards into the 2017 ISTE standards. These standards have seven domains into which their learning objectives are divided: Empowered Learner, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator, and Global Collaborator (Crompton, 2017b).

The first domain of the revised ISTE standards is Empowered Learner, which requires students to serve as active participants in their learning. These standards require students to set personal goals regarding their takeaways from a given lesson, regardless of subject matter. Within the Empowered Learner domain, students are also responsible for reflecting on their learning processes and building relationships with their peers by working together on projects with some choice and agency (ISTE, 2016). Following the Empowered Learner domain is the Digital Citizen domain, which relates to identity development in digital spaces (ISTE, 2020d). Here, students understand that their online actions have lasting, real-world repercussions. They must also use technology ethically, protect their personal information, and understand concepts of data collection and tracking (ISTE, 2016).

Next, the Knowledge Constructor domain concerns how students use tools online to generate new artifacts and make meaning. This includes learning effective research habits, discerning the accuracy and credibility of sources, gathering information in a new format, and exploring issues with real-world significance (ISTE, 2016). Innovative Designer relates to students' use of the design process, encouraging students to either generate new media or find new solutions to existing problems. Under this domain, students also must grow comfortable with ambiguity and approaching open-ended problems (ISTE, 2020f).

The fifth domain, Computational Thinker, domain revolves around algorithms, data collection, and data analysis. Students must break down problems into their composite parts and rearrange them creatively into new models (ISTE, 2020b). Creative Communicator, on the other hand, concerns how students select and choose both the creative content and the dispersive format of their academic projects. In disseminating their knowledge, students are encouraged to use digital tools that incorporate multimodality, such as visualizations, models, and videos, considering their desired audience (ISTE, 2016, 2020c). The final strand, Global Collaborator, encourages students to connect with other individuals cross-culturally, as facilitated by digital tools to build new understandings (ISTE, 2016). In this manner, students must learn how to play various roles on a team as they work to find solutions to real-world local and international problems (ISTE, 2020e).

According to ISTE's 2020 Annual Report, all 50 states in America have incorporated at least part of ISTE's standards, whether their standards for students (as explained here) or for Educators (ISTE, 2020a). The Georgia Standards of Excellence, studied here, have many links to these standards, making Georgia a practical point through which to examine one state's understanding of literacy and computer science competencies.

Georgia Standards of Excellence

Computer Science. While the ISTE standards and K12CS framework exist as national recommendations, the Georgia Computer Science Standards of Excellence are one state's actualized guidelines for computer science instruction. These standards have six components: Empowered Learner, Digital Citizen, Creative Communicator, Innovative Designer and Creator, Reflective Researcher, and Digital Awareness (GADOE, 2020). These organizational domains are also accompanied by extended Teacher Notes, varying from 25 to over 50 pages per domain. The reader may already ascertain that these domains also correspond with the ISTE standards, with some of them being directly analogous. In fact, Empowered Learner, Digital Citizen, and Creative Communicator have precisely the same headlines. Likewise, Innovative Designer in the ISTE framework maps onto Innovative Designer and Creator on the GSE, but not entirely.

Finally, the GSE have Reflective Researcher and Digital Awareness, while ISTE has Computational Thinker, Knowledge Constructor, and Global Collaborator. The overlaps between these two frameworks are depicted in Table 3.

Table 3

ISTE and GSE Alignment

GSE CS Domain	ISTE Corrollary
Empowered Learner	Empowered Learner
Digital Citizen	Digital Citizen
Creative Communicator	Creative Communicator
Innovative Designer and Creator	Innovative Designer
Reflective Researcher	
Digital Awareness	
	Knowledge Constructor
	Computational Thinker
	Global Collaborator

English Language Arts. As mentioned above, the ISTE and K12CS frameworks focus more explicitly on computer science, not necessarily *intentionally* incorporating literacy skills. Since metaliteracy originates from the field of information literacy but also incorporates ideas from digital literacies and critical literacy, it serves as a more comprehensive prior framework for the bounds of this study. Similarly, this dissertation is interested in modern literacy as linked to digital practices; therefore, it examines the Georgia Computer Science standards, explained above, and the English Language Arts standards.

The Georgia Standards of Excellence (GSE) in English Language Arts are a more recent iteration of what were once called the Common Core Georgia Performance Standards (CCGPS), which were introduced in 2010 shortly after the debut of the Common Core State Standards (CCSS) (GADOE, 2016). Since then, partially as a response to political backlash over the Common Core, the standards have been revised to the Georgia Standards of Excellence (GSE). In 2019, after his election and inauguration as Governor, Brian Kemp stoked these past indignations and publicly stated his intent to rid the GSE of continuing influences of the CCSS (Bluestein, 2019). This political debacle continues, with new standards slated to be released in late 2023 (Grapevine, 2023). Despite these turbulent waters, the study of the standards could help illuminate the degree to which the state of Georgia embodies metaliteracy concepts and conceptualizes literacy as inclusive of digital competencies. If anything, now is an especially opportune time for this project, as its findings could be used to influence future iterations of the state's educational directives.

Conclusion

This chapter has provided a literature review of topics integral to the understanding of this dissertation. It began with a brief historical review of society's progression into the Information Age, providing the rationale for viewing literacy as inherently digital under consideration of sociocultural theories of literacy. Next, a review of extant relevant literature regarding metaliteracy, digital literacies, and young children was conducted. The results of this review indicated that, generally, metaliteracy remains an understudied framework within elementary education. However, examinations of other relevant studies found that teachers generally feel unprepared to teach digital literacy skills and that greater clarity around technology integration in the classroom is still needed. Additionally, research showed that interactive media and digital tools wherein the learner has greater agency and creative control benefit children's development, though limits on screen time should be kept in mind.

Next, a review of research about the content analysis of educational standards and background on the current landscape of standards related to young students' digital skills was conducted. Again, this review provided further evidence for the importance of the present study, as a) such research designs in an elementary literacy context are rare and b) the ongoing development of the Georgia Standards of Excellence necessitates a deep understanding of the current state of the standards.

3 METHODOLOGY

Introduction

The purpose of this study was to evaluate the Georgia Standards of Excellence for kindergarten, first grade, and second grade in both Computer Science (CS) and English Language Arts (ELA) to discern their current embodiment of concepts of metaliteracy, as well as themes related to new literacies more broadly. The research questions framing the study were:

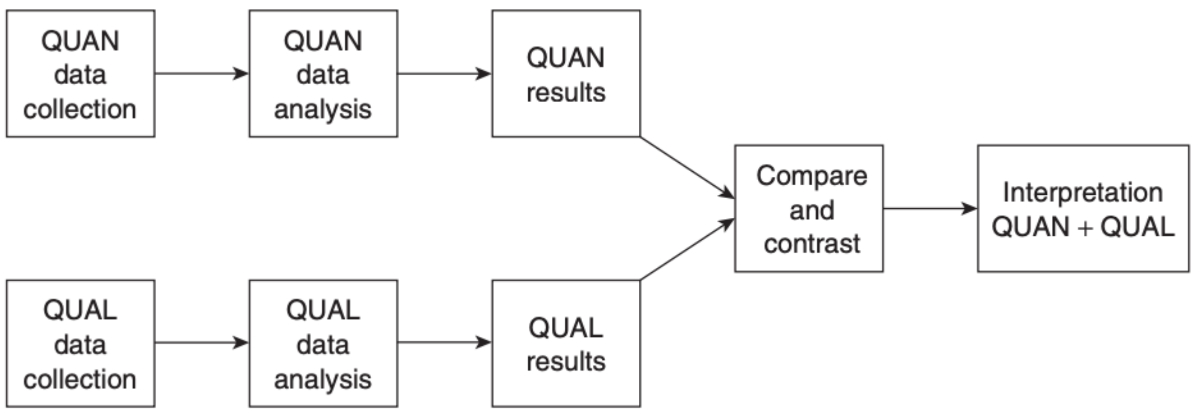
1. To what extent are the learning goals, learning domains, learner roles, and learner characteristics of metaliteracy (metaliteracy concepts) evident in the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts?
    a. How do metaliteracy concepts differ in prevalence between the CS and ELA corpora of standards?
    b. How do metaliteracy concepts differ between grade levels, considering both CS and ELA standards together?
2. What are the prevailing themes related to processes and practices in the K-2 Georgia Standards of Excellence for Computer Science and English Language Arts?

The study employed a mixed-methods triangulation design (Creswell, 1999). In this design, the same topic is observed using different approaches that are intended to complement one another; usually, this is meant to highlight and circumvent the respective strengths and weaknesses of qualitative and quantitative methods (Creswell & Clark, 2017). The first research question used a deductive quantitative content analysis approach to analyze the standards quantitatively. Neuendorf (2017) provided this research question's nine-step quantitative content analysis framework. Additionally, the study referenced other content analysis scholars like Krippendorff (2013), Lasswell (1968), and Berelson (1952) in its design. Schreier (2012)'s research on qualitative content analysis (QCA) and the history of content analysis also proved helpful in gaining context for the methodological decisions in this study, as did Hoffman (2011)'s chapter on the history of content analysis research. I employed a qualitative content analysis (QCA) approach using data-driven (inductive) categories to answer the second research question (Schreier, 2012). The process of building the coding frame and conceptualizing the codes was informed by thematic analysis (Braun & Clarke, 2012; Clarke et al., 2015) and completed according to the open coding approaches recommended in Saldaña (2015)'s *Coding Manual for Qualitative Researchers*.

My decision to employ this bilateral study design was both practical, to pursue the central problem, and meta-rhetorical, in that the design itself comments on convergence culture's emphasis on the participatory, dynamic, interactive nature of modern information (Jenkins, 2008). In a sense, the mixed-methods approach to rendering the data reflects the user's status as both consumer (and comprehender) and producer (and creator) of data and information, particularly that encountered in digital environments. I analyzed the first research question in a systematic, descriptive, quantitative manner that utilized *a priori* codes and concepts from the metaliteracy framework; here, I "reflected" the information–as much as possible. The second research question, though, represents my shift into an active participant and producer in "remixing" my knowledge, where I added new interpretations of the data and created novel thematic concepts indirectly influenced by my positionality. While these two research questions could arguably be viewed in isolation, their consideration in tandem speaks to the nature of the participatory media culture towards which metaliteracy could reframe students' literacy instruction and understanding. This follows the convergence model of triangulation mixed methods design, a depiction of which can be seen in Figure 4 (Creswell & Clark, 2017).

Figure 4

Convergence Model of Triangulation Mixed-Methods Design



(Creswell & Clark, 2017, p. 63)

In this chapter, I will detail the methods for both research questions. For my first research question, the content analysis method necessitates a discussion of theory and rationale, conceptualization decisions, variables, coding schemes, sampling measures, coding processes, reliability and validity, and data analysis and reporting (Neuendorf, 2017). The QCA in the second research question includes a discussion of theory and rationale, conceptualization decisions, building the coding frame, pilot testing, revising the coding frame, completing the QCA, ensuring reliability and validity, and data analysis and reporting.

Quantitative Content Analysis

The first research question of this study examines the extent to which the learning goals, learning domains, learner roles, and learner characteristics of metaliteracy (concepts of metaliteracy) are evident in the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts. For this question, content analysis was used to investigate the data. While it has evolved significantly with the development of the internet and the diversification of multimedia message sources, content analysis as a research method has existed for over 75 years (Prasad, 2008). Some even cite Wilcox (1900)'s study of newspaper articles during the Spanish American War as one of the earliest examples of modern content analysis (Bernard et al., 2016).

In *The Content Analysis Guidebook*, Kimberly Neuendorf defines the method as "the systematic, objective, quantitative analysis of message characteristics," which can be either human-coded or computer-aided text analyses (CATA) (Neuendorf, 2017, p. 1). This description of content analysis as a systematic, objective, and quantitative process is echoed by several other content analysis methodologists (Kassarjian, 1977; Riff et al., 2014; Weber, 1990). In addition, Neuendorf highlights the following six criteria as definitive of content analysis: reliance on the scientific method, quantitative in nature, summarizing in nature, applicable to all contexts, and available to all message characteristics.

Relying on the Scientific Method. In pursuing the scientific method, it is essential to remember concepts of objectivity-intersubjectivity, a priori design, reliability, validity, generalizability, replicability, and hypothesis testing (Neuendorf, 2017). Due to the mixed methods framing of this study, true objectivity was not the goal, as the study is grounded in sociocultural theories, which posit that lived experiences are shaped by culture and context (Gee, 2010; Lewis et al., 2007; Vygotksy, 1978) However, the study did aim towards intersubjectivity, or consistency with past inquiries in the field, as seen in the argument of the problem statement and the evidence in the literature review (Babbie, 2020). It also followed *a priori* design, meaning variables and measurements were decided upon before the content analysis. The remainder of these elements are discussed subsequently in the chapter.

The Message as the Unit of Analysis. Content analysis makes a clear distinction between the *unit of data collection* or *unit of observation*, which refers to “the element on which each variable is measured,” and the *unit of analysis*, which is that “for which findings are reported” (Neuendorf, 2017, p. 13). In content analysis, one or both units must be a *message unit*, or a piece of communication content. In this research question, the individual standard is the unit of data collection and analysis.

Quantitative. While content analysis often examines what is typically considered qualitative subject matter, like the contents of various documents, it does so by examining specific categories and amounts of variables, meaning that numerical processes undergird the study design. Neuendorf (2017) refers to this as the quantification of qualitative information. Variables within the content are operationalized and coded, and then their frequencies are reported and analyzed. Various descriptive and inferential statistics, including frequency data, correlation measures, and relations between variables, may be used to make sense of the content analysis data (Neuendorf, 2017).

Summarizing. The form of content analysis followed in the first research question aims to provide an overview of the representation of sets of characteristics across a set of units (Neuendorf, 2017). In so doing, the findings are explicit but broad. As conceptual content analysis provides a summary or overview of the contents of the text according to certain variables, its pairing with the inductive, open thematic analysis approach of research question 2 leads to rich findings.

Applicable to All Contexts. While content analysis has often been applied to the study of mass media or other mass communications, it can be applied to any field employing communicative units. For example, the analysis of educational standards may not be the most common usage of content analysis, but it does have precedent in the existing body of research (e.g., Bruckner et al., 2014; Love & Strimel, 2016; Wright & Domke, 2019). The context of state educational standards is appropriate for content analysis.

Availability of All Message Characteristics. A variety of qualities of messages may be analyzed in content analysis, including content elements, form elements, function, sequence, and latent or manifest themes (Morgan & Shanahan, 2010). Within this study's context, certain semi-latent metaliteracy concepts were made manifest via a researcher-created codebook with dictionary-like definitions. This process will be discussed further in the section of this chapter related to variable selection and operationalization.

Other Conceptualization Decisions. The decision was made to focus on kindergarten through second grade standards only in order to build off the ample body of research highlighting the importance of high-quality early learning opportunities, particularly in literacy skills such as reading and writing, while maintaining a feasible scope (Aram, 2005; Beals & De Temple, 1993; Bloodgood, 1999; Copple & Bredekamp, 2009). Furthermore, metaliteracy was chosen as the lens through which to analyze these standards because it provides a framework for integrating the skills needed for consuming and producing multimedia content from both a literacy and a computer science perspective (Jacobson & Mackey, 2017). Additionally, there is a comparative dearth of research regarding metaliteracy knowledge in the early elementary years. As stated in the literature review, metaliteracy has primarily been studied from a higher education and high school context and from the perspective of learning sciences (Atkinson, 2020; Jacobson & Mackey, 2013; Sales, 2022). Viewing this concept through an elementary literacy lens will further the discipline and address a gap in the research.

Qualitative Content Analysis (QCA)

The second research question did not use *a priori* codes but rather sought to identify novel insights from the standards. As such, it necessitated a fundamentally different approach. Several methods were considered, including grounded theory, discourse analysis, thematic analysis, and qualitative coding. Ultimately, Schreier (2012)'s data-driven (inductive) qualitative content analysis (QCA) was followed, and techniques inspired by Saldaña (2015)'s qualitative coding cycles also guided initial analyses and the development of the coding frame.

Schreier defines content analysis as "a method for systematically describing the meaning of qualitative material" that is "done by classifying material as instances of the categories of a coding frame" (Schreier, 2012, p. 12). Qualitative content analysis is justified by three core attributes: it is systematic, it is flexible, and it reduces data (Schreier, 2012). *Systematic* indicates that it follows the same sequence of steps in each project. The steps of qualitative content analysis followed in this study are:

1. Deciding a research question
2. Selecting material
3. Developing coding frame
4. Determining units
5. Pilot testing of the coding frame
6. Revising the coding frame

7. Conducting the main analysis
8. Data analysis and reporting (Schreier, 2012).

The ability to inductively develop the coding frame, pilot-test the coding frame, and revise the coding frame before conducting the main analysis all speak to qualitative content analysis's second main principle, its *flexibility*. The coding frame is iteratively tailored to the specific material being used and the insights the researcher uncovers while proceeding through each stage of the process. As such, the data-driven nature of coding frame development also incorporates researcher *reflexivity* into the study design process. Following a qualitative interpretivist epistemology, this second research question is further guided by the understanding that reality may have multiple meanings and interpretations (Schreier, 2012). As the researcher develops coding categories iteratively and inductively while coding and re-coding the data, the qualitative content analysis process also recognizes the researcher's reflexivity in generating results (Schreier, 2012).

Finally, qualitative content analysis *reduces data* by focusing the insights from the data on selected refined categories across cases or instances. As compared to other methods of analysis, it increases the amount of information gleaned in an aggregate sense while perhaps reducing the level of individual granularity. Here, given the study's framing regarding activity theory, metaliteracy, and convergence culture, the research focused on uncovering themes in the active processes required of the learner in the standards. The specifics of how the coding frame was developed are discussed in the "Coding" section of this chapter.

Qualitative Coding

In *The Coding Manual for Qualitative Researchers*, Saldaña (2015) describes a variety of approaches to first-cycle coding methods. Given the nature of my research question, I used the following three first-cycle coding procedures: In Vivo Coding for verb usage, Process Coding, and Values Coding. These first-cycle codes were used in a second-cycle pattern coding to uncover connections between the generated codes as related to the processes in which they asked students to engage; this led to the prototype of the novel coding frame that was utilized in the pilot test.

Sample

Both research questions utilized the same sample of data, which was collected via purposeful sampling and consisted of the K-2 GSE in CS and ELA. Importantly, this study advocates for the instruction of technology standards concurrently with literacy standards to develop digitally fluent learners capable of evaluating the information they encounter online. This is the rationale for focusing on both CS and ELA standards while not incorporating other GSE areas, such as math. Metaliteracy is a framework that can be used by many school personnel–general education teachers, literacy teachers, media specialists and librarians, technology teachers, etc. It can and should be applied to the fields of both literacy and computer science as it has its roots in information literacy and multimodal comprehension. Therefore, the study examines the themes evident in computer science and literacy standards using a limited scope–Georgia Standards of Excellence (GSE) for K-2.

The CS standards include the following categories: Empowered Learner, Knowledge Constructor, Digital Citizen, Innovative Designer and Creator, Computational Thinker, Creative Communicator, Global Collaborator, Reflective Researcher, and Digital Awareness (GADOE, 2020). The ELA standards are comprised of the following: Reading Literary, Reading Informational, Reading Foundational, Writing, Speaking and Listening, and Language (GADOE, 2016). Due to the nature of the research questions, I excluded the Reading Foundational and Language standards from the sample, which largely revolve around the rote instruction of phonics and grammar rules in the English language.

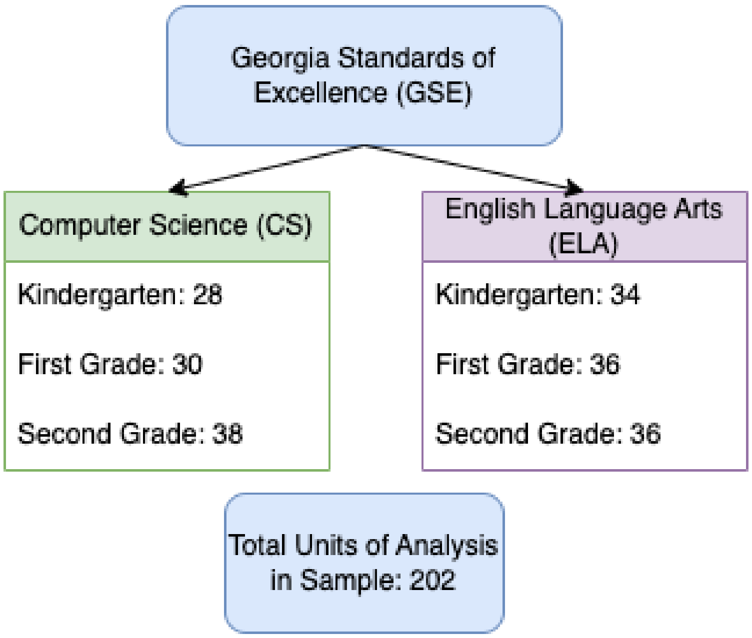
I also chose to focus on the Georgia Standards of Excellence (GSE) instead of observing multiple states or a more general framework because the results aimed to be relevant to teachers and to address the gap between theory and practice. Additionally, the GSE were intentionally designed using the ISTE and CSK-12 frameworks, which are also used by many other states. Therefore, while these results cannot be directly extrapolated from one state to the next, they serve as a useful starting point for future states' analysis, given that they do reflect much of the same source material.

Georgia Standards of Excellence

Viewing the standards documents, I unitized the standards by segmenting them into unique standards or sub-standards that expressed an entire message in one sentence or long phrase. In Georgia, there are 28 CS standard units for kindergarten, 30 for first grade, and 38 for second grade, making for a total of 96 standards. In the ELA GSE, there are 34, 36, and 36 standard or sub-standards in K, Grade 1, and Grade 2, respectively; this adds to 106 standards in all for ELA. Therefore, a total of 202 standards are used as the units of analysis in this content analysis. A representation of this is found in Figure 5. All standards are also in Appendix A.

Figure 5

K-2 Georgia Standards of Excellence in Computer Science and English Language Arts



(GADOE, 2016; GADOE, 2020)

There are a variety of ways to determine sample size for content analysis. Gottschalk and Bechtel (1995) recommend analyzing at least 85 to 90 words to ensure a representative sample, which this study surpasses. Neuendorf (2017) uses confidence intervals and standard error to determine adequate sample size. For a 10% sampling error and 99% level of confidence, the recommended sample size is 167 items, which this study exceeds (Neuendorf, 2017).

Units and Segmentation

Unitizing refers to determining which units of analysis, or text segments, are coded and analyzed in the study (Neuendorf, 2017). In the first research question, I collected data at the level of the individual standard or sub-standard as the unit. This standard usually took the form of a directive statement, e.g., “Ask and answer questions about key details in a text” (GADOE, 2016). The standards documents were segmented into individual standard or sub-standard statements, these statements were coded, and the results of this coding process were analyzed. However, I then used these results to reflect on the meaning of the comprehensive body of standards, which became the unit of analysis. Additionally, the standards were also analyzed according to their subject and grade-level attributes, serving as further units of analysis.

The second research question's unitizing process was a bit more complex. As I was building my frame for pilot testing, I used the individual word as the unit of data collection, as I generated In Vivo codes from each action verb in the sample (described in more detail later in this chapter). Moving into the refinement of the coding frame, the standard or sub-standard in statement form was used as the unit of data collection for the remainder of the study. Finally, to draw conclusions from and interpret the coding frame, the overall body of all 202 standards was once again used as the unit of analysis.

Coding

Research Question 1

Variables. For large-scale, quantitative content analysis, Neuendorf (2017) recommends the careful selection of critical variables through a variety of means. One method, which was used in this study, is the definition of variables based on prior research, frameworks, or theories. This study uses metaliteracy as the inductive theoretical basis for the variables in the content analysis. Metaliteracy divides its learning objectives into four overarching goals, thirty-four learning objectives, four learning domains, eight characteristics, and nine roles for the learner (Jacobson & Mackey, 2022). The eight characteristics and nine roles of metaliteracy are relatively straightforward, as they are predominantly nominalized verbs (as in roles) or action-oriented adjectives. The learning domains and learning goals are more latent and less easily visible in the raw units of analysis; therefore, they required more thoughtful parsing out and more subjective coding based on the researcher's definition of and understanding of these concepts.

The metaliterate learner characteristics are listed as follows: reflective, civic-minded, adaptable, open, productive, informed, collaborative, and participatory. On the other hand, the metaliterate learner roles are collaborator, producer, publisher, researcher, participant, communicator, translator, author, and teacher ("Integrated Metaliterate Learner Figure," 2020). There are 34 learning objectives across four goals, all of which correspond to one of four metaliterate learner domains: the cognitive, the behavioral, the affective, and the metacognitive (Jacobson & Mackey, 2022). To define these codes, I created *conceptual definitions* of the variables, which are detailed descriptions of each code that help guide the content analysis process.

Operationalization. The variables were operationalized by developing the dictionary-based codebook and designating the categories for each code. A total of 25 variables were coded for across 202 units of analysis. I ensured that these codes were exhaustive, mutually exclusive, and appropriate. Codes were *exhaustive* because each standard was ascribed to at least one representative code. Codes were *mutually exclusive* in that I viewed and coded for each variable separately, and there was no overlap within individual subcategories. Mutual exclusivity was initially a major issue with the study design because the concepts of metaliteracy are, by design, *not* mutually exclusive. For example, the creators of metaliteracy emphasize how one individual learning standard can occupy both the Cognitive and the Behavioral Learning Domain; similarly, there is overlap, though not total concentricity, between interrelated terms, like the characteristics of Producer and Author. Roles and Characteristics have corollaries as well, as seen in the equivalencies of the Participant Role and the Participatory Characteristic, for example.

I operationalized these variables by ascribing the standard under consideration a score of 0 if the given variable was not observed and a score of 1 if the given variable was observed. These variables were then analyzed via hypothesis testing using frequency data, variable presence scores (a measure of salience), and percentages. Dictionary-like definitions and inclusion criteria were also generated for each variable based on prior research and theory on metaliteracy (Jacobson & Mackey, 2013, 2017, 2022). Definitions of these variables, along with an excerpt from the researcher-created codebook, can be found in Appendix B.

Simulation of Hypothesis Testing. Krippendorff (2013) and Neuendorf (2017) recommend the hypothesis testing simulation model as one method of analyzing content analysis data. Since I had many variables and was seeking to determine their level of prevalence in the data, this fit the purposes of the study well. This process requires the coder to "cognitively-logically link each verbal recording unit with any one of several mutually exclusive hypotheses and ascertain to which it pertains and sometimes how strongly it supports or rejects either alternative" (Krippendorff, 2013, p. 79). The hypothesis testing procedure herein required a null hypothesis with twenty-five hypotheses to be tested. The full enumeration of these hypotheses can be found in Appendix C.

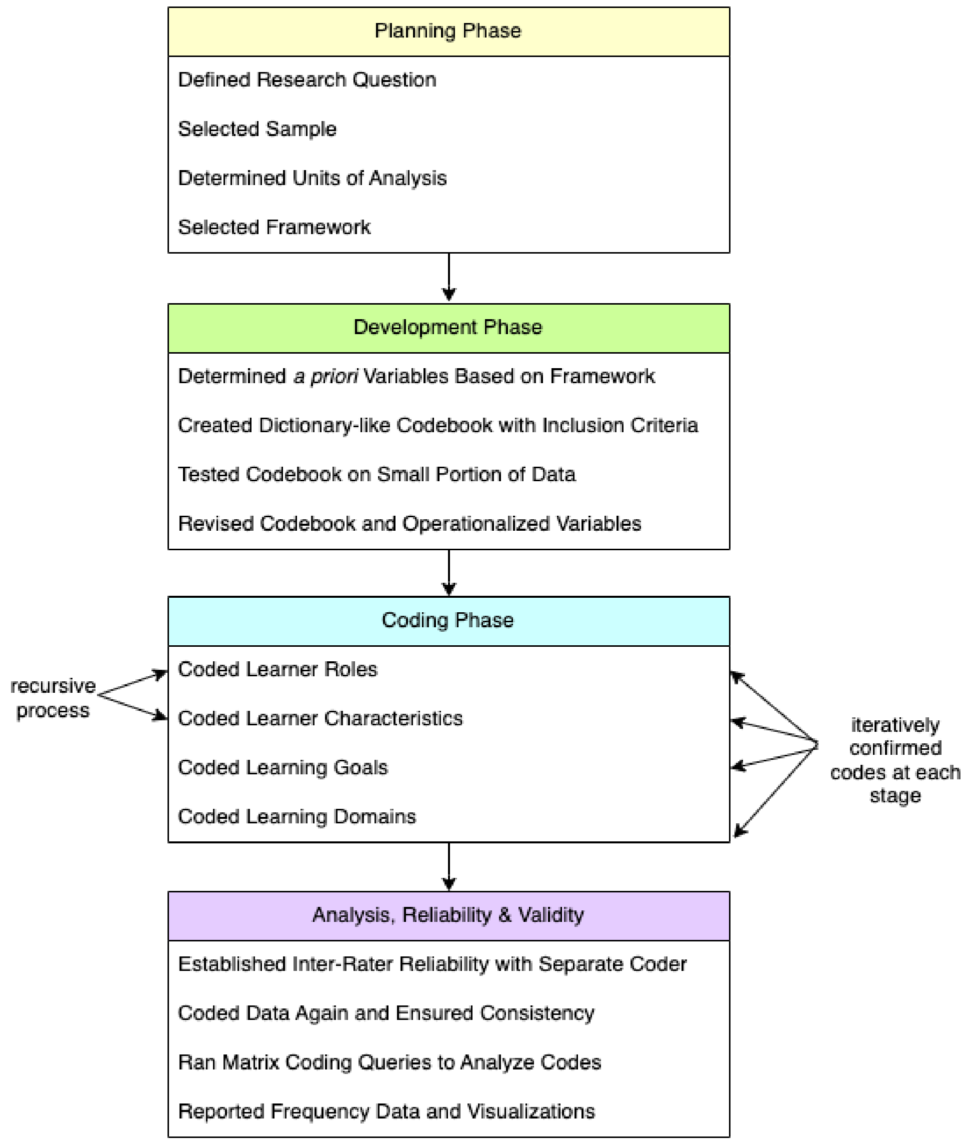
Content Analysis Process. The standards were stored in NVivo databases. The data was coded in NVivo according to a researcher-created codebook that drew heavily on *a priori* concepts influenced by metaliteracy. The coding process began with Learner Roles and Learner Characteristics for the kindergarten standards. Roles and Characteristics were concurrently coded due to their overlapping nature. For example, the “producer” role is akin to the “productive” characteristic; other paired codes include participant/participatory and collaborator/collaborative. These codes were also the most manifest out of the four coding categories, making them relatively straightforward. After completing the roles and characteristics for kindergarten, the coding process followed with the same two code categories for first and second grade.

Once the first round of Learner Roles and Learner Characteristics coding was complete, the process moved on to the first round of coding for Learning Goals. The researcher coded for the presence of all 4 of the metaliteracy learning goals for all three grades. The final category to be coded in this first coding cycle was that of the four learning domains: behavioral, affective, cognitive, and metacognitive. While there were only four codes within this category, it was a lengthy and arduous process, as these codes were more general than the Roles, Characteristics, or Goals; furthermore, individual units of data collection often had the presence of multiple Domains.

After this initial round of coding was complete, the researcher conducted a round of re-coding, comparing these results with the first round of codes. Double coding is highly recommended to ensure the reliability of content analyses (Krippendorff, 2013; Neuendorf, 2017). After the double-coding process, the author confirmed the codes with an additional coder and established inter-rater reliability once the codes had been confirmed. A graphical representation of the coding process for the first research question can be found in Figure 6.

Figure 6

Quantitative Content Analysis Coding Process for Research Question 1



Research Question 2

Developing and Revising the Coding Frame. Qualitative content analysis (QCA) differs from other common qualitative methods like coding, discourse analysis, thematic analysis, and semiotics in several ways, one of which is the development of a specific coding frame via several cyclical processes *before* conducting the main analysis. The qualitative coding frame focuses the research analysis on several key aspects, called *dimensions* or *main categories*, which are then broken down hierarchically into *subcategories* that specify the manifestations of the main categories (Schreier, 2012). These can either be developed in a concept-driven (deductive), data-driven (inductive), or hybrid format. This study used a data-driven process to select, structure, and generate the coding frame wherein the researcher allowed key categories and concepts to emerge from the data. One method of creating and structuring a data-driven coding frame is to use adapted grounded theory processes (Schreier, 2012). Therefore, I utilized several qualitative coding methods to begin category and subcategory generation, including In Vivo codes, process codes, and values codes for first-cycle coding methods and pattern coding for second-cycle coding methods (Saldaña, 2015; Schreier, 2012).

In Vivo Coding and Process Coding are both elemental methods of first-cycle coding, meaning that they "have basic but focused filters" and "build a foundation for future coding cycles" (Saldaña, 2009, p. 66). During the In Vivo coding process, the actual words in the body of data are used as short codes. According to Saldaña, "salience may be attributed to such features as impacting nouns, action-oriented verbs, evocative word choices" and more (Saldaña, 2009, p. 75). In the case of this study, I was interested in what the GSE are asking students to do—what behaviors teachers are eliciting from their students with every lesson. As such, I began the open coding process by making codes for all the action verbs in the text.

After generating these In Vivo codes, I started pattern coding, or grouping codes into a smaller number of loosely defined concepts or themes (Saldaña, 2015). Specifically, I did this by writing all the verbs on their own individual small notecards and arranging them evenly across a flat surface. At this stage, there were a total of 116 unique verbs. I began to reduce the data into categories by grouping similar words and finding loose connections in the activities suggested by the verbs. I grouped verbs according to similarities, starting with the simplest condensations. For example, even grouping together the gerund and active form of the same verb (e.g., use and using) condensed the list of codes significantly. I then examined the verbs with the greatest number of coding references in the aggregate data and grouped similar verbs accordingly. This arranging and re-arranging process took several iterative and recursive cycles, through which I took many descriptive analytic memos and consulted with two peer debriefers. Ultimately, I was able to generate five *main categories* for my coding frame from this process. Each category represented a continuum of related activities and learning processes suggested by the standards.

To develop subcategories and further refine the coding frame, I used process coding. Process coding consists of labeling the actions in the data by researcher-generated gerunds that may be latent or manifest (Saldaña, 2015). While this process was like the aforementioned In Vivo coding process, I was not lifting verbs directly from the text but rather summarizing the entire standard's demands of the student into one or multiple processes as I read and re-read the content. As I proceeded through the data with these process codes, I continued to revise and refine the five categories generated by the In Vivo coding process. At this stage, I developed three subcategories for each of the five main categories.

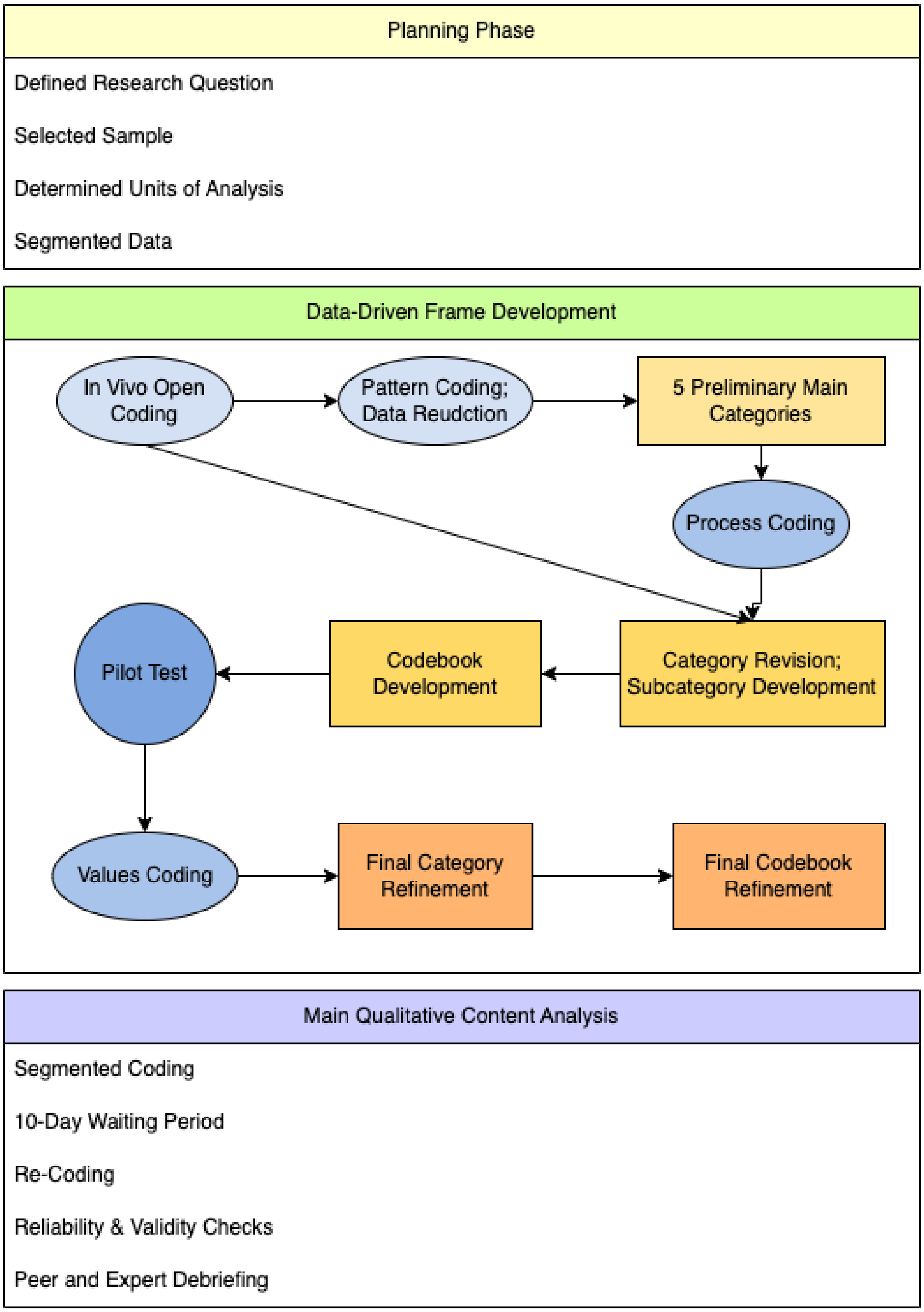
Pilot Testing and Revision. After developing and refining the initial coding frame, I conducted a pilot testing process. The pilot testing process "involves trying out your coding frame on part of your material" and "allows you to identify the inevitable shortcomings of your coding frame at an early stage" (Schreier, 2012, p. 147). It is recommended to try out your coding frame on 10 to 20 percent of your overall material, so I used the kindergarten computer science standards (one-sixth of my overall data), keeping analytic memos noting my successes and difficulties. During this phase, I noticed several standards whose actions were not adequately captured by the five main categories I had generated. I also realized that two of my preexisting categories could be condensed into one category with more nuanced subcategories. At this point, I was left with four categories and an extraneous scattering of codes that did not quite fit.

To rectify this, I engaged in Values Coding, an affective coding method focusing on "subjective qualities of human experience… by directly acknowledging and naming those experiences" (Saldaña, 2009, p. 86). Here, I named the values, beliefs, and opinions embedded within the standards, which I constructed cyclically during this third round of coding. Upon reconciling these with the pre-existing coding frame, I found that all but a small, related group aligned with the five predetermined main categories in my coding frame. I created, then, a final main category to encompass this last group of values-related actions. As I had also collapsed two of my prior categories during the pilot testing process, my coding frame now consisted of five main categories, each with three subcategories.

Main Analysis. After developing and refining the coding frame, I coded the data systematically using the developed frame and definitions. To improve reliability and validity, qualitative content analysis recommends double coding the main analysis after a designated elapsed time of 10-14 days. I followed this approach by re-coding the data myself after two weeks had passed from my first attempt at the main analysis. A visual depiction of the iterative coding processes in which I engaged can be seen in Figure 7.

Figure 7

Qualitative Content Analysis Coding and Frame Development Process



Data Analysis and Reporting

Research Question 1

This research question revolved around understanding the presence of metaliteracy's goals, domains, roles, and characteristics in the K-2 CS and ELA GSE. As mentioned earlier in this chapter, traditional content analysis often consists of creating specific hypotheses about the relationships between variables observed in the study according to trends from past research (Krippendorff, 2013; Neuendorf, 2017). In determining how to analyze this type of data, Neuendorf writes that more exploratory questions in content analysis are often answered without statistical tests but rather with "simple frequencies of occurrence" (Neuendorf, 2017, p. 184).

This study used the simulation of hypothesis testing method to analyze the first research question with descriptive methods to explore its two subquestions. For each standard, numerical frequencies were coded categorically for each variable (0 if absent and 1 if present). From these frequencies, variable presence (*VP*) measures were calculated using the following formula:

$$VP = a/n$$

Here, *a* indicates the number of 1s recorded for a given variable, and *n* indicates the total number of units in the sample. This determination of variable presence is similar to the concept of salience and has precedence in other content analysis studies (Krippendorff, 2013; M. Smith & Taffler, 2000; Vega, 2010).

To determine whether a given variable was adequately supported by the standards, the researcher used a formula to determine cutoff scores. Keeping in mind the nature of the metaliteracy framework and past content analysis and alignment studies, the researcher determined that support would be defined by equal representation for a given variable as compared with other variables of the same type. In other words, a variable could be considered supported by the curriculum if it was present in a proportional share of the total body of standards. This is supported by past research that also determines the alignment of state standards to latent themes (Vega, 2010). The formula to determine the adequate support levels was as follows:

$$SL = 1/c$$

where c indicates the total number of variables within a given category, e.g., 9 Learner Roles, 8 Learner Characteristics, 4 Learning Domains, and 4 Learning Goals.

After conducting these calculations, the support levels were determined to be .111 for Learner Roles, .125 for Learner Characteristics, .25 for Learning Domains, and .25 for Learning Goals. Each variable's prevalence level was evaluated compared to this support level to determine whether its hypothesis could be rejected or would fail to be rejected. Additionally, data matrices and graphs were used to present the findings, where the researcher reported and discussed the evidence for each variable in the data in both raw frequency and percentage form. For the subsequent research questions exploring the variations in variable manifestation according to subject and grade level, simple frequencies, descriptive statistics, and visual representations were presented and interpreted.

Research Question 2

Schreier (2012) states that in many instances of qualitative content analysis (QCA), the resulting, refined, complete coding frame serves as the most important finding from the study and may be presented descriptively, category by category. Therefore, the report of my results began with a detailed qualitative description of the nature of each category, with relevant illustrations and quotations to depict each component. I utilized NVivo, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS), to store, categorize, and analyze my data. From NVivo, I ran matrix coding queries that allowed me to view frequency data for each main category and subcategory. From this data matrix, I presented basic frequency data and qualitative descriptive data from the standards to further illustrate the nature of each category and its prevalence in the standards.

Researcher Role and Positionality

As this study is mixed methods, it incorporates qualitative methods for a significant portion of the study, as seen in the pursuit of Research Question 2, using qualitative content analysis. Even in the first research question, the quantitative content analysis design means that the researcher is "intimately involved in interpreting and finding meaning in the text because meaning is not readily apparent on the surface" (Kleinheksel et al., 2020, p. 129). Content analysis studies often include a "Role of the Researcher" section to elaborate on how the researcher's background, interests, and worldviews may have interacted with the source material (Holmes & Gary, 2020). Throughout this research process, I have kept a reflexive dissertation journal where I carefully considered, at each stage, how my identity and past experiences might have affected the research product. This statement on the role of the researcher delineates several areas of my positionality that I believe are crucial and relevant to how I conceptualized this project and how it fits into the world of education research more broadly.

Several factors of my identity have impacted the choices and lived experiences that have led me to this very moment, writing this dissertation. It is impossible to completely and discretely isolate the impacts that one factor of my identity may have had without considering how they are all situated beside and between one another. Like any researcher, I bring to the interpretation of the data many unique points of view and experiences, of which I may or may not be aware. This dissertation is about elementary educational standards in the state of Georgia within the subjects of Computer Science and English Language Arts. To this context, I bring my positionality as a white, millennial doctoral student and developing researcher with considerable experience teaching in elementary schools throughout the Southeastern United States. Before I was a doctoral student, I was a teacher; before that, I was an undergraduate student. Still earlier, I was a child who, in many ways, grew up alongside the internet itself. Each of these shifting identities, in part, catalyzed its successor.

As an elementary school student in the 1990s, I was extremely privileged to have access to technology at school: a handful of “Green Screens” on which I mostly remember playing Snake and Lemonade Stand. The way I recall it, I was immediately enraptured by this digital world. It might be shocking to hear this from someone writing a dissertation, but I was a *bit* of a nerd, and technology opened a whole new universe to me: one where I finally felt like I fit in. As time went on and this universe expanded, my passion deepened; to this day, I am an avid gamer and have actual, close, “IRL” friends I first met in online communities. Growing up in the age of the internet has provided me with a firsthand understanding of the rapid changes that have taken place in technology and the need to instruct students regarding digital engagement thoughtfully.

These early experiences allowed me to view the internet as a powerful place for social change, a place where one’s voice and view could both be extended, if utilized strategically. On the internet, opportunities can feel unlimited–if you have access. The amount of access to technology I have always had in my educational experiences is a privilege that is still not universal in schools (Warschauer et al., 2014). Though I actively seek other opinions and consider the impacts of my identity markers, I can, in some ways, only understand this study from this perspective. While this study's framing does not explicitly relate to racial identity, it is important to consider how race interacts with digital literacy and how this may impact my interpretations. Even "nerd culture" in America is typically seen as distinctly white and male (Bucholtz, 2001). While I am passionate about viewing the internet as a tool for social action and change, I recognize the limitations of my vantage point.

In my years of experience in the classroom, I have worked at various schools, each with their own unique cultures, student bodies, and resources. Having taught kindergarten through third grade, as well as ESOL and intervention, I have seen firsthand how technology and digital media have become increasingly present in the lives of young learners. My experiences have driven my interest in exploring how technology and digital media can be integrated into early elementary education to promote digital literacy. I have worked at schools with one-to-one technology that only used it to put students in front of scripted learning programs, and I have worked in a classroom with two old desktop computers where my students were able to thoughtfully create multimedia digital research projects. These experiences have guided me to believe in the importance not only of improving access to updated technological devices but also of improving the quality of and awareness around digital literacy instruction.

Most recently, I bring my experiences in academia to this work. As an undergraduate education policy student who became an elementary school teacher, I developed a passion for bridging the gap between policy and practice. In my subsequent experiences in the Ph.D. program, I pursued advanced quantitative methods coursework while assisting with several qualitative research studies; I became simultaneously fascinated by data and subjectivity. Engaging in directed readings and other courses related to race, power, and privilege, I developed an understanding of the importance of recurrent and mindful consideration of my own identity and how it might shape my research trajectory. While the focus of this dissertation is to analyze the content of a subset of educational standards, my beliefs about the liberatory and expansive potential of schooling (Freire, 1970) likely shape my interpretations.

Digital devices, tools, and media have been influential in the very drafting of this dissertation. I used NVivo to collect, organize, and analyze my data, visualizing it with other software like Draw.io and Tableau. I used Google Docs to keep track of each chapter's progress, sharing it with my debriefers for feedback. I even used a citation manager, Zotero, to keep track of my references, which were located via electronic databases. While I could have completed the dissertation with much *less* connection to the online world, using the reference materials at the library and writing with a basic word processor, these instruments help me process my data, edit my thoughts, and share my content in an accessible format. Furthermore, the digital skills that I utilized in creating this dissertation are ones that I first began developing as a child, from playing Type to Learn 3 in the computer lab to building fan pages with organized hyperlink collections about my favorite book and television characters. In this way, writing this dissertation has allowed me to embody many of the principles of metaliteracy and has underscored to me the importance of digital literacy development.

Reliability and Validity

Research Question 1

Reliability in content analysis refers to the replicability of similar results throughout repeated trials and is a manner of measuring trustworthiness. In order to increase reliability, I consulted an expert debriefer and two peer debriefers throughout every stage of the design, data collection, and data analysis processes. Additionally, Krippendorff (2013) recommends that a second coder works independently with a portion of the dataset to improve reliability. Similarly, Neuendorf (2017) recommends that reliability is measured as "the amount of agreement or correspondence among two or more coders" (p. 141). To this end, I recruited and trained one additional coder to calculate reliability on a portion of the dataset.

The second coder, another doctoral student in early childhood education, was trained in the processes recommended by Neuendorf (2017). I explained the relevant research from these three chapters to the coder. I then familiarized the coder with the content to be analyzed and the codebook. I also provided the coder with all relevant materials via hard copy and electronic format. Following this, I described to the coder the content analysis process, and I demonstrated to the coder how to code the data by modeling the coding of one unit of analysis (e.g., one standard). The coder and I then coded several units together and discussed the selection of codes and any disagreements. Then, the coder and I individually coded several more units and engaged in a similar discussion as to the rationale behind coding decisions. After this point, the coder and I independently, yet concurrently, coded 20% of the overall dataset. We compared our codes using two measures of reliability: the percentage of agreement and Cohen's kappa. The formula for percentage of agreement used was:

$$Percentage\ of\ agreement\ = \frac{\text{Number of units with coding agreement}}{\text{Total number of units}} \times 100$$

In addition to percentage of agreement, Cohen's kappa was also used to improve the reliability of the content analysis. Cohen's kappa provides a more robust measure of reliability and is useful when there are only two coders and the variables observed are categorical and mutually exclusive (Neuendorf, 2017; Warrens, 2015). Given this study's design, Cohen's kappa was calculated for all variables in the study, which was calculated using the following formula (Cohen, 1960):

$$\kappa = \frac{p_o - p_e}{1 - p_e}$$

where p_o indicates observed agreement and p_e represents the agreement that could be reasonably expected due to chance (Cohen, 1960; Warrens, 2015). This value was calculated for all 25 variables coded in this part of the study. Prior research determines that kappa values between 0.41 and 0.60 are moderate, values from 0.61 to 0.80 are substantial agreement, and any kappa value over 0.81 indicates excellent or almost perfect agreement (McHugh, 2012). Kappa values for all variables in the study ranged from 0.69 to 1.00, with 18 variables reaching a perfect 1.00 agreement measure. Therefore, adequate interrater reliability was achieved before finalizing the codes and determining the study's findings.

Validity refers to the degree to which a measurement precisely represents the concept it is intended to measure (Krippendorff, 2013; Neuendorf, 2017). In content analysis, this means that the coding categories and criteria accurately capture the intended content, representing the phenomenon under investigation. To accomplish this, I established an inductive coding scheme encompassing all relevant metaliteracy aspects. Additionally, I employed a systematic and rigorous approach to coding, ensuring consistency and objectivity in my interpretations. By addressing these validity considerations, I have improved the credibility of my findings and contributed to the overall strength of the research. As the study's findings assist in answering the research questions that form the basis of the study, it is considered valid.

Research Question 2

The QCA portion of the study followed procedures for credibility, transferability, and dependability in qualitative studies as recommended by Lincoln and Guba (1986). Adapting commonly held measures of trustworthiness for quantitative studies, the authors developed measures to ensure “truth value, applicability, consistency, and neutrality” (Lincoln & Guba, 1986, p. 76). I also triangulated the data by using two research questions employing different methods which viewed the data from different perspectives. I increased transferability by providing ample background data and using a set of standards influenced by national frameworks. Finally, I worked towards dependability by supplying precise and complete records of all methodological decisions in the study, including all information generated during the data analysis process (Cho & Lee, 2014; Lincoln & Guba, 1986).

In QCA, *stability* is used as a concept related to reliability, wherein, according to Schreier, “the coding frame is considered reliable to the extent that the results of the analysis remain stable over time” (Schreier, 2012, p. 177). This was achieved in several ways. First, I engaged in an extensive coding frame development process with three refinement cycles, including a full pilot test. This also helped ensure credibility or truth value by ensuring I had prolonged contact with the data, engaging with it repeatedly over an extended period (Lincoln & Guba, 1986). Next, I completed the main analysis phase twice, with a 10–14-day period between coding rounds, and I ensured that my results were consistent. Finally, I enlisted the aid of two peer debriefers and one expert debriefer to cross-check my results. While I did not have a formal inter-coder agreement procedure for this research question, as it was not necessitated by the methodology I pursued, I did discuss the codes with these debriefers in detail to evaluate the stability of the coding frame.

Two main facets of validity are of interest in a descriptive, qualitative, data-driven content analysis: face validity and content validity (Schreier, 2012). *Face validity* refers to “the extent to which your instrument gives the impression of measuring what it is supposed to measure” (Neuendorf, 2017, p. 115). Conversely, content validity can be inferred to exist “to the extent that an instrument covers all dimensions of a concept” (Schreier, 2012, p. 185). Face validity was determined during the pilot testing phase of the study. There, I ensured that I could adequately describe my data in terms of my categories; my categories adequately encompassed the material.

Additionally, I improved face validity during the pilot testing process by adding my sixth category, which allowed me to capture all themes contained in the standards more precisely. I also ameliorated face validity by inspecting the distribution of the standards across the subcategories, ensuring that there was not an improper balance away from or towards a particular category that could not be explained by the actual differences in the standards. During the second phase of the development of the initial coding frame, using the process codes, I improved this face validity by breaking down the five main categories into their nuanced subcategories. Content validity was achieved by comparing my coding frame and results with preexisting theory and other related coding frames, such as the Metaliteracy framework, ISTE standards, and the K12CS framework (Crompton, 2017a; Jacobson & Mackey, 2017; K12CS, 2016). I also consulted with an expert debriefer who determined that the categories adequately represented the concepts observed.

Summary

This chapter described the methods used in this dissertation, which sought to understand the presence of metaliteracy in the K-2 GSE for CS and LA and the prevailing themes in the standards. The data were analyzed for the first research question using content analysis (Krippendorff, 2013; Neuendorf, 2017). The data source was comprised of 202 standard phrases from the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts for Kindergarten through Second Grade. The unit of analysis was the individual standard or objective. Data were coded manually in NVivo according to a predetermined codebook, which was researcher-created. The researcher-created codebook was developed in reference to the framework of metaliteracy's learning goals, learning domains, learner roles, and learner characteristics (Jacobson & Mackey, 2022). Data were coded twice by the researcher to ensure that the codes were comprehensive. In addition, a peer debriefer was enlisted to verify the coding process and ensure study reliability. Data were analyzed using descriptive statistics, frequency tables, and hypothesis testing with the aid of NVivo and Microsoft Excel. Frameworks and visualizations were generated using NVivo, Draw.io, and Tableau. The same standards were analyzed using qualitative content analysis (QCA) and thematic analysis for the second research question. First-cycle coding methods included In Vivo coding, process coding, and values coding. Second-cycle and third-cycle pattern coding processes revealed themes in the overall data, which were analyzed and reported using narrative descriptions and network and matrix displays. The findings of this process are delineated in Chapter 4.

4 RESULTS

As the digital environment continues to shape cultural literacy practices, it becomes increasingly important to explore the intersection of metaliteracy, instructional processes, and educational standards. This chapter presents the findings of a two-phase, mixed-methods research study examining the themes of the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts. The researcher used quantitative and qualitative content analysis methods to uncover these notions (Krippendorff, 2013; Neuendorf, 2017; Saldaña, 2015; Schreier, 2012). The following research questions guided this pursuit:

1. To what extent are the learning goals, learning domains, learner roles, and learner characteristics of metaliteracy (metaliteracy concepts) evident in the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts?
    a. How do metaliteracy concepts differ in prevalence between the CS and ELA corpora of standards?
    b. How do metaliteracy concepts differ between grade levels, considering both CS and ELA standards together?
2. What are the prevailing themes related to processes and practices in the K-2 Georgia Standards of Excellence for Computer Science and English Language Arts?

Analysis for the first research question is presented using frequency tables and descriptive statistics for each of the 25 categorical variables coded. The second research question's findings are primarily depicted through the presentation and description of the novel researcher-created coding frame. A summary of the data reported concludes each section.

Research Question 1: Simulation of Hypothesis Testing

The researcher downloaded the Georgia Standards of Excellence for Kindergarten, First Grade, and Second Grade in Computer Science and English Language Arts from the Georgia Department of Education website. Next, the researcher uploaded these files to NVivo, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS). The data were segmented by individual standard or sub-standard, which formed the unit of analysis. A total of 202 items were gathered to serve as the sample for the data, with 96 items from the Computer Science curriculum and 106 from the Language Arts curriculum. After developing the codebook based on the Learner Characteristics, Learner Roles, Learning Goals, and Learning Domains of Metaliteracy, the researcher coded the data, including a double-coding process and establishing inter-rater reliability with an additional coder.

The resulting content analysis examined 25 variables: nine roles, eight characteristics, four domains, and four goals. These variables were operationalized as binary categorical variables wherein a value of 0 indicated no presence of the code and a value of 1 indicated evidence for the code. This study design was modified to meet the content analysis criteria of mutual exclusivity, wherein subcategories cannot overlap (Krippendorff, 2013). As such, this does limit some of the interpretation available in the content analysis, which must be kept in mind as the findings are presented.

This section presents total counts for each variable across all 202 standards. After reporting this data, Variable Presence Scores will be compared to the Adequate Support Levels established in Chapter 3. Subquestions for this research question included comparisons across grade levels (kindergarten, first grade, and second grade) and subject areas (Computer Science and English Language Arts).

Overall Results

For each of the 25 variables observed, the researcher calculated the frequency of 0s (no presence in the unit), frequency of 1s (indicating presence of the given code), Variable Presence Score, and percentage prevalence, which can be found in Appendix D. Frequency of 1s for each variable ranged from 5 to 126, while the Frequency of 0s ranged from 76 to 197. The total number of units coded for each variable was $n = 202$. These frequency counts were used to determine Variable Presence (*VP*) scores via the following formula:

$$VP = a/n$$

, where a indicates the total frequency of 1s and n is the total number of units coded for a given variable. For example, the Author role received a score of $a = 38$ for Frequency of 1s. Dividing this number by n=202 results in the Variable Presence Score of 0.188, demonstrating the proportion of the standards coded that indicated support for the Author role of metaliteracy.

These Variable Presence Scores were then used to decide whether to reject the hypotheses for each variable. A higher Variable Presence Score, which ranges from 0 to 1, reflects a greater proportion of the curriculum being aligned to or showing support for the given variable. The Support Level benchmarks, used to reject or fail to reject each hypothesis, were designed based on precedent from several prior content analysis and alignment studies (Beach, 2011; Neuendorf, 2017; Vega, 2010; Seitz, 2017). A minimum criterion benchmark for Support Level (*SL*) to reject or fail to reject a hypothesis was determined following the assumption of the null hypothesis that the concepts of metaliteracy could be equally and adequately supported by the GSE. To establish the minimum benchmark for *SL*, a cut-score value was determined using:

$$SL = 1/c$$

, where *c* indicates the number of variables measured within a given category of metaliteracy. Because each category of metaliteracy (Roles, Characteristics, Goals, and Domains) is conceptualized and presented separately, separate *SL* values were determined for each area. As this is an introductory and exploratory study in this field, a generous benchmark was established, assuming a minimal equal spread per category, even though multiple variables within a given field could be ascribed to a particular standard. In other words, the *SL* benchmarks assume that the Author role could be seen in at least 1/9 of the standards, as it is one of 9 roles, although it could theoretically be seen in a greater proportion of the standards without *impeding* on another role's potential visibility. Table 4 shows the Adequate Support Levels for each variable.

Table 4

Adequate Support Levels for Quantitative Content Analysis Hypothesis Testing

Variables	Adequate Support Level
Author, Collaborator, Communicator, Participant, Producer, Publisher, Researcher, Teacher, Translator	.11
Adaptable, Civic-Minded, Collaborative, Informed, Open, Participatory, Productive, Reflective	.13
Affective, Behavioral, Cognitive, Metacognitive	.25
Goal 1, Goal 2, Goal 3, Goal 4	.25

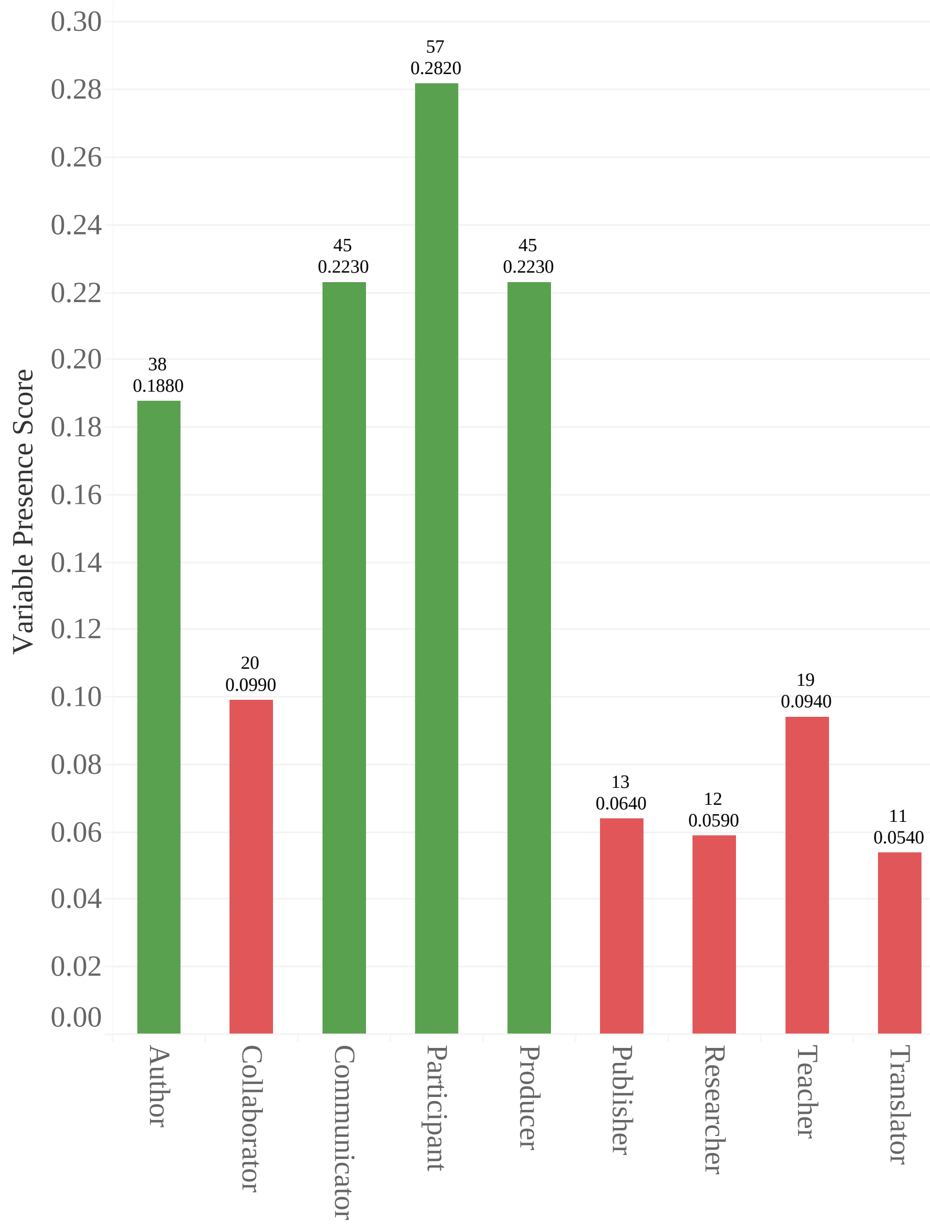
The Variable Presence Scores for each variable were then compared to their respective Adequate Support Levels to determine the outcome of each hypothesis test. The complete results of the hypothesis testing process are reported in Appendix D. Overall, eight hypotheses were not able to be rejected: H_1 (Author Role), H_3 (Communicator Role), H_4 (Participant Role), H_5 (Producer Role), H_{15} (Participatory Role), H_{16} (Productive Role), H_{19} (Behavioral Domain), and H_{20} (Cognitive Domain). In contrast, the remaining seventeen hypotheses did not have adequate support in the data collected and were rejected. Therefore, across the entire sample, the standards encourage students to serve as Authors, Communicators, Participants, and Producers while engaging in Behavioral and Cognitive processes. However, the standards lack emphasis regarding the remaining variables: Collaborator, Publisher, Researcher, Teacher, Translator, Adaptable, Civic-Minded, Collaborative, Informed, Open, Reflective, Affective, Metacognitive, Goal 1, Goal 2, Goal 3, or Goal 4.

This chapter will delve deeper into the relative manifestations of these 25 variables, discussing the Learner Roles, Learner Characteristics, Learning Goals, and Learning Domains in turn, using data matrices and graphs to visualize the findings. Subsequently, the subquestions exploring comparisons across grades and subjects are also examined. Chapter 5 will further interpret these findings and evaluate their significance for the elementary literacy space.

Learner Roles. Figure 8 depicts the 9 Learner Roles in bar graph form. Participant (n = 57) was the most common category, followed by Producer (n = 45) and Communicator (n = 45), Author (n = 38), Collaborator (n = 20), Teacher (n = 19), Publisher (n = 13), Researcher (n = 12), and Translator (n = 11).

Figure 8

Learner Roles Variable Presence, Entire Sample



Note: The first value above each bar represents the frequency of 1s coded for each variable, while the second value indicates the Variable Presence Score for that variable.

Out of the nine learner roles, there were four whose hypotheses could not be rejected: Participant, Communicator, Producer, and Author. The Participant role was present in over 28% of the standards and represented the learner's engagement in communities of learning, both digitally and in the classroom space. The Communicator and Producer roles were both present in 22.3% of the standards. The Communicator role refers to the learner's ability to exchange information with others in local, digital, and global senses, while the Producer role represents the generation of content, media, or material by the learner, either in novel or remixed form. Finally, the Author role, representing the learner's ability to create unique messages both in the written word and multimedia, was present in 18.8% of standards. Table 5 presents selected standards representative of these roles.

Table 5

Adequate Presence Learner Role Example Excerpts

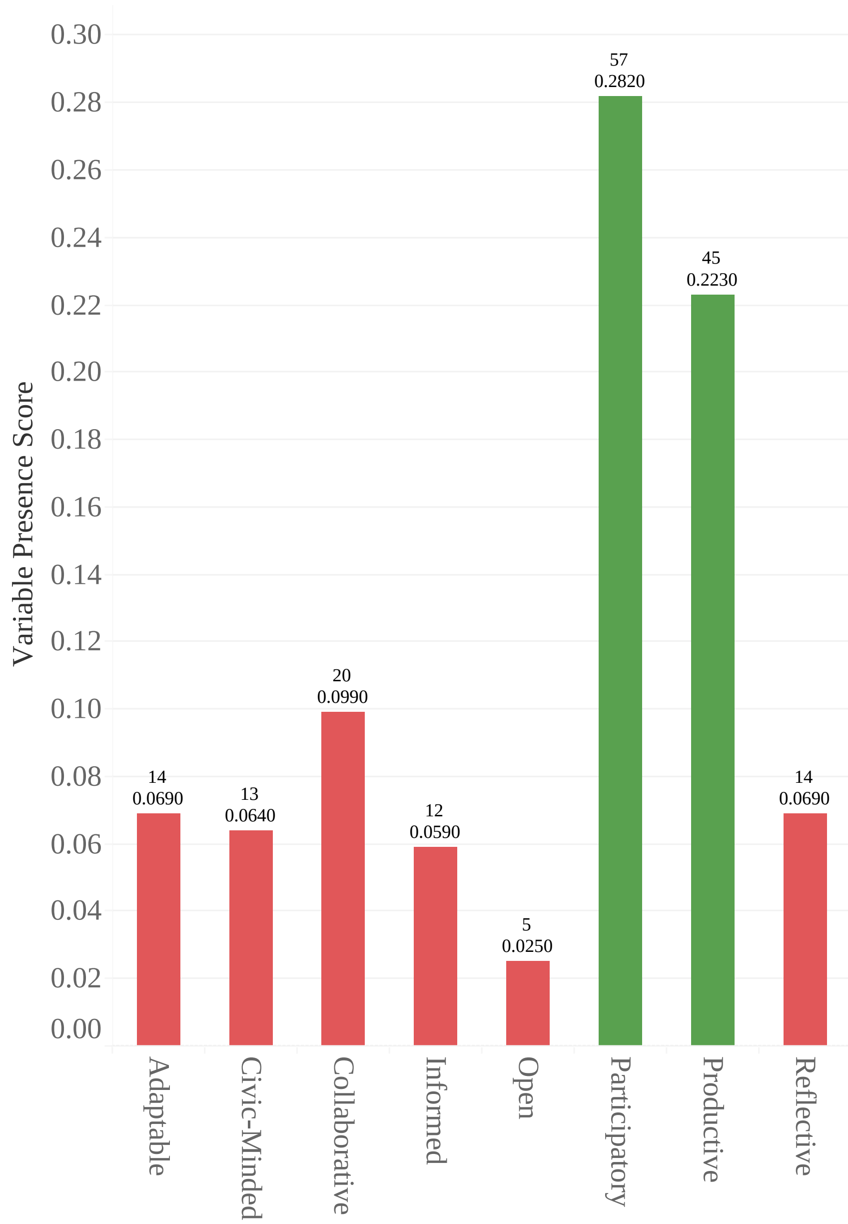
Role	Percent Prevalence	Example
Participant	28.20%	Participate in shared research and writing projects.
Communicator	22.30%	Build on others' talk in conversations by responding to comments through multiple exchanges
Producer	22.30%	Build (use, modify and/or create) collections of digital images and words to communicate learning using a variety of media types.
Author	18.80%	Write informative/ explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.

Several Learner Roles failed to meet the threshold for adequate Variable Presence in the standards. Compared to the Communicator and Participant roles, the underrepresentation of the Collaborator role suggests that while students are engaging in conversations with one another and even sharing information with one another, they may not be working together in their learning processes. Similarly, the lack of presence of the Publisher and Teacher roles, contrasted with the presence of the Author and Producer roles, suggests that the standards do guide the students towards creating their own original works within the classroom but may not encourage students' connections to broader society. Finally, the Researcher (*VP* = .06) and Translator (*VP* = .05) roles did not meet threshold scores for Variable Presence, either. The Researcher role relates to evaluating sources, compiling information, using online databases, and other research-oriented skills. In contrast, the Translator role concerns the dissemination of knowledge via its transformation from one media format into another. This provokes consideration of whether these processes have a greater place in elementary literacy education.

Learner Characteristics. Next, the frequencies and Variable Presence Scores were examined for the following Learner Characteristics: Adaptable, Civic-Minded, Collaborative, Informed, Open, Participatory, Productive, and Reflective. Figure 9 depicts the Learner Characteristics visually in the entire sample.

Figure 9

Learner Characteristics Variable Presence, Entire Sample



Note: The first value above each bar represents the frequency of 1s coded for each variable, while the second value indicates the Variable Presence Score for that variable.

In the hypothesis testing portion of the study, the characteristics of Participatory (*n* = 57, *VP* = .28) and Productive (*n* = 45, *VP* = .22) met criteria for adequate Variable Presence. This is consistent with the findings for Learner Roles, where the Participant and Producer roles also met Variable Presence criteria. The drastically greater visibility of these two Characteristics is evident in Figure 10. As these variables were nearly identical to their Role counterparts, they necessitate little further explanation at this stage.

Many characteristics failed to meet criteria for variable presence. The Open characteristic (*n* = 5, *VP* = 0.03) had the least visibility in the data. This variable represents the understanding of different perspectives and interaction with individuals who come from different backgrounds (Jacobson & Mackey, 2022). Relatedly, the Civic-Minded (*n* = 13, *VP* = .06) characteristic was coded for when the standard related to creating and sustaining communities, either in the classroom or online, including developing understandings about the individual's role and responsibility in impacting and upkeeping their community. The Reflective (*n* = 14, *VP* = .07) characteristic, whose hypothesis was also rejected, indicated standards that engaged the learner in metacognitive processes, such as the consideration of their level of understanding of a topic or the evaluation of their work's strengths and weaknesses. The underrepresentation of these categories may indicate that the standards are more oriented toward the learner's expression of skills and competencies over the development of understandings within the learner regarding their role in society, how they connect with others, and their own identity development as a learner on a mindset level.

Three other characteristics that did not meet the Adequate Variable Presence level were the Informed, Adaptable, and Collaborative characteristics. Informed (*n* = 12, *VP* = .06) relates specifically to understanding information *about* content, such as its authorship, origin, reliability, and potential biases, while Adaptable (*n* = 14, *VP* = .07) was marked in standards specifically related to developing the learner's capacity to engage with information and content in multiple formats. Finally, the Collaborative characteristic (*n* = 20, *VP* = 0.10) is related to the Collaborator role. Just as in the Learner Roles section of the findings, this characteristic narrowly missed presence threshold scores. This indicates that while the standards do encourage learners to work together on projects, this is less common than either solitary productive (*n* = 45) tasks or participatory (*n* = 57) activities that do not necessarily require collaborative work on a shared project. Table 6 presents a text matrix giving examples of standards that met each code.

Table 6

Learner Characteristics Example Excerpts

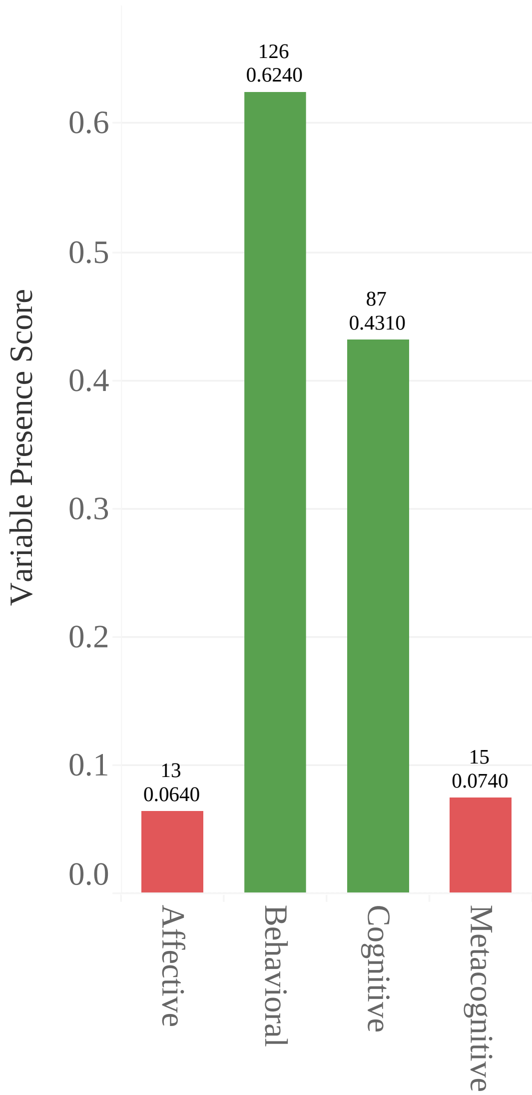
Role	Prevalence	Example
Participatory	28.20%	Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.
Productive	22.30%	Create an artifact that shows the use of positive safe behavior when using technology.
Collaborative	9.90%	Use digital tools to collaborate with others both locally and globally.
Reflective	6.90%	Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.
Adaptable	6.90%	Identify multiple ways solutions can be applied to solve problems. Vocabulary Term: Abstraction
Civic-Minded	6.40%	Identify the rights, responsibilities, and opportunities of living, learning, and working in an interconnected society and model behaviors that are safe, legal, and ethical.

Informed	5.90%	Understand that resources on the Internet vary in quality and are found in a variety of places so care is needed in selection.
Open	2.50%	Use digital tools to connect with individuals from different backgrounds and cultures.

Learning Domains. Figure 10 shows the representation of each Learning Domain across all 202 units of analysis. The Behavioral, Cognitive, Affective, and Metacognitive domains were coded for, and their frequencies were analyzed. According to the hypothesis testing process, the Behavioral and Cognitive scores met criteria for adequate support in the sample (*VP* = .62 and .43, respectively). However, the Affective (*VP* = .06) and Metacognitive (*VP* = .07) domains' hypotheses were rejected. This indicates a much greater emphasis in the standards on behavioral and cognitive tasks, as opposed to metacognitive or affective demands.

Figure 10

Learning Domains Variable Presence, Entire Sample



As a reminder, the Behavioral Domain relates to the instruction of skills and basic understandings, including technical and literary skills. On the other hand, the Cognitive Domain relates to higher-order thinking processes such as evaluation, analysis, problem-solving, and creation. The Metacognitive Domain relates to the learner's "thinking about their own thinking," and the Affective Domain concerns the development of attitudes, dispositions, and mindsets that are useful in navigating online learning environments. Table 7 presents a text matrix with selected example units matching these variables.

Table 7

Learning Domains Example Excerpts

Domain	Variable Prevalence	Example
Behavioral	.62	Ask and answer questions about key details in a text.
Cognitive	.43	Build (use, modify and/or create) collections of digital images and words to communicate learning using a variety of media types.
Metacognitive	.07	Describe how technology can impact an individual's life positively and negatively.
Affective	.06	Create an artifact that demonstrates a positive personal digital identity.

Learning Goals. Finally, Figure 11 depicts the manifestation of the four Learning Goals across the 202 standards viewed as the entire sample. As a reminder, the four learning goals are as follows:

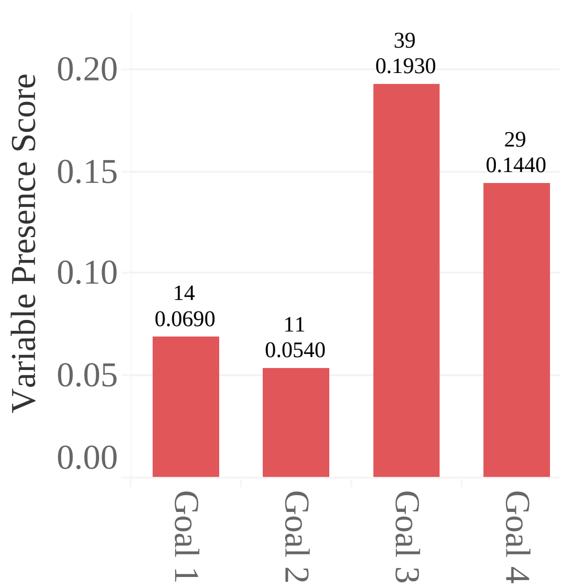
> "Goal 1: Actively evaluate content while also evaluating one's own biases…
> Goal 2: Engage with all intellectual property ethically and responsibly…
> Goal 3: Produce and share information in collaborative and participatory environments…
> Goal 4: Develop learning strategies to meet lifelong personal and professional goals." (Mackey & Jacobson, 2019)

No Learning Goals met the hypothesis testing criteria for adequate support in the standards. However, Goal 3 (n = 39, VP = 0.193) returned the highest frequency count, followed by Goal 4 (n = 29, VP = 0.144), Goal 1 (n = 14, VP = 0.069), and Goal 2 (n = 11, VP = 0.054).

The highly specific nature of the Learning Goals led to precise inclusion criteria in the codebook, which, in turn, resulted in overall low frequencies for each Learning Goal. The methodological decision was made to code for the entire Learning Goal as opposed to counting for presence of part of the Learning Goal's phrasing in the unit of observation. As an example, a standard related to "evaluating content" that did not also emphasize "evaluating one's own biases" would not be counted as evidence of Learning Goal 1. Future studies could revise this inclusion criteria and disaggregate the Learning Goal into its composite parts to observe alignment. For now, this is noted in this and the subsequent chapter of the dissertation.

Figure 11

Learning Goals Variable Presence, Entire Sample



Subquestion 1: Comparing Subject Variable Presence Scores

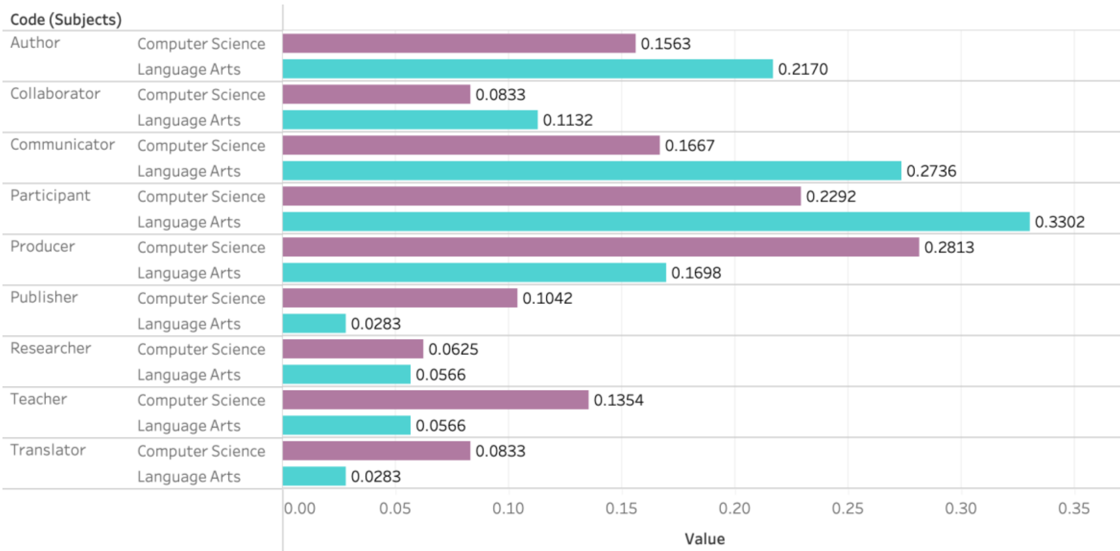
Learner Roles. In addition to the formal hypothesis testing process, this research question sought to uncover any notable differences in Variable Presence between the Computer

Science and English Language Arts bodies of standards. While the sample size is smaller for these two subsets (*n*=96 for Computer Science and *n*=106 for English Language Arts), the comparison across subjects still reveals several interesting disparities as compared to the overall data. Appendix D provides a table disaggregating all variables according to subject, including their frequency counts and variable presence scores. The rest of the notable differences will be presented here visually.

Figure 12 depicts the presence of Learner Roles according to subject. The four variables (Author, Communicator, Participant, and Producer) that met the threshold for adequate presence in the overall dataset also met criterion for presence in both subjects. The most notable discrepancy from the Learner Roles came from the Teacher variable, which met presence criteria in Computer Science (*VP*=0.14), but not English Language Arts (*VP*=0.03). In the researcher-created codebook, the Teacher role was defined as "one who uses one's own skill sets or abilities to educate others" and "one who shares their learning with others." This indicates that while both subjects encourage authorship and producing content, the Computer Science standards have a proportionally greater emphasis on the sharing and dissemination of one's own knowledge to an audience.

Figure 12

Learner Roles, All Grades, According to Subject

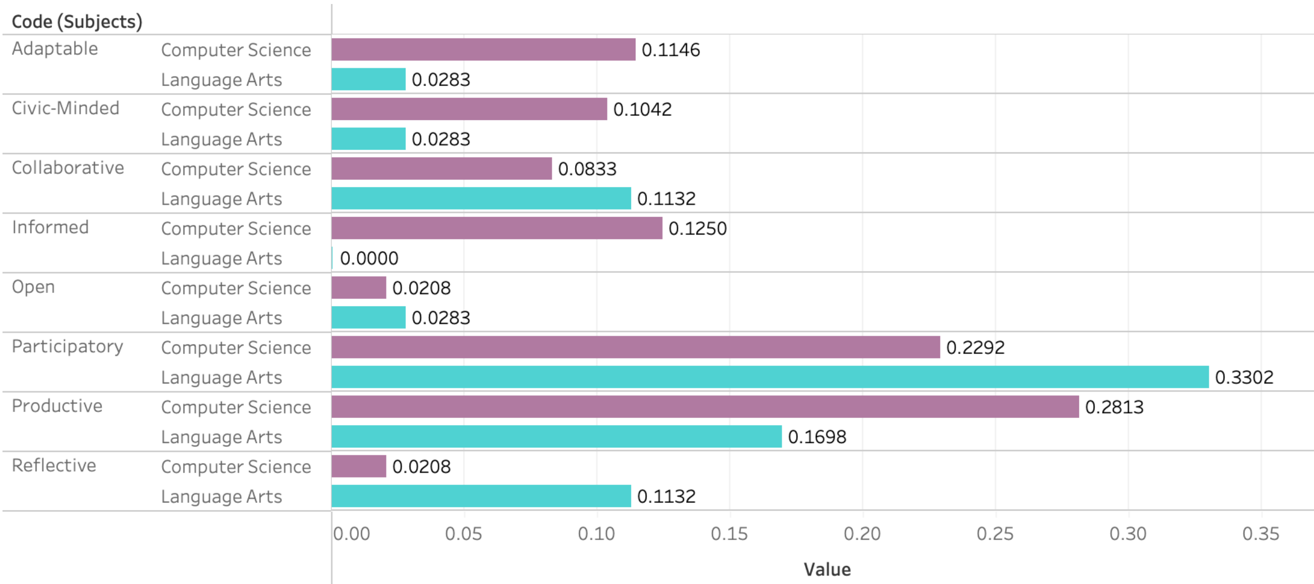


Further observations from the comparison bar chart include the higher visibility of the Translator and Publishing roles in the Computer Science standards as compared to English Language Arts, despite neither of them meeting criteria for Variable Presence. On the other hand, the Author, Communicator, and Participant roles did meet presence score criteria for both subjects but were visibly more present in Language Arts than Computer Science.

Learner Characteristics. Several further discrepancies could be found in the Learner Characteristics category, as depicted in Figure 13. Namely, the Collaborative, Reflective, and Open characteristics had greater frequency counts in English Language Arts than in Computer Science, while Adaptable, Civic-Minded, and Informed came more frequently from Computer Science than English Language Arts. In fact, the Informed Characteristic (n = 12) came entirely from Computer Science; there were no English Language Arts standards that could definitively meet inclusion criteria for this characteristic.

Figure 13

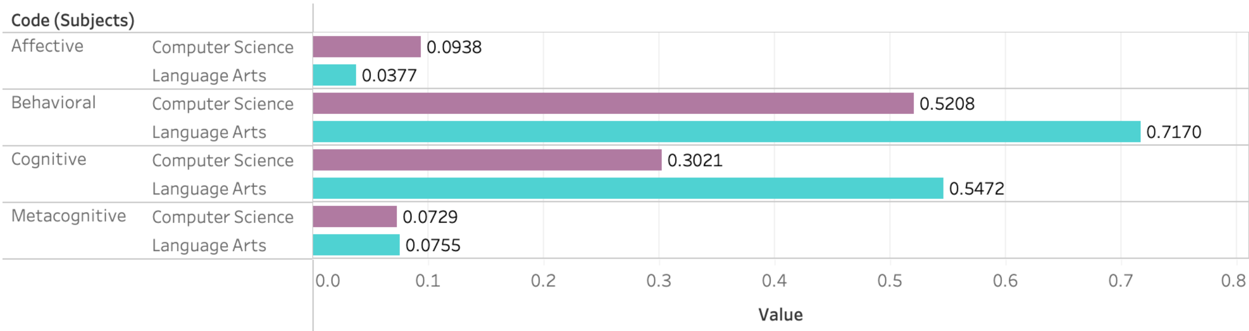
Learner Characteristics, All Grades, According to Subject



Learning Domains. Disaggregating the data according to subject, similar trends are visible. The Behavioral domain met presence criteria in Computer Science (*VP* = 0.52) and English Language Arts (*VP* = 0.72), having more references in English Language Arts overall. The Cognitive domain also met presence criteria in both Computer Science (*VP* = .30) and English Language Arts (*VP* = 0.55), with greater frequency counts in English Language Arts. The Metacognitive Domain's levels of presence in Computer Science and English Language Arts were roughly equivalent (*VP* = .07 and .08, respectively), while the Affective Domain had higher presence in Computer Science than English Language Arts (*VP* = .09 versus VP = .04). This information can be seen in Figure 14.

Figure 14

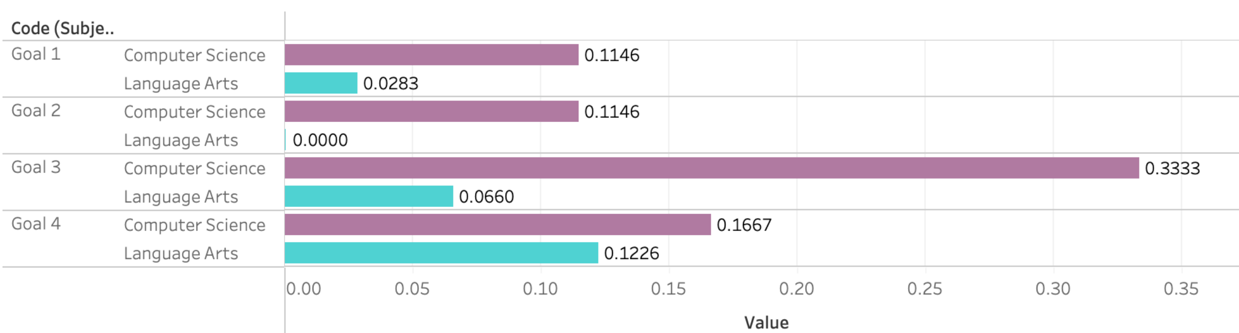
Learning Domains, All Grades, According to Subject



Learning Goals. All 4 Learning Goals had higher Variable Presence in Computer Science than English Language Arts, even though none met Support Level criteria in the whole dataset. Furthermore, Goal 3, "Produce and share information in collaborative and participatory environments," was adequately represented in Computer Science (*VP* = 0.333) but not in Language Arts (*VP* = 0.066).

Figure 15

Learning Goals, All Grades, According to Subject



Subquestion 2: Comparing Grade Variable Presence Scores

The final subquestion I explored as part of Research Question 1 was a comparison of representation of characteristics between grades. This data in full can be found in Appendix D.

Differences between grades were largely not remarkable, likely due to the spiraled nature of the standards—many of the standards across grades are interrelated, building in depth and complexity as students age. Relatedly, this caused the counts for some variables to increase as the grade level increased, as seen in: Learner Roles of Author, Collaborator, Communicator, Participant, Producer, Publisher, Teacher, and Translator; Learner Characteristics of Adaptable, Collaborative, Informed, Participatory, and Productive; the Cognitive Learning Domain; and Learning Goal 3. Other than this general trend, frequencies across grades occasionally oscillated or varied by 1 or 2 counts, as seen in variables such as Author, Communicator, Participant, Publisher, Researcher, Collaborator, Producer, Civic-Minded, Open, Reflective, Teacher, and the other three Learning Goals. Overall, the small sample sizes when disaggregated by grade make meaningful interpretation of this data difficult, but the data are still presented out of fidelity toward the original research question.

Summary

This section of the chapter presented the findings for the first research question, which consisted of a quantitative content analysis of the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts using a codebook of 25 binary variables derived from the metaliteracy framework (Jacobson & Mackey, 2022). The researcher used a simulation of hypothesis testing to determine whether the variables were adequately supported by the standards. A total of four Learner Roles, two Learner Characteristics, two Learning Domains, and no Learning Goals were found to have adequate presence in the data: the Author, Communicator, Participant, and Producer Roles; the Participatory and Productive Characteristics; and the Behavioral and Cognitive Domains. Tables and bar graphs visualized the data, which were also disaggregated according to subject area and grade level. Discrepancies between Variable Presence Scores (*VP*) in Computer Science and English Language Arts were also noted. Variables that had sufficient *VP* in Computer Science, but not Language Arts included the LCs Adaptable, Civic-Minded and Informed, the LRs Publisher and Teacher, and Learning Goal 3. Finally, grade-level differences were also reported in a descriptive, exploratory fashion, including their corresponding *VP* levels. In the next section of the findings chapter, the novel coding frame generated from the inductive qualitative content analysis of the same standards will be presented.

Research Question 2: Data-Driven Novel Coding Frame

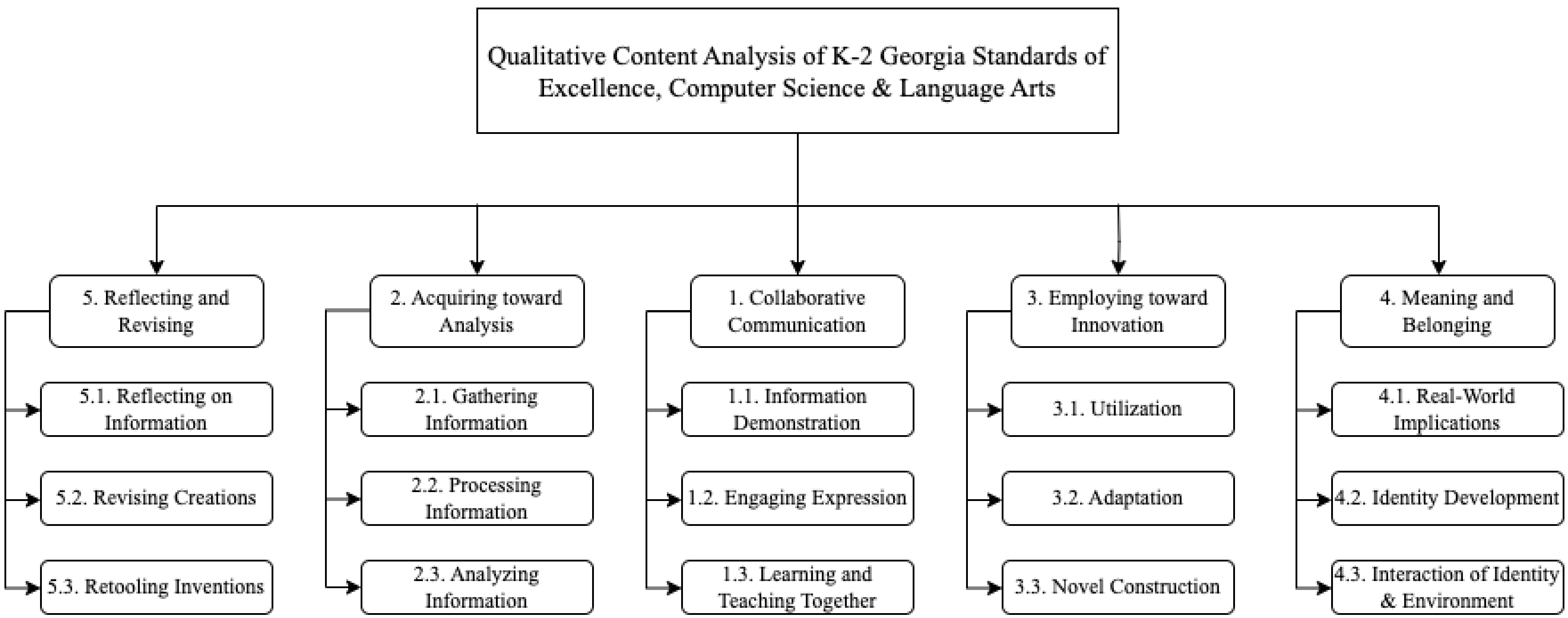
To answer the second research question, I utilized a multi-stage qualitative content analysis approach to generate the overarching categories for the coding frame, which was then pilot tested and revised before coding the 202 standards in the sample (Saldaña, 2015). NVivo, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS), was used to code the data and generate frequency information. The analysis resulted in the following five *main categories*, in order of their frequency in the data: Collaborative Communication (n = 84), Acquiring Toward Analysis (n = 44), Employing Toward Innovation (n = 32), Meaning and Belonging (n = 25), and Reflecting and Revising (n = 17). Each of these five categories was broken down into three mutually exclusive subcategories.

In *Qualitative Content Analysis in Practice*, Schreier (2012) states that in a qualitative content analysis, "the different research phases (data collection, data analysis, presenting your findings) are often not distinct, but merge with each other… Keeping this in mind, your coding frame itself may be your most important finding. This is the case whenever you want to explore or describe your material in certain respects and are using data-driven categories to do so" (p. 219). As this design describes my study, I will present the findings for this research question by descriptively introducing the novel data-driven coding frame.

Elucidating each main category in turn, I will begin by defining the contents of each category and its respective subcategories using a combination of continuous text, text matrices, and descriptive statistics, including comparisons across subjects. I will then include an explanation of how my first- and second-cycle coding methods led to the generation of the category. As this was an inductive process, the coding frame itself serves as the most prominent finding. However, frequency data for each category will also be presented, along with comparisons across subject levels. To begin, Figure 16 depicts the overall coding frame; overall frequency data can be found in Appendix E.

Figure 16

Qualitative Content Analysis Coding Frame



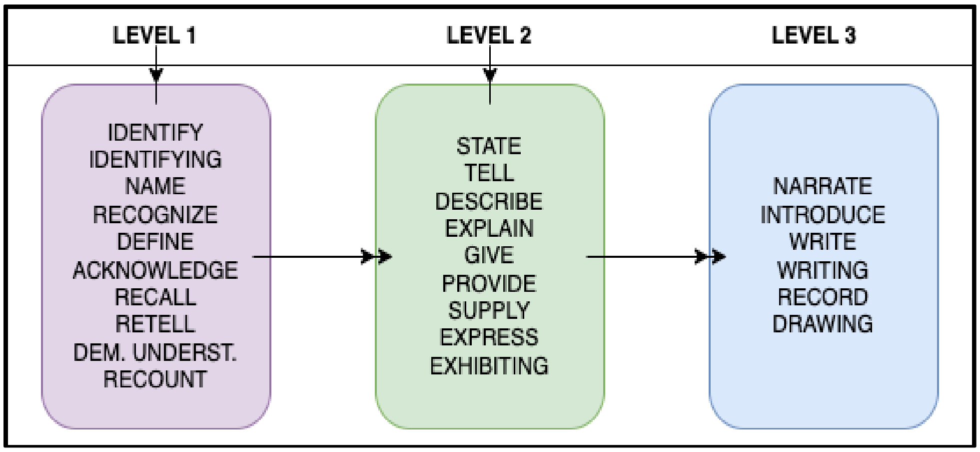
Collaborative Communication

The most prominent category ($n = 84$) in the coding frame was titled "Collaborative Communication" and includes the subcategories "Information Demonstration," "Engaging Expression," and "Teaching and Learning Together." The Collaborative Communication category represents standards that ask the student to express their knowledge of a topic in a community setting. The three subcategories of the category represent a progression from individual demonstrations of knowledge without an audience at the first level, to one-way expression of knowledge toward an audience at the second level, to, finally, a collaborative co-production of knowledge with fellow learners. This main category being the most prominent out of the entire dataset supports the understanding that some of the most common processes in the standards, across both subjects, relate to the communication and demonstration of one's learning.

To develop this code, I engaged in coding of the *in vivo* action verbs, which generated a provisional thematic category that I first called "showing and telling." A visual representation of this prototype is found in Figure 17. The "showing and telling" theme represented a continuum of practices in which students demonstrated their knowledge and shared it with others.

Figure 17

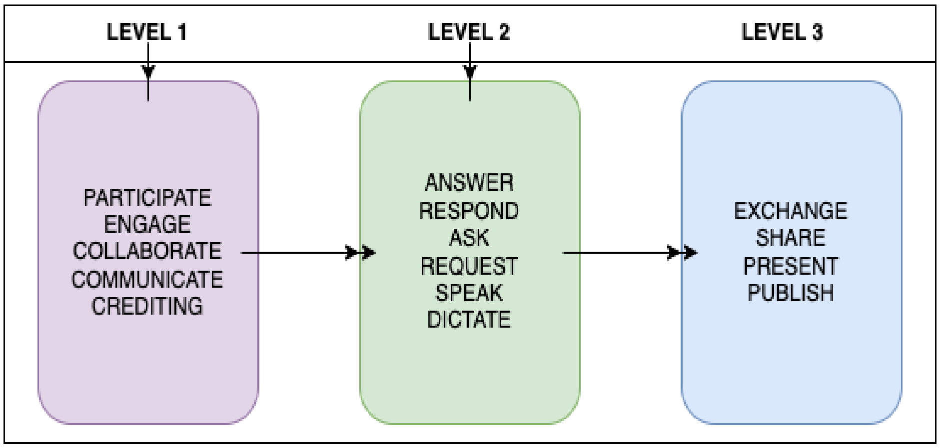
Showing and Telling Proto-Category Development



Upon pilot testing of my provisional codes on a subset of my data, I realized that this category was in many instances not mutually exclusive with another one of my provisional categories: “Learning and teaching together.” This provisional category, depicted in Figure 18, generally related to interaction/communication with other learners. Again, I perceived three layers in the data. The first layer represented plain verbal expression without specific references to community, e.g.: “ask,” “answer,” “respond,” “speak,” and “dictate.” The second layer was related to collaboration- and engagement-oriented codes: “participate,” “engage,” “collaborate,” “communicate,” and “credit.” Finally, the last layer indicated where the individual shares their learning with others: “express,” “share,” “present,” and “publish.”

Figure 18

Teaching and Learning Together Proto-Category Development



Viewing these two codes together in the context of the actual segments of data I was analyzing–entire standards as opposed to individual words–, I realized that many of these words ran into and over one another. For example, it was difficult to tell where "identify" stopped and "answer" began. Condensing these two groups, I re-envisioned the category as "Collaborative Communication." This category captured both the knowledge communication elements of the first provisional category and the collaborative learning aspects of the second category.

Table 22 presents the appearances of each of the subcategories of the Collaborative Communication main category in the data. The most common subcategory was the first, "Information Demonstration" (*n* = 36), indicating that a plurality of the standards currently require students to demonstrate knowledge about some sort of skill or concept.

Table 22

Collaborative Communication Category Frequencies

Subcategory	References
1. Information Demonstration	36
2. Engaging Expression	25
3. Teaching and Learning Together	23
Total	84

The Engaging Expression subcategory (*n* = 25) is the second subcategory within the Collaborative Communication main category. At its core, it still requires the learner to demonstrate their knowledge of technical skills or content understandings. However, unlike the subcategory before it, the Engaging Expression subcategory requires the learner to interpret the information they are disseminating, to some degree, rather than merely recapitulate it. For example, this category included writing standards, such as “Write opinion pieces in which they introduce the topic or the name of the book they’re writing about, state an opinion, supply a reason for the opinion, and provide some sense of closure.” While this First Grade English Language Arts standard does not explicitly mention a specific audience to which the student is addressing their opinion piece, it does draw upon the learner’s own interpretations of the information they are presenting. On the Computer Science side, an example of this code is “Use digital tools to creatively share and express ideas.” Again, here, the student is sharing information and doing so in a creative way, while not necessarily working collaboratively or tailoring their information toward a specific audience.

The third and final subcategory in the Collaborative Communication main category is entitled "Teaching and Learning Together" (*n* = 23). This subcategory builds on the two before it by similarly incorporating a) the learner's sharing of information and b) the learner's own interpretations of content, but it adds on to the previous two subcategories by also necessitating c) collaborative engagement on a given product or project. As an example, the English Language Arts standard "Participate in shared research and writing projects" would fall under this category, as would the Computer Science standard "Use digital tools to collaborate with other both locally and globally." Table 9 provides excerpts from each of these three subcategories in text matrix form.

Table 9

Collaborative Communication Excerpt Text Matrix

Communicating and Collaborating	
Describe characters, settings, and major events in a story, using key details. Identify words and phrases in stories or poems that suggest feelings or appeal to the senses. Recount or describe key ideas or details from written texts read aloud or information presented orally or through other media.	1. Information Demonstration
Identify patterns. Present information using a digital device.	2. Engaging Expression

Communicating and Collaborating	
Write informative/ explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.	3. Teaching and Learning Together
Exchange information or ideas clearly and creatively using digital tools while considering audience and intended purpose.	
Use digital tools to collaborate with others both locally and globally.	
Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.	
Participate in various roles on a team to work on a common goal and create an inclusive environment.	
Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).	

Acquiring toward Analysis

Acquiring toward Analysis (*n* = 44) was the second-most common main category found in the data-driven coding frame. Table 10 presents this category and the frequencies of its three subcategories. This category represents receptive learning and understanding, exhibiting a continuum from “Gathering Information,” where students are receiving or amassing information, to “Processing Information,” where students begin to digest and internalize information, to “Analyzing Information,” where students are using critical thinking skills to evaluate information within a given context.

Table 10

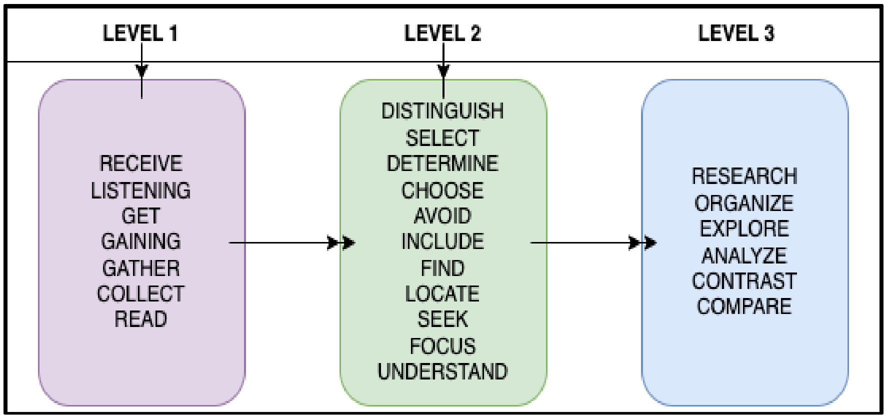
Acquiring toward Analysis Category Frequencies

Subcategory	References
2.1. Gathering Information	13
2.2. Processing Information	9
2.3. Analyzing Information	22
Total	44

Whereas the Collaborative Communication category began with basic productive knowledge action verbs, the next category I focused on began with the basic receptive verb of "get." To further this, I searched for words related to accessing items and information without more profound thought or complicated processes, adding "receive" and "gaining" to this category. As this category became further fleshed out, the information-gathering verbs became increasingly cognitively demanding, beginning to take shape as a collective description of gathering information as part of a research and analysis process. Again, this proto-category had three "tiers" increasing in complexity at each stage, all generally relating to information intake. Examples of these in vivo codes for each subcategory can be seen in Figure 19.

Figure 19

Acquiring Toward Analysis Category Development



After pilot testing and ensuring the utility of this code with the data set, I gave it the name *Acquiring Toward Analysis*. This category encompasses receptive learning processes from getting information and building understanding to evaluating content and entertaining different interpretations of knowledge. Its three levels relate to the collection of information, the comprehension of information, and the analysis of information, a continuum requiring progressively more consideration and discernment on the part of the learner. A text matrix with selected corresponding excerpts from each of the three subcategories in this main category is presented in Table 11.

Table 11

Acquiring Toward Analysis Excerpt Text Matrix

Acquiring toward Analysis	
Understand there is an appropriate place to find information to research the answer to a question.	1. Gathering Information

Acquiring toward Analysis	
Select appropriate sources to conduct authentic research to produce a relevant and credible product.	
Recount stories, including fables and folktales from diverse cultures, and determine their central message, lesson, or moral.	2. Digesting Information
Recognize that problems can be broken down into smaller parts in order to create a solution.	
Analyze collections of digital images and words for how well each collection communicates learning.	3. Analyzing Information
Compare and contrast the most important points presented by two texts on the same topic.	

The “Gathering Information” subcategory (*n*=13) relates to how students might acquire information and gain knowledge in the classroom, but it does not necessitate that students do anything with that knowledge at this stage. For example, they might “Recognize common types of texts” (a Kindergarten English Language Arts standard), but they are not yet saying anything *about* those texts or analyzing them within a given context. Similarly, within Computer Science, students, might be called upon to “Understand that answers to questions can be found through research from a variety of sources” (a kindergarten standard), but they are not yet researching independently towards a certain goal.

The “Processing Information” subcategory (*n* = 9) requires students to go slightly deeper than merely acquiring information, but it does not yet ask students to evaluate or think critically about content. For example, English Language Arts standards ask students to “Describe the overall structure of a story,” which requires that they understand certain elements of story structure like plot and characters but does not lead the reader to evaluate the story's messages or how it functions as compared to other texts or real-world scenarios.

The final subcategory, "Analyzing Information" (n = 22), requires that students explain, interpret, evaluate, compare and contrast, or otherwise distinguish components of a given text or piece of content. Importantly, this differs from the Collaborative Communication standards because the former relates to expressing one's learning, either toward a teacher, an audience, or as part of a collaborative effort, while this category concerns internal processes within the learner. For example, "Analyzing Information" in the English Language Arts standards might look like, "Explain major differences between texts that tell stories and texts that give information." In Computer Science, the standards might ask students to "Analyze collections of digital images and words for how well each collection communicates learning."

Employing Toward Innovation

The qualitative coding frame's third category, "Employing Toward Innovation," relates to the use of various tools and features necessary to comprehend and engage with content. The three categories, "Utilization," "Adaptation," and "Novel Construction," evolve from learning how to use certain components, to applying them towards specific ends, to, finally, developing tools of one's own. Table 12 provides frequency data for the Employing Toward Innovation subcategories.

Table 12

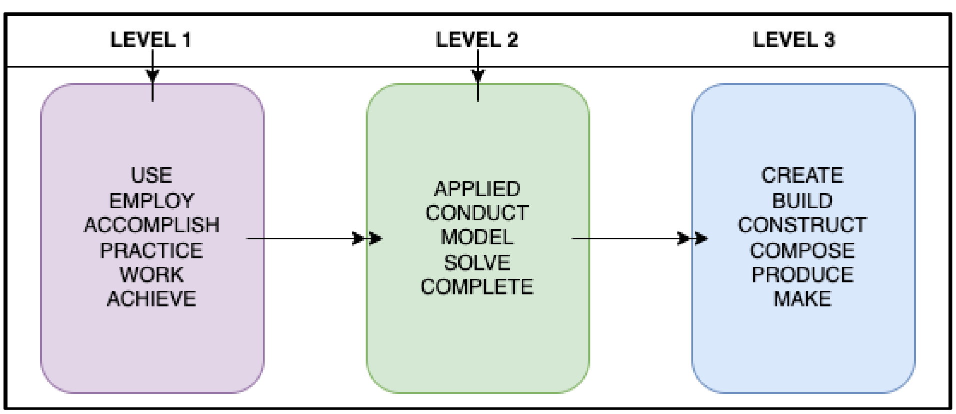
Employing Toward Innovation Subcategory Frequencies

Subcategory	References
1. Utilization	12
2. Adaptation	12
3. Novel Construction	8
Total	32

This main category initially emerged due to one of the most dominant verbs in the in vivo codes: “use.” The category began to take shape as a set of related processes to how students explicitly learn to use a variety of tools toward their own specific needs and applications, ultimately creating their own projects, models, or pieces that could be used and interpreted by others. A depiction of the in vivo codes that inspired the three subcategories for this main category can be found in Figure 20.

Figure 20

Employing Toward Innovation Category Development



On the first “tier,” the relevant verbs centered the machine or system as the artifact doing the heavy work of the interaction, where the student served as a generic figure interacting with it on a base level, not employing their own critical thought or unique creative input. I call this subcategory “Utilization.” In the “Utilization” subcategory (*n* = 12), students are learning how to use preexisting tools, be them digital or otherwise. This is not tied to any specific end in terms of content knowledge but rather the basic acquisition of the skill. For example, students might “Identify and use the home row of the keyboard effectively,” as seen in the first grade Computer Science standards, or they might “Know and use various text features (e.g., headings, tables of content, glossaries, electronic menus, icons) to locate key facts or information in a text,” which is included in first grade English Language Arts. These are necessary skills that must be cultivated in order to even access much of today’s digital information.

Next, the “Adaptation” subcategory (*n* = 12) requires students to not only utilize tools but also employ them toward a specific learning goal. The second layer included verbs like “applied,” “practice,” “work,” “conduct,” and “model;” this subcategory was ultimately titled “Adaptation.” This secondary layer represented verbs wherein students engaged with preexisting platforms toward a specific end concerning their unique needs. One might view the student and the machine on equal footing in these interactions; the student provides some input while the machine facilitates their requests. Notably, most of the examples throughout this category do come from the Computer Science set of standards, as they more deliberately incorporate the use of digital tools and media.

Finally, the verb "create" inspired the third layer of this theme, called "Novel Construction." This included words like "build," "construct," "compose," "produce," and "make." This third level still represents the interaction between students and external structures or devices. However, it requires the highest degree of student input, creativity, voice, and design. Here, students use platforms as accessories to create novel, unique content or develop entirely new models or creative works to achieve their learning goals. The Novel Construction main category fundamentally involves the use of tools like the other two subcategories before it, but it differentiates itself by its emphasis on the student's unique contribution. For example, the standard "Create and test a model and analyze it from the perspective of an end user" requires students to develop new models using what they already know about technology and to critically evaluate them. Table 13 depicts a text matrix with selected standards relevant to each subcategory within the Employing Toward Innovation main category.

Table 13

Employing Toward Innovation Text Matrix

Employing toward Innovation	
Identify and use the home row of the keyboard effectively. Know and use various text features (e.g., headings, tables of content, glossaries, electronic menus, icons) to locate key facts or information in a text.	1. Utilization
Modify an existing model for a specific purpose or for a specific group of users. Develop and employ Computational Thinking strategies (break-down, find patterns, and create algorithms) to identify and solve problems.	2. Adaptation

Create and test a model and analyze it from the perspective of an end user. Create a product of research collaboratively or independently. (e.g., table of data, writing assignment, collection of resources).	3. Novel Construction

Meaning and Belonging

The “Meaning and Belonging” category represents the penultimate main category in terms of references in the data (*n* = 25), but it was in fact the last category to be added after the pilot testing of the coding frame. In this way, the category development process for this code different from that of the other four main categories. After explaining how this category came to exist, this section will then provide explanations for the three subcategories within the Meaning and Belonging category: “Real-World Implications,” “Identity Development,” and “Interaction of Identity and Environment.” As an overview, Table 14 gives frequency counts for how many standards, or units of observation, were ascribed to each of these three subcategories in the analysis.

Table 14

Meaning and Belonging Category Frequencies

Subcategory	References
1. Real-World Implications	11
2. Identity Development	3
3. Interaction of Identity & Environment	11
Total	25

After engaging in the multi-phase coding processes, I could collapse all of the in vivo and process codes into the five proto-themes of "showing and telling," "teaching and learning together," "acquisition and analysis," "employing and innovating," and "reflecting and revising." However, upon conducting a pilot test, I found a subset of standards representing values and concepts that did not fit within the categories I had developed. These codes all embodied the same concepts of identity, meaningfulness, real-world relevance, and social action, which I grouped into the overarching category "Meaning and Belonging." Figure 21 demonstrates the process by which I condensed these outlier values codes into one umbrella code. Table 15 shows a text matrix of selected standards falling under the three subcategories of the Meaning and Belonging category.

Figure 21

Meaning and Belonging Category Development via Values Code Collapsing

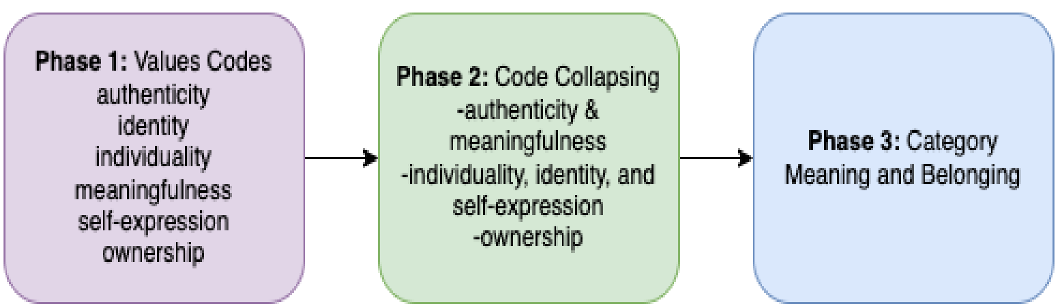


Table 15

Meaning and Belonging Category Text Matrix

Meaning and Belonging	
Recognize that technology provides the opportunity to enhance relevance, increase confidence, offer authentic choice, and produce positive impacts in learning.	1. Real-World Implications
Understand that technology is everywhere and changes our lives.	
Create an artifact that demonstrates a positive personal digital identity.	2. Identity Development
Understand that when you are on a networked device you are connected to other people.	
Describe how technology can impact an individual's life positively and negatively.	3. Interaction of Identity & Environment
Identify the rights, responsibilities, and opportunities of living, learning, and working in an interconnected society and model behaviors that are safe, legal, and ethical.	

The first subcategory, "Real-World Implications," encapsulates standards that directly draw connections between what is being learned in class and its impacts within the "real world" outside of the classroom (n = 11). This included standards such as "Understand how people can use technology" and "Identify that technological innovation changes how people live and work." Here, the main function of the standard itself is to draw students' attention to why their learning matters outside of class, with particular attention to digital environments.

The next category, "Identity Development," is also related to connecting learning to something beyond the material itself; in this case, this is the individual learner and their identity (n = 3). For example, the standard “Create an artifact that demonstrates a positive personal digital identity” allows students to build conceptualizations of who they are in the context of an online world. However, there were not many standards that fit this description at all, indicating that while identity development may certainly be a process occurring in the elementary classroom, it is rarely directly encouraged in either Computer Science or Language Arts instructional directives.

The final subcategory in the Meaning and Belonging category is called “Interaction of Identity and Environment” (n = 11). This subcategory represents the merge of the previous two categories, including standards that connect the student’s identity to the world outside of class. One standard that fit this category description was “Identify the rights, responsibilities, and opportunities of living, learning, and working in an interconnected society and model behaviors that are safe, legal, and ethical.” In this way, the student is building understandings of how their learning affects society, and the student is also engaging in behaviors that promote their own identity development as an ethical digital citizen.

Reflecting and Revising

The final main category, with the smallest total number of representations in the datatset, was “Reflecting and Revising,” n=17. This category contains standards that require the learner to reflect on their work or their own habits as a learner. Table 16 presents frequency data for each of the three subcategories.

Table 16

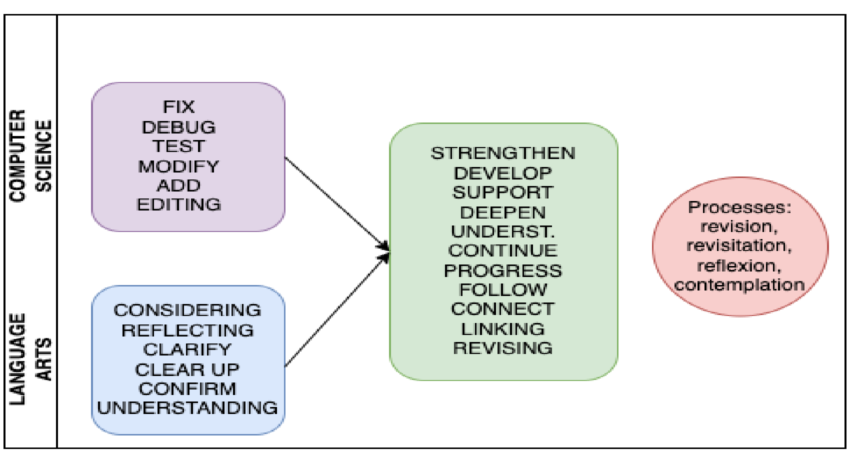
Reflecting and Revising Category Frequency Table

Subcategory	References
1. Reflecting on Information	10
2. Revising Creations	5
3. Retooling Inventions	2
Total	17

The Reflecting and Revising main category represents standards primarily pertaining to reflection, recursivity, and the additive and iterative nature of learning. Verbs like "modify," "revise," "edit," and "develop" all support the conceptualization of learning as a looping continuum. In both Computer Science and English Language Arts, students are encouraged to return to their learning in multiple stages, using terms like "debug," "fix," and "test" in Computer Science and "clarify," "support," "add," and "strengthen" in Language Arts. Figure 22 depicts the development of the category in the initial coding processes.

Figure 22

Reflecting and Revising Category Development



The first subcategory, “Reflecting on Information” (*n*=10), requires the learner to monitor their thinking and understanding about topics. For example, students might “Ask and answer questions to help determine or clarify the meaning of words and phrases in a text” or “Ask and answer questions about what a speaker says in order to gain additional information or clarify something that is not understood.” Interestingly, this category’s contents all came from the English Language Arts standards, and most of them were related to clarifying information that was provided to the learner to ensure understanding. There were not any standards related to evaluating one’s level of understanding of a topic, nor were there standards related to reflection on the understanding of digital skills and understandings specifically.

The next category, “Revising Creations,” made up a very small portion of the overall coding frame (*n*=5). This category also related to English Language Arts standards and asked the student to return to and improve their work. For example, the writing standard “With guidance and support from adults and peers, focus on a topic and strengthen writing as necessary by revising and editing” fell into this category.

Finally, the subcategory “Retooling Inventions” was specifically related to fixing errors in technical programs. The Computer Science standard “Analyze and debug (identify and fix) with or without a computing device” fell into this category. Overall, this main category was the least common in the data, with only 17 references, comprising 8.4% of all codes. However, it relates to multiple concepts of metaliteracy, namely the Metacognitive Domain and the Reflective Role. The paucity of standards in this code aligns with the findings in the first category indicating that metacognition is not emphasized in the current Computer Science and

English Language Arts standards as compared to other types of skills and demands. Table 17 provides a text matrix with selected excerpts from each of these 3 subcategories.

Table 17

Reflecting and Revising Category Excerpt Text Matrix

Employing toward Innovation	
Ask questions to clear up any confusion about the topics and texts under discussion. With prompting and support, ask and answer questions about unknown words in a text.	1. Reflecting on Information
With guidance and support from adults, focus on a topic, respond to questions and suggestions from peers, and add details to strengthen writing as needed. Add drawings or other visual displays to descriptions as desired to provide additional detail.	2. Revising Creations
Analyze and debug with or without a computing device.	3. Retooling Inventions

Coding Frame Manifestations in Computer Science vs. Language Arts

Another point of interest for this analysis was the manifestation of each coding frame category in the Language Arts and Computer Science subsets of standards. I ran a series of matrix coding queries in NVivo to discern these differences. The results of these matrix coding queries are presented in Table 18.

Table 18

Matrix Coding Query Results for Coding Frame Across Subjects

Category	*n*, Computer Science	Percent of CS codes	*n*, English Language Arts	Percent of ELA Codes
Collaborative Communicator	23	23.71	61	58.10
Acquiring Toward Analysis	18	18.56	26	24.76
Employing Toward Innovation	29	29.90	3	2.86
Reflecting to Revise	2	2.06	15	14.29
Meaning and Belonging	25	25.77	0	0.00
Total	97	100	105	100

From greatest to least number of standards contained, Computer Science's category manifestations can be viewed as follows: Employing toward Innovation (*n* = 29, 29.90%), Meaning and Belonging (*n* = 25, 25.77%), Collaborative Communicator (*n* = 23, 23.71%), Acquiring toward Analysis (*n* = 18, 18.56%), and Reflecting to Revise (*n* = 2, 2.06%). On the other hand, English Language Arts standards were most commonly ascribed to Collaborative Communicator (*n* = 61, 58.10%), followed by Acquiring toward Analysis (*n* = 26, 24.76%), then Reflecting to Revise (*n* = 15, 14.29%), and Employing toward Innovation (*n* = 3, 2.86%). The Meaning and Belonging category had no representations in English Language Arts, which was a noticeable observation from this comparison.

Additionally, the Reflecting to Revise was comparatively underrepresented in both subject areas (*n* = 2 for Computer Science and 15 for English Language Arts). This suggests a potential paucity of emphasis on reflection and metacognition in the standards overall, which corroborates the findings of Research Question 1. Furthermore, Computer Science's counts for the other four categories vary from 18 to 29, indicating a range of 11, while Language Art's other frequencies are anywhere between 0 and 60, indicating a range of 60 – over five times higher than that of Computer Science. This suggests that Computer Science's category distributions within this coding frame are must more equally dispersed, while the English Language Arts group more noticeably emphasizes some categories, like Collaborative Communicator, and does not incorporate others to the same degree, like Employing Toward Innovation. The Employing Toward Innovation category mostly does rely on technical skills and creation using digital devices, so its greater inclusion in Computer Science is natural, perhaps. However, if we are to reconceptualize our instruction of English Language Arts as necessitating digital competencies, this is an important area of underdevelopment.

Summary

This chapter provided an overview of the findings from a research study evaluating the visibility of metaliteracy concepts in the current K-2 Georgia Standards of Excellence in Computer Science and English Language Arts and the other predominant themes in this same body of standards. The second research question, detailed in this subsection, followed an inductive qualitative content analysis (QCA) procedure and generated five main categories, each with three subcategories, from the data. The coding frame was developed from an analysis of In

Vivo, Process, and Values codes and included the main categories Collaborative Communication, Acquiring Toward Analysis, Employing Toward Innovation, Reflecting and Revising, and Meaning and Belonging. This chapter has provided an overview of each of these categories along with their three respective subcategories. This was accomplished via the reporting of frequency data, visualizations of the codebook development process, and text matrices with selected excerpts from each code. Additionally, exploratory comparisons were observed between the Computer Science and English Language Arts subject areas.

In the following and final chapter, Chapter 5, the researcher will discuss the significance of these findings, links to the extant literature (including ISTE and CSK-12), and implications for research, policy, and practice. The final chapter will also discuss how to reconcile the findings of the first two research questions in consideration of a path forward for metaliteracy and digital literacies within the Language Arts and Computer Science subjects.

5 DISCUSSION

In her 2020 essay, “The I in the Internet,” Jia Tolentino reflects on the paradoxically hyper-intimate and estranging ramifications of growing up and later living and working online. “Now I’m thirty,” she writes, “and most of my life is inextricable from the internet, and its mazes of incessant forced connection – this feverish, electric, unlivable hell” (Tolentino, 2020, p. 3). Tolentino (2020) goes on to explain how the Internet’s promises of reinvented, improved iterations of our own identity, once imbued with the glimmering hope that comes with newfound freedom, often devolve into a depressing reality where we cannot escape capitalist consumption, performative activism, or our problematic past selves. It is a nightmarish, pessimistic envisioning of our collective life online, one that dares to grow more dire each day.

In many ways, Tolentino is right. Persuasive half-truths, and even propaganda pieces, are pushed by hidden algorithms that quickly learn their users' unspoken desires (Ali & Zain-ul-abdin, 2021; Weimann & Masri, 2023). As a result, online discussion spaces are becoming more polarized and vitriolic (Castaño-Pulgarín et al., 2021). In a 2018 systematic review of literature on digital polarization and political disinformation, the authors conclude that “the growth in polarization has seemingly supercharged political misinformation, leading to widespread partisan misperceptions and conspiracy theories that pollute public debate, distort public policy, and intensify polarization” (Tucker et al., 2018, p. 51). Adding insult to injury, our attention spans for sustained reading are dwindling (Carr, 2020; Fillmore, 2015; Liu, 2005; Medvedskaya, 2022), and our self-esteem is shot, thanks to social media (Hawi & Samaha, 2017; Jan et al., 2017).

Presented with this harrowing news, the urge to abandon it all and run, quite literally, “for the hills” would be understandable, but the Internet is now all-but-inescapable. The prevalence of digital devices in our living and working worlds is undeniable, and all signs point toward the acceleration of technology’s influence on culture and society. Innovations like GPT-4 and generative AI, neurotechnology, and wearable, screenless devices may make the line between humans and technology nearly indistinguishable in the future. Within this study’s context in American public schools, meaningful, successful, and productive engagement with the world functionally necessitates digital interaction.

Digital reality *is* reality. Technology and digital media have shaped society, citizenship, and, in turn, the literacy practices needed to engage successfully with modern culture. As students’ digital selves grow inextricable from their offscreen identities, literacy curricula must cultivate their ability to interrogate online environments critically. However, while there are many valid reasons to criticize the nature of some of these worlds, they also unlock incredible potential for human progress, connection, and innovation. Perhaps with a new generation’s cultivation and care, the pruning of the Internet is possible. We can begin to get closer to this goal by exploring how the current standards are, or are not, preparing students to be digital citizens fluent in the new literacies (Knobel & Lankshear, 2014; Leu, 2006).

To this end, this study explored two main research questions: *To what extent are the learning goals, learning domains, learner roles, and learner characteristics of metaliteracy (metaliteracy concepts) evident in the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts?* and *What are the prevailing themes related to processes and* *practices in the K-2 Georgia Standards of Excellence for Computer Science and English Language Arts?* with subquestions that explored these two topics' manifestations on cross-subject and inter-grade levels. To answer these questions, the study employed a mixed methods triangulation design utilizing a convergence model, wherein the qualitative and quantitative analyses were conducted independently, with different designs, concerning the same sample (Creswell, 1999). In the discussion section of this study, these two studies' findings will be interpreted together to generate integrated recommendations for research, policy, and practice. I begin by summarizing the study's design and reviewing its key findings, connecting them to existing research concerning metaliteracy and digital literacies in young learners.

Namely, the findings suggest that the standards support the development of behavioral and cognitive skills and competencies and encourage the development of engaged learners who create new content. However, several elements do not yet show ample presence in the standards, and their incorporation is worth considering based on prior research. These include concepts of community and identity, metacognition and reflection, and digital research skills. Additionally, viewing "digital-literacy-as-literacy," the English Language Arts standards have several discrepancies compared to the Computer Science standards. After discussing the findings as contextualized in the literature, I will discuss the implications of this study for research, policy, and practice. Next, I will reflect on limitations and boundaries. Finally, I will close by considering possibilities for future research.

Study Review

The first research question in this study sought to uncover the presence of 25 variables representing concepts of metaliteracy within the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts through traditional content analysis (Berelson, 1952; Krippendorff, 2013; Neuendorf, 2017). The researcher developed an a priori codebook with dictionary-like definitions and inclusion criteria representing each Learner Characteristic, Learner Role, Learning Goal, and Learning Domain of metaliteracy. After creating the codebook and operationalizing 25 binary categorical variables, the researcher coded the data using NVivo, ensuring inter-rater reliability by using an additional coder and calculating acceptable Cohen's *kappa* measures (Warrens, 2015). The data were analyzed utilizing a simulation of hypothesis testing content analysis process (Krippendorff, 2013; Neuendorf, 2017), wherein 25 hypotheses (one related to each variable) were tested against Adequate Variable Presence Scores per prior research on standards alignment (Machalow, 2020; Polikoff et al., 2015; Vega, 2010).

Through this process, a total of seventeen hypotheses were rejected. In comparison, eight hypotheses failed to be rejected, indicating that they had representation in the standards that was at least equivalent to their proportional makeup of their metaliteracy concept area (e.g., Characteristics, Roles, Domains, or Goals). These were the Author Role, the Communicator Role, the Participant Role, the Producer Role, the Participatory Characteristic, the Productive Characteristic, the Behavioral Domain, and the Cognitive domain. On the other hand, the hypotheses that were rejected, indicating a lack of adequate evidence in the standards, revolved around the Collaborator Role, the Publisher Role, the Researcher Role, the Teacher Role, the

Translator Role, the Adaptable Role, the Civic-Minded Characteristic, the Collaborative Characteristic, the Informed Characteristic, the Open Characteristic, the Reflective Characteristic, the Affective Domain, the Metacognitive Domain, and all four Learning Goals. The data were also analyzed with descriptive statistics and graphical representations to explore differences between grades and subjects.

The second research question was more exploratory and sought to uncover the overall themes of the K-2 GSE in CS and LA, viewed in tandem, that may or may not be captured by the metaliteracy framework. To pursue this aim, the researcher followed a qualitative content analysis protocol, utilizing elements of qualitative coding to guide the data-driven category development process (Saldaña, 2015; Schreier, 2012). After developing data-driven main categories, the researcher conducted a pilot testing and codebook revision process to generate the resulting coding frame, which consisted of five main categories, each with three unique subcategories. The resulting coding frame was then used to code the 202 standards examined in the first research question. This comprehensive coding process was completed twice, after a fourteen-day waiting period, to improve the reliability of the results.

The main categories that resulted were Reflecting and Revising (subcategories Reflecting on Information, Revising Creations, and Retooling Inventions), Acquiring Toward Analysis (subcategories Gathering Information, Understanding Information, and Analyzing Information), Collaborative Communication (subcategories Information Demonstration, Engaging Expression, and Learning and Teaching Together), Employing Toward Innovation (subcategories Utilization, Adaptation, Novel Construction), and Meaning and Belonging (subcategories Real-World

Implications, Identity Development, and Interaction of Identity and Environment). The contents of these categories were presented using exemplifying text matrices.

Frequency data were also examined for the whole sample and the representations of each main category within each subject domain (Computer Science and English Language Arts). The data suggested that the most significant emphasis was on the Collaborative Communicator category, whereas the Reflecting to Revise category had the least overall evidence in the standards. The data also revealed that Computer Science standards showed more evidence for the Employing toward Innovation and Meaning and Belonging categories. In contrast, the English Language Arts standards had a comparatively more significant presence of the Collaborative Communicator, Acquiring Toward Analysis, and Reflecting to Revise categories.

Strengths of the Standards

Interpreting and contextualizing the findings of both research questions has proved challenging, even when considering how to structure such an endeavor. Therefore, I sought to converge the traditional and qualitative content analysis I conducted concurrently to observe whether the two studies' findings confirmed or contradicted one another. To structure this section, then, I will synthesize and interpret the data by using both research questions' findings to evaluate, first, what the standards *are* currently emphasizing, both in terms of MLCs (RQ1) and general processes (RQ2), and, next, what messages the standards are communicating by what they are leaving *out*, also known as the *null curriculum*, both in terms of intellectual processes and content knowledge (Eisner, 1985). To organize this, the discussion will compare the MLC variables observed in RQ1 and the qualitative coding frame categories generated in RQ2.

Communicating and Participating in the Classroom

The two research questions' findings achieve synergy when comparing the most common category in the qualitative content analysis with the Learner Roles and Characteristics that demonstrated the greatest Variable Presence Scores. The Collaborative Communication category was the densest in the overall qualitative content analysis, and the first subcategory within that, "Information Demonstration," was the most common subcategory out of all fifteen in the coding frame. This subcategory did not involve the active engagement of an audience or intentional collaboration with peers. In this way, the plurality of standards is focused on rote demonstrations of understanding via expressive output.

Similarly, the Learner Roles and Learner Characteristics that met the threshold for adequate Variable Presence all revolved around aspects of Collaborative Communication: Communicator, Participant (and Participatory), Author, and Producer (and Productive). While the Collaborator and Collaborative variables did not meet threshold criteria, this also corresponds with the second research question's findings. The three tiers of subcategories within the Collaborative Communication category were 1. Information Demonstration (n = 36), 2. Engaging Expression (n = 25), and 3. Teaching and Learning Together (n = 23). This indicates that the standards were focused more on expressive communication than collaboration.

The benefits of collaborative work and communication in the classroom are well-documented (Du et al., 2021; Gee, 2010; Heath, 1983; Vygotsky & Cole, 1978). The standards' emphasis on communication and language as a means toward greater learning have roots in Vygotskyian sociocultural theory and sociocultural theories of literacy, which undergird this study (Gee, 2010; Holland & Lachicotte, 2007; Lewis et al., 2007; Vygotsky & Cole, 1978). While new literacies and metaliteracy might emphasize connecting across cultures and differing perspectives specifically, they do emphasize communication skills as integral to the learning process (Knobel & Lankshear, 2014; Mackey & Jacobson, 2014).

Developing Behavioral and Cognitive Skills and Capacities

Both the traditional and qualitative content analyses revealed that the standards in both subjects highly emphasize behavioral skills and, to a lesser extent, cognitive processes. In the deductive content analysis, two of the four LDs met Variable Presence Score criteria: Behavioral and Cognitive. The Behavioral Learning Domain had the greatest presence score out of all four of the Learning Domains, in both Computer Science and English Language Arts, with a total VP of 0.624. At the same time, the Cognitive Domain was also visible in a large proportion of the standards (*VP* = 0.431). This suggests that the standards as written are highly geared toward assessing student understanding of basic skills. In English Language Arts, this included tasks like "Ask and Answer Questions" and "Retell Stories." In Computer Science, behavioral skills included standards such as "Identify and use the home row of the keyboard" and "Practice using a variety of computer hardware and software." As a reminder, the Behavioral Domain relates to "what students should be able to do… skills, competencies," while the Cognitive Domain encompasses "what students should know upon successful completion of learning activities–comprehension, organization, application, evaluation" (Mackey & Jacobson, 2019, p. 1).

Comparing this with the second research question's findings, most subcategories within the coding frame attend to Behavioral or Cognitive competencies, including those found in the main categories of Collaborative Communication, Acquiring Toward Analysis, and Employing Toward Innovation. This means n = 160 standards primarily dealt with these two domains (compared to the Affective or Metacognitive Domains). In particular, the Acquiring Toward Analysis and Employing Toward Innovation categories demonstrate the progression from behavioral mastery to cognitive development. For example, the Employing Toward Innovation category begins with standards that have students develop technical fluency with a given skill (Behavioral) and ends with students applying those learned skills to create innovative new artifacts and programs (Cognitive).

These findings corroborate the idea that standards are primarily in place to define the specific skills and understandings students need to understand each year of schooling (Beach, 2011; Clune, 2001; Hamilton et al., 2008; Wright & Domke, 2019). If standards are conceptualized as "academic expectations for students," or "what students should know and be able to do" (Hamilton et al., 2008, p. 11), it logically follows that the most-represented domains in the sample would be Cognitive (what students should know) and Behavioral (what students should be able to do). However, as standards can be representative of multiple learning domains at once, they need not necessarily focus on these two domains at the exclusion of metacognitive and affective considerations.

Doing, Making, and Creating

Another trend that was observable in the findings was a prevalence of standards related to students' active participation in *doing*, *making*, or *creating*. In the first research question's results, this can be seen in the adequate presence of the Author, Producer, and Productive variables, while in the second research question, the prevalence of the Acquiring Toward Analysis and Employing Toward Innovation categories affirms this implication. These findings correspond with previous literature regarding teachers' knowledge of digital literacy skills suggesting that teachers view technology integration from a behavioral or skill-acquisition lens (List et al., 2020; Sadaf & Johnson, 2017). Additionally, this emphasis on producing and creating corresponds with research on participatory media culture and new literacies (Baker, 2010; Jenkins, 2008; Knobel & Lankshear, 2014). In "Studying New Literacies," Knobel & Lankshear (2014) write, "Doing, contributing, making, and sharing are significant activities… Schools approach knowledge in terms of consuming information and practicing teacher-taught strategies, often driven by packaged curriculum and textbooks, rather than in terms of production by insiders to a field and novices learning to become insiders" (p.99). This focus on producing, writing, and creating in the standards as they stand now is a promising reinforcement of research regarding sociocultural theory and learning by doing, although it might not yet incorporate digital practices specifically to the desired degree.

Areas for Future Emphasis

The initial interpretation of what is overtly present in the standards does instill some promise. The standards, viewed comprehensively, are concerned with helping students acquire essential behavioral and cognitive competencies for success in society. Students are encouraged to participate in their coursework, communicate their learning, and even write and produce novel content in a variety of forms. On the other hand, certain concepts are not emphasized to the same degree, as revealed by this analysis. Past research has deemed this *untaught* information the "null curriculum," defining it as "the options students are not afforded, the perspectives they may never know about, much less be able to use, the concepts and skills that are not part of their intellectual repertoire" (Eisner, 1985, p. 107). Reviewing the results of both parts of this dissertation, several thematic categories about this null curriculum emerge. I will discuss the implications of these as they relate to current research. These are, broadly: community, meaning, and identity; metacognition and revision; and research skills and sharing in online environments.

Community, Meaning, and Identity

The sample's representation of MLCs related to Community, Meaning, and Identity did not reach adequate threshold parameters in several instances. The Collaborator Role and Collaborative Characteristic, which relate to how the student is at once a teacher and a learner, a co-creator in the knowledge space, were close but did not meet adequate presence scores. The Civic-Minded and Open Characteristics had lower presence levels (*VP* = 0.064 and 0.025, respectively). All these characteristics relate in some way to learners' positionality as community members inside *and outside* of the classroom space, adding a dimension of personal relevance that is more aligned with concepts of critical digital literacies (Avila & Pandya, 2013; Freire & Macedo, 2005; Golden, 2017; Luke, 2018).

These underrepresented categories all relate to the learner's significance in the world outside the classroom, both physically and online. They also encourage the learner's cultivation of attitudes and dispositions to help them succeed in digital environments outside of school. Relatedly, the Affective Domain received a VP of 0.064, meaning a little over 6% of standards in both subjects referenced this domain. The Affective Domain, to remind the reader, “describes individual attitudes, feelings, and beliefs” about learning and validates the interactive nature of learning (Jacobson & Mackey, 2022, p. 25). In so doing, the Affective Domain recognizes that the learner’s funds of knowledge, experiences, emotions, and attitudes are all involved in co-creating a transaction with the text that then leads to learning and impact. Rarely do the standards explicitly draw on these conceptions, although they could be invoked by teachers throughout their instruction as an add-on.

Examining the second research question, the most straightforward connection between these concepts and the qualitative content analysis’s findings comes through in the Meaning and Belonging Category of the coding frame. A total of 25 out of the 202 standards fell into this category, meaning that 12.4% of the curriculum was directly tied to these concepts; however, *all* of these came from the Computer Science standards. No Language Arts standards had as their *primary* function either a) the connection of content to the real world, b) the development of the learner’s identity, or c) ways in which the learner can bring their unique background to the work and impact their community. Recognizing the lack of attention given to these concepts in Language Arts standards highlights potential areas for improvement in curriculum development.

Ample past research emphasizes the benefits of connecting what students learn in school to their identities and their communities. In particular, the critical literacy framework is a way of examining and analyzing texts in the classroom to understand power dynamics, uncover hidden meanings and biases, and extend literacy learning outside the four walls of the classroom (Behrman, 2006; Comber, 2006; Creighton, 1997; Freire, 1972; Lewison et al., 2002; Luke, 2012; Vasquez et al., 2019). The metaliteracy framework extends many concepts of critical literacy by connecting them to information literacy and digital texts; the first chapter of their book *Metaliteracy in Practice* grounds the framework in Freire and Macedo (2005)'s concept of problem-posing education, stating, "The metaliterate learner as producer is similarly an ongoing praxis when individuals are reflective and active in creating new knowledge while transforming themselves and their world" (Jacobson & Mackey, 2022, p. 12).

Involving these concepts more actively in the standards would connect students' funds of knowledge and identity to their learning (Esteban-Guitart & Moll, 2014; Gonzalez et al., 2006; Moll et al., 1992). These practices have been shown to abet students' engagement, agency, connection, and problem-solving skills (Brownell & Rashid, 2020; Comber et al., 2001; Fisher, 2008). Additionally, it would increase the alignment with some aspects of the ISTE framework, namely the Empowered Learner, Digital Citizen, and Global Collaborator bands (Crompton, 2017b).

Metacognition and Revision

Another less visible concept in the standards revolved around developing students' metacognitive capacities and abilities to reflect on their learning and revise and reconceptualize their work. This, of course, is most directly tied to the Metacognitive Domain. Like the Affective Domain, the Metacognitive Domain was also one of the two less-present Domains in the sample, with a VP of 0.074, indicating that 7.4% of the standards employed metacognitive strategies.

Similarly, the Reflective Characteristic (*VP* = 0.069), which "fosters self-awareness about being a metaliterate learner" (Jacobson & Mackey, 2022, p. 32), also failed to meet the threshold criteria.

Viewing the qualitative content analysis results, the Reflecting and Revising Category is the most relevant section of the coding frame regarding this area of underrepresentation. This category was the least prevalent overall, with just 17 standards or 8.4% of the sample falling into its three subcategories. Of these 17 standards, 15 came from English Language Arts, while just two were from Computer Science. While this does indicate that students are engaging in reflective practices in the English Language Arts classroom, it also sparks concern that students are not being actively metacognitive about their *digital* literacy practices.

In past research, metacognitive development has been shown to benefit students' literacy development and reading comprehension (Ceylan & Harputlu, 2015; Michalsky et al., 2009; Ozturk, 2015; Ruan, 2005). By helping students become more aware of their own thinking processes, metacognition can enable them to better understand and analyze the material they are reading and develop critical thinking skills. Additionally, metacognition abets literacy learning by promoting deeper engagement with the material. When students are encouraged to think about their own thinking, they are more likely to approach reading and writing tasks with a sense of curiosity and inquiry, rather than simply passively absorbing information (Flavell, 1979). This can lead to more meaningful learning experiences and greater ownership over one's learning. Additionally, research-based processes like peer editing, writing conferencing, and reflective journaling have been shown to have notable impacts on student performance (Allan & Driscoll, 2014; Bardine & Fulton, 2008; Stemper, 2002)

The Online Environment as Mediator for Research and Literacy Practices

Concepts related to various stages of the research process in the digital space, from gathering sources online to sharing student-created works with external audiences, were also found to be relatively underrepresented in both research questions. Namely, there was little explicit reference toward instructing students how to evaluate the trustworthiness of sources, and there was also little emphasis on reaching an audience with one's novel work. The Learner Role of Informed (*VP* = .059) and the Learner Characteristic of Researcher (*VP* = .059) both speak to the first point, while the Learner Roles of Publisher (*VP* = .094) and Teacher (*VP* = .094) relate to the latter argument. Additionally, even the underrepresented Translator role (*VP* = .054) relates to this category, as it pertains to remixing content into new media formats. In the second research question's findings, no main category was entirely related to research skills and information literacy; this corroborates the first research question's findings, indicating a lack of emphasis in this area. The "Acquiring Toward Analysis" category relates to information gathering and processing; however, some research skills were embedded in other main categories, but research skills generally were not the focus of the standards.

These findings align with prior research suggesting that skills related to the critical evaluation of courses are limited for teachers and students (Stockham & Collins, 2017; Trujillo Torres et al., 2020). The limited presence of the Informed Role and the Researcher Characteristic across the entire sample indicates that the standards do not currently emphasize this skill at this age range. However, debate persists about the degree to which this instruction is developmentally appropriate at the early childhood level. Pangrazio (2018) discussed how social media disinformation proliferation has raised the urgency of instruction regarding critical digital literacy practices. A 2021 study on students in grades one through five's ability to evaluate the credibility of online sources stated, "Just as teachers teach nonfiction text features in paper-based books and how to use the glossary, heading, charts, tables, and facts vs. opinions, in the online information age, they are charged to teach how to determine source credibility and help them to develop reliability reasoning" (Pilgrim & Vasinda, 2021, p. 9). Since it is documented that secondary and higher education students, as well as teachers themselves, struggle with discernment of credibility and trustworthiness of online sources, the incorporation of scaffolded, developmentally appropriate objectives toward this end in the K-2 grade band is worth exploring (Marttunen et al., 2021; Pilgrim et al., 2019).

Past research also shows that many teachers currently view technology as an "add-on" or enhancement to literacy practices in the classroom rather than something integral to content instruction (Lee et al., 2012; List et al., 2020). While it certainly would not provide an immediate fix to the issue, perhaps a greater focus on the online environment's unique features in the research process could be a start toward ameliorating this mismatch. Research indicates that digital tools mediate our collective literacy practices and impact the research process (Karanasios et al., 2021).

Features of online environments affect our processing of information (Abdallah, 2013; Kaptelinin & Nardi, 2006; Li et al., 2021). However, particularly within the English Language

Arts standards, there was hardly any direct reference to *digital* skills and competencies. For example, the Behavioral and Cognitive domains were present in both the Computer Science and English Language Arts standards. However, looking at the subject matter therein, most English Language Arts standards related to the comprehension of literary and informational texts without specific reference to digital formats. Of course, it is vitally important that early elementary students continue to receive these foundational literacy skills. However, including digital competencies is not at odds with this instruction and could likely be easily incorporated therein. For example, the findings of the second research question revealed that the English Language Arts standards had comparatively very few (*n* = 3, compared to *n* = 30 for CS) standards in the "Employing Toward Innovation" category, which revolves around the use of digital tools. Additionally, although they did not meet variable presence scores in either subject area, the variables of Adaptable, Civic-Minded, Publisher, Teacher, Translator, and Informed all had greater Variable Prence in Computer Science than in English Language Arts. This suggests that the Computer Science set of standards had a comparatively greater emphasis on cultivating certain dispositions to learning, like flexibility with various digital formats, issues of reliability and credibility, and connections between the classroom and the broader community.

Within convergence culture, learners simultaneously consume, interpret, and produce; in this way, they both impact and are impacted by the learning system in which they interact (Engeström, 1999; Jenkins, 2009). As they exist now, the K-2 GSE in CS and ELA do not emphasize the sharing of student work and the development of student voice and agency as compared to their communication and information retention within the four walls of the classroom. Lankshear and Knobel (2014) write, “Remixing cultural items to produce new works is valued and central to cultural development within societies… this challenges schools’ assumptions about the importance of individualized authorship and the production of ‘original’ works” (p. 99). However, the findings of this study indicate that the standards–*particularly* the English Language Arts standards–do not strongly reflect this notion. This is seen in the total lack of representation of the “Meaning and Belonging” category in the English Language Arts standards and the lack of presence of variables such as Publisher, Teacher, Civic-Minded, and Translator. Increasing our standards’ incorporation of these elements could better position our students to develop their unique voices as participatory agents in modern culture and engender positive social change (Luke, 2012).

Study Implications

Research

This study addresses several critical gaps in the current research on metaliteracy, elementary digital literacies, and standards alignment. First, it stands as one of the only pieces of extant literature examining the concepts of metaliteracy from an elementary perspective. Metaliteracy is a relatively new framework, and most research on metaliteracy instruction has been conducted at the higher education or secondary level (Atkinson, 2020; Gilmore & Smith, 2005; Mackey et al., 2018; Sales, 2022). This study’s framing makes a case for the importance of metaliteracy’s ideas at the elementary level and within literacy instruction in the general education classroom. Previously, many elements of metaliteracy instruction have been siloed to either computer science classrooms or media specialist positions. However, from an equity perspective, we cannot consistently rely on students having access to supplemental resources like this in their schools regularly. Furthermore, the skills espoused by metaliteracy, from publishing information digitally with the intent to engage others to evaluate different online source materials for their reliability, are integral to becoming meaningfully literate in today's society and culture.

Students at the elementary level are reading and engaging online, both at school and at home. This study demonstrates how our teaching policies and practices do not align with this reality and adds to research positing a path forward. In this way, this study contributes to the conversation surrounding new literacies in the elementary classroom. It connects theoretical ideas concerning instructional emphases with practical realities of classroom instructional mandates. By examining the Computer Science and English Language Arts standards, the study hopes to bring awareness to how compatible these two sets of standards are in many ways.

This study also contributes methodologically to content analysis, mixed-methods research, and standards alignment research. There needs to be more consistency and rigor among content analysis studies (Strijbos et al., 2006). Additionally, there needs to be more clarity regarding standardized, methodical means for evaluating the degree of alignment between standards and other frameworks or curricular documents (Machalow, 2020). This study's approach provides one possible means of assessing the alignment of future materials via content analysis. Furthermore, the convergent design employing two different approaches to content analysis allows the reader to understand how each one may benefit the pursuit of a given research question and how the two approaches may even complement one another.

Policy

There are several main areas in which policy could be directly revised based on the findings of this study: a) revising the K-2 GSE in both CS and ELA to be more reflective of some of the underrepresented variables and categories in this study, b) revising the K-2 ELA GSE to be more reflective of digital literacy practices generally, perhaps incorporating some analogous CS standards, and c) introducing measures to ensure that general education teachers have access to, are aware of, and have the resources necessary to implement relevant CS standards into the ELA curriculum.

In terms of incorporating more MLCs into the existing CS and ELA standards, it is essential to pay attention to several factors: a) which variables are currently the most underrepresented, b) which variables are most useful as indicated by past research, and c) which variables would be the easiest to implement via minor tweaks to the current standards. The Affective and Metacognitive domains are in dire need of greater emphasis, and past research indicates that increased focus on metacognition delivers benefits regarding students' reading comprehension and attitudes about lifelong learning (S. Chen & McDunn, 2022; Flavell, 1979; Ozturk, 2015). Many Learner Characteristics–Adaptable, Civic-Minded, Informed, Open, and Reflective–were visible in fewer than 7% of the current standards, and many of these would also fall under the Affective Domain. Increasing students' Adaptability and Openness, for example, could lead to greater flexibility concerning the inevitability of new technological developments. This is important because gearing our instruction around technical fluency with current digital innovations is a losing battle. We must also incorporate the mental dispositions needed to tackle the future digital unknown within our standards. Toward the last point, the already-present roles of Communicator, Participant, Producer, and Author could tie in the other roles of Collaborator, Publisher, Researcher, Teacher, and Translator with small language shifts.

In May 2023, the Georgia Department of Education released draft copies of new, to-be-adopted K-12 English Language Arts standards (Grapevine, 2023). The K-2 standards are separated into three categories in these new drafts: K-2 Language, K-2 Foundations, and K-2 Texts. Already in the K-2 Texts draft document, some shifts directly relate to some of the findings of this study; for example, a new standard under the “Research & Analysis Big Idea” encourages students to “Explore various sources of information, including print, digital, and personal communication” (GADOE, 2022). However, these new standards are not slated to be implemented for several academic years at the earliest, and it will take even longer for teachers and students to become fluent and comfortable working with these new standards. In the meantime, education professionals can continue to consider what shifts can be made to improve students’ metaliteracy competencies in the elementary general education classroom.

While a complete analysis of these provisional standards is outside the scope of this dissertation, an initial review by the researcher still leads to the deduction that several MLCs (and categories from the qualitative content analysis) still need to be represented, even in the new standards. Additionally, these standards revisions are being issued amid a divisive political context, with Governor Brian Kemp vowing to eradicate all traces of the Common Core from Georgia’s standards (Bluestein & Tagami, n.d.; Dzhanova, 2021). Georgia’s education policy landscape must also be considered, as debates continue over what concepts should and should not be included in the curriculum (Downey, 2021; Dzhanova, 2021; Tagami, 2021). Metaliteracy advocates for social action, identity development, critical reflection, and collaboration across cultural backgrounds to build fluent, productive digital citizens (Jacobson & Mackey, 2013, 2022). The extant body of theory and research pointing toward the educational benefits of these concepts should be regarded when making policy recommendations (S. Chen & McDunn, 2022; Garcia et al., 2020; Gee, 2010; Gonzalez et al., 2006; Jacobson & Mackey, 2013; Lee & Soep, 2016; Leu, 2010; Luke, 2018; Street, 2003; Vasquez et al., 2019).

In the era of fake news, deepfakes, and false advertising, we must make sure that updates to our educational directives are grounded in research on best practices for instruction and are centering on the learner, not politics. In addition, new developments in generative artificial intelligence, neurotechnology, and screenless wearable technology will only continue to blur the line between "virtual" and "reality" (Farahany, 2023; Lim et al., 2023; Pichai, 2023). To become fully realized digital citizens, students must understand how to navigate technology fluently and evaluate ethics and privacy issues.

Practice

The implications for professional practice from this study are multifold. This study underscores the importance of integrating Computer Science standards into the English Language Arts curriculum at the elementary level. As the comparisons across subjects revealed, the Computer Science standards were more representative of certain variables (in research question 1) and categories (in research question 2) than the English Language Arts standards. In particular, the Computer Science standards had a greater presence of the Affective Domain, the

Civic-Minded Characteristic, and the Publisher, Teacher, and Translator roles. Because these roles are not inherently evident in the English Language Arts standards, it could be taken to incorporate them more thoughtfully into literacy lessons. For example, since the Author and Producer Roles are well-represented, teachers could extend these tasks by having students share their creations online (Publisher), present their creations (Teacher), or take their classmates' creations and "remix" them using new media (Translator).

One concrete example of how teachers could work towards including more of the underrepresented concepts and categories observed in this study could be implementing Project-Based Learning units into their practice. Project-Based Learning (PBL) organizes instruction around student-selected, authentic projects with driving questions that critically engage students in impacting the world around them while building their skills and understandings as encouraged by the state standards (Larmer et al., 2015; Larmer & Mergendoller, 2010). This approach has been shown to support students' information literacy and digital literacy skill development (Chu et al., 2011; Fallon & Breen, 2005).

This study also illuminates the difference between expanding technology access and improving digital literacy instruction. From the results of this study, practice could be adapted to teach students the skills they need to be fluent users of technology *and* the critical thinking and discernment skills necessary for students to evaluate online content. Teaching practices must consider how literacy practices have changed with the advent of technology and will continue to change as other developments occur. Also, teachers can consider the potential that incorporating concepts of metalitearcy into their classrooms could afford regarding critical considerations. By emphasizing student voice, collaboration, creation, and sharing in online communities, metaliteracy can potentially disrupt systems of power and inequity if leveraged appropriately.

Limitations

While this study is significant for several reasons and makes an essential contribution to the field, it exhibits several limitations worth considering. First, the mixed-methods nature of the study provided many benefits in data analysis and findings generation, but it also inhibited the study in a few ways. Because the dissertation essentially encompassed two studies in one, it required a great deal of time, mental energy, and pages to complete, and depth and nuance of interpretation were perhaps sacrificed in favor of the comprehensive picture that the mixed methods were able to paint. Suppose I had not designed a mixed-methods study and had instead selected one of these two research questions to explore fully. In that case, I might have had the capacity to go deeper by expanding the sample or conducting additional analysis methods.

Additionally, content analysis has its own unique set of advantages and disadvantages. One disadvantage to the content analysis techniques I employed is that the data is not triangulated to the degree that it might be in other forms of qualitative research. Had I decided on another method, such as the case study, I could have utilized various data sources, such as interviews, artifacts, and observations. Here, the standards are the entire sample, and the multiple analysis methods provide triangulated insights. Additionally, while content analysis (of both forms used here) benefits from being relatively standardized and methodical when employed correctly, this can also inhibit the researcher’s freedom to draw unique and innovative conclusions from the data. Had I decided to use thematic analysis, for example, I could have had a different outcome from the study.

The 202 standards used as the sample in the study also serve as a limitation in terms of generalizability. Because I only focused on three grades' standards in one state, the findings only apply to that specific setting. I focused on the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts (Reading: Literature, Reading: Informational, and Speaking/Listening). In so doing, I limited the scope of the findings to kindergarten, first-grade, and second-grade classrooms. While examining upper elementary (3-5) classrooms would have been interesting, likely fruitful, and added a lengthier set of standards to review, it would have fundamentally changed the nature of the work by changing the nature of the target population of the standards. I limited the standards to K-2 only because I was interested in how students learn to read online or in a digital context. Nevertheless, some generalizability is sacrificed.

However, future research could extend this generalizability by analyzing the similarity of the GSE in CS and ELA to the standards in other states or by analyzing a national framework. Additionally, I chose to look at Computer Science and English Language Arts in tandem due to my argument that digital literacy *is* literacy and should be instructed as such; however, in so doing, I may have missed out on additional insights that could be found by viewing interdisciplinary tie-ins to computer science/digital literacy/metaliteracy/computational thinking in math, science, and social studies.

I also chose only to examine the standards themselves rather than including any supplemental literature corresponding with the standards documents. I chose this because the existing standards are the documents most likely to fall into the hands of teachers and be used daily. While the supplemental materials could probably garner additional insights, their inclusion would necessitate a fundamental reframing of the research question & purpose of the study. Using activity theory led me to focus on observing what was asked of students in terms of concrete actions in the classroom, which led me to the standards. The additional materials, while perhaps intriguing regarding the latent values they might push forward, would not be used by children and therefore were excluded.

Additionally, my analysis of the differences among grade levels was minimal because of the small sample sizes when disaggregating by grade. This could be improved upon in future studies by expanding the sample to include supplemental documents or standards from other grade levels or subjects, as explained above. It also must be stated that all four Learning Goals failed to meet the criteria for adequate Variable Presence in the first research question. However, this is likely due to the particular nature of each learning goal. The Metaliteracy website disaggregates each learning goal into several objectives that meet a portion of the goal's essence. In future studies, perhaps the learning goals could be made into latent goals by unpacking the goal into several composite elements and coding for those elements separately. However, this was not possible in the present study due to the scope of the project and the selected methodology.

Areas for Future Research

Given the relatively new field to which this study contributes, there are ample opportunities for future research, which will only expand as technological progress continues. As this is a mixed-methods triangulation convergent design, quantitative and qualitative suggestions for future research readily come to mind. First, either of the research questions' methodologies could be replicated and expanded to include a larger sample. This could include more grade levels' Computer Science and English Language Arts standards in Georgia or the K-2 Computer Science and English Language Arts standards for more states. It would be interesting to see if the Variable Presence Scores for MLCs remain consistent with a larger sample, and the application of the novel qualitative coding frame towards a larger amount of data would also be fascinating. Additionally, several supplementary online documents accompany the Georgia Standards of Excellence to explain their rationale and provide context, which were not included in this study due to the desire to focus on what the standards are demanding and how they might manifest in the classroom. While the segmentation process would have to be altered, including these documents in a future content analysis study could also be illuminatory.

Repeating this study with a larger sample per one of the abovementioned methods could also provide an opportunity for more sophisticated inferential statistics methods. For example, the cross-grade analysis could be extended to observe whether the differences in category manifestations across grades are statistically significant. Additionally, because this was an exploratory study in an under-researched field, the researcher utilized binary categorical variables for the first research question's pursuit to get a baseline sense of the manifestation of each concept of metaliteracy within the sample. Additionally, repeating the study with interval variables wherein each variable was coded according to its level of embodiment of the given concept of metaliteracy could also be helpful, as standards vary in their level of depth when approaching these concepts. There are other, more extensive models for measuring educational alignment (Blank et al., 2001; Webb, 2007). However, these models have traditionally been used to measure the alignment between standards and enacted curricula rather than standards and external frameworks. It would be interesting to apply these models to the problem of the present study; however, given the broad, exploratory, and mixed-methods nature of this study's design, this is better saved for a future project.

There are also many opportunities to extend this research in the future when viewing the problem from a qualitative perspective. Given the results of this study, the most logical next step, in my opinion, would be to interview, survey, and observe K-2 teachers in Georgia to get a sense of how metaliteracy instruction is currently integrated into the classroom and what supports teachers might need in adapting their literacy instruction to keep up with our digital world. Depending on the results of these endeavors, this work could be expanded into professional development opportunities for teachers and subsequent analyses of the effectiveness of such programs. Overall, much potential work is ahead, and this study provides an exciting starting point.

Conclusion

> It's a bit like falling in love -- that terrifying realization that your fate is linked to someone else's, that you are no longer your own. But isn't that closer to the truth anyway? Our fates are linked, to each other, to the places where we are, and everyone and everything that lives in them. How much more real my responsibility feels when I think about it this way! This is much more than just an abstract understanding that our

> survival is threatened by global warming, or even a cerebral appreciation for other living beings and systems. Instead this is an urgent, personal recognition that my emotional and physical survival are bound up with these 'strangers', not just now, but for life. (Odell, 2020, p. 188)

Over the past several years, and increasingly in the wake of the COVID-19 pandemic, there has been a growing movement to re-examine our collective relationship with technology. Jenny Odell's *How to Do Nothing: Resisting the Attention Economy* is one such example (Odell, 2020). While Odell does spend a good portion of the book advocating for the rediscovery of nature and the enjoyment of birdwatching and rose gardens, she also makes a claim for redirection of our online efforts away from uncritical engagement with the attention economy and towards careful reflection and intentional construction of productive, collaborative online spaces.

Many social practices of reading, writing, communication, and expression that students currently engage with, which they will likely need in their future careers, now happen online. Educators must prepare students for this world. Furthermore, schools have a unique opportunity to help shape the contours of online culture by encouraging students to develop the necessary skills to navigate digital materials consciously. Many of the internet's so-called "dangers," from disinformation to cyberbullying, could be mitigated by recalibrating how one engages with technology.

This content analysis examined the processes currently asked of kindergarten, first-grade, and second-grade students by the Georgia Standards of Excellence, and its findings indicated that there are many areas for growth if the goal is to create digitally literate young students. The Metaliteracy framework, emphasizing metacognition, reflection, evaluation of sources, collaboration, and sharing, provides one path forward. Unfortunately, many adults who interact with the internet today were not afforded the wisdom of older generations as they braved the digital wilderness. As we embark on this journey towards digital literacy for our youngest learners, we must seize the opportunity to shape a new online culture where critical thinking, metacognition, and collaboration thrive.

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APPENDICES

Appendix A

Contents of Sample

Grade	Subject	Item
1	Computer Science	CSS.EL.K-2.1 Recognize that technology provides the opportunity to enhance relevance, increase confidence, offer authentic choice, and produce positive impacts in learning.
1	Computer Science	CSS.KC.K-2.2 Use digital tools (e.g. computers, tablets, cameras, software, 3D printers, etc.…) to build knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others.
1	Computer Science	3 Identify and use the home row of the keyboard effectively.
1	Computer Science	4 Build (use, modify and/or create) collections of digital images and words to communicate learning using a variety of media types.
1	Computer Science	CSS.DC.K-2.3 Identify the rights, responsibilities, and opportunities of living, learning, and working in an interconnected society and model behaviors that are safe, legal, and ethical.
1	Computer Science	3 Understand shared information on the Internet can be permanent.
1	Computer Science	4 Recognize and avoid harmful behaviors in online environments (e.g. viruses, in-app purchases, cyber-bullying, etc).
1	Computer Science	5 Follow safety rules and exhibit responsibility when using a device.
1	Computer Science	6 Create an artifact that shows the use of positive safe behavior when using technology.
1	Computer Science	CSS.IDC.K-2.4 Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.
1	Computer Science	4 Recognize that innovation in technology meets a range of needs (3D printing, coding, robotics, drones, etc.).

Grade	Subject	Item
1	Computer Science	CSS.CT.K-2.5 Develop and employ Computational Thinking strategies (break-down, find patterns, and create algorithms) to identify and solve problems.
1	Computer Science	2 Identify patterns
1	Computer Science	3 Create and use Algorithms (a set of step-by-step instructions) to complete a task.
1	Computer Science	4 Use Algorithms (a set of step-by-step instructions) to construct programs (using a block-based programming language or unplugged activities) that accomplish a task as a means of creative expression.
1	Computer Science	6 Analyze and debug (identify and fix) with or without a computing device.
1	Computer Science	CSS.CC.K-2.6 Use digital tools to creatively share and express ideas.
1	Computer Science	1 Create a variety of artifacts.
1	Computer Science	3 Present information using a digital device.
1	Computer Science	CSS.GC.K-2.7 Use digital tools to collaborate with others both locally and globally.
1	Computer Science	3 Understand features of online environments
1	Computer Science	CSS.RR.K-2.8 Select appropriate sources to conduct authentic research to produce a relevant and credible product.
1	Computer Science	2 Understand that resources on the Internet vary in quality and are found in a variety of places so care is needed in selection.
1	Computer Science	3 Understand there is an appropriate place to find information to research the answer to a question.
1	Computer Science	CSS.DA.K-2.9 Understand how people can use technology.
1	Computer Science	5 Identify that technological innovation changes how people live and work.
1	Computer Science	6 Understand that when you are on a networked device you are connected to other people.

Grade	Subject	Item
1	Computer Science	7 Practice using a variety of computing hardware and software to achieve personal learning goals.
1	Computer Science	8 Identify and describe solutions to simple hardware and software problems (ex. volume control).
1	Computer Science	9 Describe how technology can impact an individual’s life positively and negatively.
1	English Language Arts	ELAGSE1RL1 Ask and answer questions about key details in a text.
1	English Language Arts	ELAGSE1RL2 Retell stories, including key details, and demonstrate understanding of their central message or lesson.
1	English Language Arts	ELAGSE1RL3 Describe characters, settings, and major events in a story, using key details.
1	English Language Arts	ELAGSE1RL4 Identify words and phrases in stories or poems that suggest feelings or appeal to the senses.
1	English Language Arts	ELAGSE1RL5 Explain major difference between texts that tell stories and texts that give information.
1	English Language Arts	ELAGSE1RL6 Identify who is telling the story at various points in a text.
1	English Language Arts	ELAGSE1RL7 Use illustrations and details in a story to describe its characters, setting, or events.
1	English Language Arts	ELAGSE1RL9 Compare and contrast the adventures and experiences of characters in stories.
1	English Language Arts	ELAGSE1RL10 With prompting and support, read prose and poetry of appropriate complexity for grade 1.
1	English Language Arts	ELAGSE1RI1 Ask and answer questions about key details in a text.
1	English Language Arts	ELAGSE1RI2 Identify the main topic and retell key details of a text.
1	English Language Arts	ELAGSE1RI3 Describe the connection between two individuals, events, ideas, or pieces of information in a text.
1	English Language Arts	ELAGSE1RI4 Ask and answer questions to help determine or clarify the meaning of words and phrases in a text.

Grade	Subject	Item
1	English Language Arts	ELAGSE1RI5 Know and use various text features (e.g., headings, tables of content, glossaries, electronic menus, icons) to locate key facts or information in a text.
1	English Language Arts	ELAGSE1RI6 Distinguish between information provided by pictures or other illustrations and information provided by the words in a text.
1	English Language Arts	ELAGSE1RI7 Use illustrations and details in a text to describe its key ideas.
1	English Language Arts	ELAGSE1RI8 Identify the reasons an author gives to support points in a text.
1	English Language Arts	ELAGSE1RI9 Identify basic similarities in and differences between two texts on the same topic (e.g., in illustrations, descriptions, or procedures).
1	English Language Arts	ELAGSE1RI10 With prompting and support, read informational texts appropriately complex for grade 1.
1	English Language Arts	ELAGSE1W1 Write opinion pieces in which they introduce the topic or the name of the book they are writing about, state an opinion, supply a reason for the opinion, and provide some sense of closure.
1	English Language Arts	ELAGSE1W2 Write informative/ explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.
1	English Language Arts	ELAGSE1W3 Write narratives in which they recount two or more appropriately sequenced events, include some details regarding what happened, use temporal words to signal event order, and provide some sense of closure.
1	English Language Arts	ELAGSE1W5 With guidance and support from adults, focus on a topic, respond to questions and suggestions from peers, and add details to strengthen writing as needed.
1	English Language Arts	ELAGSE1W6 With guidance and support from adults, use a variety of tools to produce and publish writing, including digital tools and collaboration with peers.
1	English Language Arts	ELAGSE1W7 Participate in shared research and writing projects (e.g., exploring a number of "how-to" books on a given topic and use them to write a sequence of instructions).

Grade	Subject	Item
1	English Language Arts	ELAGSE1W8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
1	English Language Arts	ELAGSE1SL1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.
1	English Language Arts	ELAGSE1SL1.a Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion).
1	English Language Arts	ELAGSE1SL1.b Build on others' talk in conversations by responding to comments through multiple exchanges.
1	English Language Arts	ELAGSE1SL1.c Ask questions to clear up any confusion about the topics and texts under discussion.
1	English Language Arts	ELAGSE1SL2 Ask and answer questions about key details in a text read aloud or information presented orally or through other media.
1	English Language Arts	ELAGSE1SL3 Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.
1	English Language Arts	ELAGSE1SL4 Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.
1	English Language Arts	ELAGSE1SL5 Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.
1	English Language Arts	ELAGSE1SL6 Produce complete sentences when appropriate to task and situation.(See grade 1 Language standards 1 and 3 for specific expectations.)
2	Computer Science	CSS.EL.K-2.1 Recognize that technology provides the opportunity to enhance relevance, increase confidence, offer authentic choice, and produce positive impacts in learning.
2	Computer Science	CSS.KC.K-2.2 Use digital tools (e.g. computers, tablets, cameras, software, 3D printers, etc.…) to build knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others.

Grade	Subject	Item
2	Computer Science	3 Identify and use the home row of the keyboard effectively.
2	Computer Science	4 Build (use, modify and/or create) collections of digital images and words to communicate learning using a variety of media types.
2	Computer Science	5 Analyze collections of digital images and words for how well each collection communicates learning.
2	Computer Science	6 Identify a problem of interest to the learner and create a solution using digital tools.
2	Computer Science	CSS.DC.K-2.3 Identify the rights, responsibilities, and opportunities of living, learning, and working in an interconnected society and model behaviors that are safe, legal, and ethical.
2	Computer Science	7 Recognize work that is created by others.
2	Computer Science	8 Recognize that credit is given for the work of others found online.
2	Computer Science	9 Create an artifact that demonstrates a positive personal digital identity.
2	Computer Science	CSS.IDC.K-2.4 Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.
2	Computer Science	2 Modify an existing model for a specific purpose or for a specific group of users.
2	Computer Science	3 Create and test a model and analyze it from the perspective of an end user.
2	Computer Science	5 Understand that innovation follows a process such as system life cycle, engineering design (use, modify, create) or design thinking (empathize, define, ideate, prototype and test).
2	Computer Science	CSS.CT.K-2.5 Develop and employ Computational Thinking strategies (break-down, find patterns, and create algorithms) to identify and solve problems.
2	Computer Science	1 Recognize that problems can be broken down into smaller parts in order to create a solution. Vocabulary Term: Decompose (to break down)

Grade	Subject	Item
2	Computer Science	5 Identify multiple ways solutions can be applied to solve problems. Vocabulary Term: Abstraction
2	Computer Science	6 Analyze and debug (identify and fix) with or without a computing device.
2	Computer Science	CSS.CC.K-2.6 Use digital tools to creatively share and express ideas.
2	Computer Science	1 Create a variety of artifacts.
2	Computer Science	2 Exchange information or ideas clearly and creatively using digital tools while considering audience and intended purpose.
2	Computer Science	3 Present information using a digital device.
2	Computer Science	4 Create artifacts for specific purposes that give and receive feedback.
2	Computer Science	CSS.GC.K-2.7 Use digital tools to collaborate with others both locally and globally.
2	Computer Science	1 Identify technology (hardware and software) that allows collaboration with others.
2	Computer Science	2 Use digital tools to connect with individuals from different backgrounds and cultures.
2	Computer Science	3 Understand features of online environments
2	Computer Science	4 Participate in various roles on a team to work on a common goal and create an inclusive environment.
2	Computer Science	5 Participate in an online collaborative learning environment.
2	Computer Science	CSS.RR.K-2.8 Select appropriate sources to conduct authentic research to produce a relevant and credible product.
2	Computer Science	4 Progress from using a teacher developed list of resources, to selecting resources independently.
2	Computer Science	5 Select digital and analog resources, explain why a source was selected, and describe why it was the best source.
2	Computer Science	6 Collect and organize data.

Grade	Subject	Item
2	Computer Science	7 Create a product of research collaboratively or independently. (e.g., table of data, writing assignment, collection of resources).
2	Computer Science	8 Create and share a research project reflecting and crediting a variety of quality resources.
2	Computer Science	CSS.DA.K-2.9 Understand how people can use technology.
2	Computer Science	10 Use devices appropriately
2	Computer Science	11 Choose and use appropriate hardware and software tools for a given purpose using accurate terminology.
2	English Language Arts	ELAGSE2RL1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
2	English Language Arts	ELAGSE2RL2 Recount stories, including fables and folktales from diverse cultures, and determine their central message, lesson, or moral.
2	English Language Arts	ELAGSE2RL3 Describe how characters in a story respond to major events and challenges.
2	English Language Arts	ELAGSE2RL4 Describe how words and phrases (e.g., regular beats, alliteration, rhymes, repeated lines) supply rhythm and meaning in a story, poem, or song.
2	English Language Arts	ELAGSE2RL5 Describe the overall structure of a story including describing how the beginning introduces the story, the middle provides major events and challenges, and the ending concludes the action.
2	English Language Arts	ELAGSE2RL6 Acknowledge differences in the points of view of characters, including by speaking in a different voice for each character when reading dialogue aloud.
2	English Language Arts	ELAGSE2RL7 Use information gained from the illustrations and words in a print or digital text to demonstrate understanding of its characters, setting, or plot.
2	English Language Arts	ELAGSE2RL9 Compare and contrast two or more versions of the same story (e.g., Cinderella stories) by different authors or from different cultures.

Grade	Subject	Item
2	English Language Arts	ELAGSE2RL10 By the end of the year, read and comprehend literature, including stories and poetry, in the grades 2-3 text complexity band proficiently, with scaffolding as needed at the high end of the range.
2	English Language Arts	ELAGSE2RI1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
2	English Language Arts	ELAGSE2RI2 Identify the main topic of a multi-paragraph text as well as the focus of specific paragraphs within the text.
2	English Language Arts	ELAGSE2RI3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.
2	English Language Arts	ELAGSE2RI4 Determine the meanings of words and phrases in a text relevant to a grade 2 topic or subject area.
2	English Language Arts	ELAGSE2RI5 Know and use various text features (e.g., captions, bold print, subheadings, glossaries, indexes, electronic menus, icons) to locate key facts or information in a text efficiently.
2	English Language Arts	ELAGSE2RI6 Identify the main purpose of a text, including what the author wants to answer, explain, or describe.
2	English Language Arts	ELAGSE2RI7 Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.
2	English Language Arts	ELAGSE2RI8 Describe how reasons support specific points the author makes in a text.
2	English Language Arts	ELAGSE2RI9 Compare and contrast the most important points presented by two texts on the same topic.
2	English Language Arts	ELAGSE2RI10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 2-3 text complexity band proficiently, with scaffolding as needed at the high end of the range.
2	English Language Arts	ELAGSE2W1 Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g.,

Grade	Subject	Item
		because, and, also) to connect opinion and reasons, and provide a concluding statement or section.
2	English Language Arts	ELAGSE2W2 Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.
2	English Language Arts	ELAGSE2W3 Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts, and feelings, use temporal words to signal event order, and provide a sense of closure.
2	English Language Arts	ELAGSE2W5 With guidance and support from adults and peers, focus on a topic and strengthen writing as needed by revising and editing.
2	English Language Arts	ELAGSE2W5.a May include prewriting.
2	English Language Arts	ELAGSE2W6 With guidance and support from adults, use a variety of tools to produce and publish writing, including digital tools and collaboration with peers.
2	English Language Arts	ELAGSE2W7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).
2	English Language Arts	ELAGSE2W8 Recall information from experiences or gather information from provided sources to answer a question.
2	English Language Arts	ELAGSE2SL1 Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.
2	English Language Arts	ELAGSE2SL1.a Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
2	English Language Arts	ELAGSE2SL1.b Build on others' talk in conversations by linking their comments to the remarks of others.
2	English Language Arts	ELAGSE2SL1.c Ask for clarification and further explanation as needed about the topics and texts under discussion.

Grade	Subject	Item
2	English Language Arts	ELAGSE2SL2 Recount or describe key ideas or details from written texts read aloud or information presented orally or through other media.
2	English Language Arts	ELAGSE2SL3 Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue.
2	English Language Arts	ELAGSE2SL4 Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.
2	English Language Arts	ELAGSE2SL5 With guidance and support, create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts and feelings.
2	English Language Arts	ELAGSE2SL6 Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification. (See grade 2 Language standards 1 and 3 for specific expectations.)
K	Computer Science	CSS.EL.K-2.1 Recognize that technology provides the opportunity to enhance relevance, increase confidence, offer authentic choice, and produce positive impacts in learning.
K	Computer Science	CSS.KC.K-2.2 Use digital tools (e.g. computers, tablets, cameras, software, 3D printers, etc.…) to build knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others.
K	Computer Science	1 Recognize the letters, numbers, and basic functions of a keyboard, touchpad/trackpad, mouse, and other input devices.
K	Computer Science	2 Use the letters, numbers, and basic functions of the keyboard effectively (shift, space, tab, enter/return).
K	Computer Science	CSS.DC.K-2.3 Identify the rights, responsibilities, and opportunities of living, learning, and working in an interconnected society and model behaviors that are safe, legal, and ethical.
K	Computer Science	1 Identify personal information, understand the need to keep it private, and engage in activities for keeping personal information private.

Grade	Subject	Item
K	Computer Science	2 Participate in systems for keeping personal information private and protected (for example: passwords, biometric sensors).
K	Computer Science	CSS.IDC.K-2.4 Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.
K	Computer Science	1 Understand that a model is used for developing and testing ideas for a diverse range of users
K	Computer Science	CSS.CT.K-2.5 Develop and employ Computational Thinking strategies (break-down, find patterns, and create algorithms) to identify and solve problems.
K	Computer Science	2 Identify patterns
K	Computer Science	4 Use Algorithms (a set of step-by-step instructions) to construct programs (using a block-based programming language or unplugged activities) that accomplish a task as a means of creative expression.
K	Computer Science	5 Identify multiple ways solutions can be applied to solve problems. Vocabulary Term: Abstraction
K	Computer Science	CSS.CC.K-2.6 Use digital tools to creatively share and express ideas.
K	Computer Science	1 Create a variety of artifacts.
K	Computer Science	2 Exchange information or ideas clearly and creatively using digital tools while considering audience and intended purpose.
K	Computer Science	CSS.GC.K-2.7 Use digital tools to collaborate with others both locally and globally.
K	Computer Science	1 Identify technology (hardware and software) that allows collaboration with others.
K	Computer Science	2 Use digital tools to connect with individuals from different backgrounds and cultures.
K	Computer Science	CSS.RR.K-2.8 Select appropriate sources to conduct authentic research to produce a relevant and credible product.
K	Computer Science	1 Understand that answers to questions can be found through research from a variety of sources.

Grade	Subject	Item
K	Computer Science	2 Understand that resources on the Internet vary in quality and are found in a variety of places so care is needed in selection.
K	Computer Science	3 Understand there is an appropriate place to find information to research the answer to a question.
K	Computer Science	CSS.DA.K-2.9 Understand how people can use technology.
K	Computer Science	1 Understand that technology is everywhere and changes our lives.
K	Computer Science	2 Understand that there is a connection between people and devices.
K	Computer Science	3 Practice using and identifying basic hardware and software using accurate terminology.
K	Computer Science	4 Create simple artifacts using a computing device.
K	English Language Arts	ELAGSEKRL1 With prompting and support, ask and answer questions about key details in a text.
K	English Language Arts	ELAGSEKRL2 With prompting and support, retell familiar stories, including key details.
K	English Language Arts	ELAGSEKRL3 With prompting and support, identify characters, settings, and major events in a story.
K	English Language Arts	ELAGSEKRL4 With prompting and support, ask and answer questions about unknown words in a text.
K	English Language Arts	ELAGSEKRL5 Recognize common types of texts (e.g., storybooks, poems).
K	English Language Arts	ELAGSEKRL6 With prompting and support, name the author and illustrator of a story and define the role of each in telling the story.
K	English Language Arts	ELAGSEKRL7 With prompting and support, describe the relationship between illustrations and the story (how illustrations support the text).
K	English Language Arts	ELAGSEKRL9 With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories.

Grade	Subject	Item
K	English Language Arts	ELAGSEKRL10 Actively engage in group reading activities with purpose and understanding.
K	English Language Arts	ELAGSEKRI1 With prompting and support, ask and answer questions about key details in a text.
K	English Language Arts	ELAGSEKRI2 With prompting and support, identify the main topic (main idea) and retell key details of a text (supporting details).
K	English Language Arts	ELAGSEKRI3 With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
K	English Language Arts	ELAGSEKRI4 With prompting and support, ask and answer questions about unknown words in a text.
K	English Language Arts	ELAGSEKRI5 Identify the front cover, back cover, and title page of a book.
K	English Language Arts	ELAGSEKRI6 Name the author and illustrator of a text and define the role of each in presenting the ideas or information in a text.
K	English Language Arts	ELAGSEKRI7 With prompting and support, describe the relationship between illustrations and the text (how the illustrations support the text).
K	English Language Arts	ELAGSEKRI8 With prompting and support, identify the reasons an author gives to support points in a text.
K	English Language Arts	ELAGSEKRI9 With prompting and support, identify basic similarities in and differences between two texts on the same topic (e.g., in illustrations, descriptions, or procedures).
K	English Language Arts	ELAGSEKRI10 Actively engage in group reading of informational text with purpose and understanding.
K	English Language Arts	ELAGSEKW1 Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are "writing" about and state an opinion or preference about the topic or book (e.g., My favorite book is…).
K	English Language Arts	ELAGSEKW2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they

Grade	Subject	Item
		name what they are writing about and supply some information about the topic.
K	English Language Arts	ELAGSEKW3 Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.
K	English Language Arts	ELAGSEKW5 With guidance and support from adults, respond to questions and suggestions from peers and add details to strengthen writing as needed.
K	English Language Arts	ELAGSEKW6 With guidance and support from adults, use a variety of tools to produce and publish writing, including digital tools in collaboration with peers.
K	English Language Arts	ELAGSEKW7 With guidance and support, participate in shared research and writing projects (e.g., explore books by a favorite author and express opinions about them).
K	English Language Arts	ELAGSEKW8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
K	English Language Arts	ELAGSEKSL1 Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
K	English Language Arts	ELAGSEKSL1.a Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
K	English Language Arts	ELAGSEKSL1.b Continue a conversation through multiple exchanges.
K	English Language Arts	ELAGSEKSL2 Confirm understanding of written texts read aloud or information presented orally or through media by asking and answering questions about key details and requesting clarification if something is not understood.
K	English Language Arts	ELAGSEKSL3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.
K	English Language Arts	ELAGSEKSL4 Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.

Grade	Subject	Item
K	English Language Arts	ELAGSEKSL5 Add drawings or other visual displays to descriptions as desired to provide additional detail.
K	English Language Arts	ELAGSEKSL6 Speak audibly and express thoughts, feelings, and ideas clearly.

Appendix B

Research Question 1 Sample Codebook Excerpt

Name	ML Area	Definition	1 Criteria	0 Criteria	Examples
Author	Roles	one who writes or creates new texts or media	unit specifically references the student writing or creating something new or remixed.	unit does not specifically involve the student in creating new content/writing.	creating content; using different platforms; engaging in the writing process; journaling; revising and editing; posting on social media
Behavioral	Domains	applying knowledge through active abilities; pertaining to skills and competencies individuals must develop fluency in to participate in online environments; both literacy foundational skills and technical skills specific to certain platforms and tasks	unit's directives concern the acquisition or demonstration of behavioral skills or technical understandings.	unit does not directly ask the student to demonstrate knowledge of or acquire basic competencies.	completing rote tasks; building technical skills; demonstrating knowledge; memorization; basic understanding
Reflective	Characteristics	thinking about one's own thinking; developing understandings about gaps in one's knowledge and strengths and/or growth areas as a learner; developing self-awareness about one's role in the world	unit requires the learner to reflect on their learning, work, and/or positionality.	unit does not explicitly engage learner in reflective processes.	identifying and addressing gaps in knowledge; evaluating one's understanding of a concept; assessing one's work and improving it over time

Appendix C

Variables and Hypotheses for Simulation of Hypothesis Testing

Variable 1: *Adaptable* is the characteristic representing an effort to accommodate the constantly changing nature of technology and demonstrating flexibility when introduced to new forms of knowing.

Variable 2: *Civic-Minded* is the characteristic related to a sense of responsibility to one's community and the impetus to create and sustain meaningful communities through social action.

Variable 3: *Collaborative* is the characteristic of a student who works with a team as both a learner and producer in digital and classroom spaces.

Variable 4: *Informed* is the characteristic of understanding details about new information, such as its source of origin, reliability, accuracy, authorship, and any potential biases.

Variable 5: *Open* is the characteristic revolving around the development of an open-mindedness to new ideas, with an emphasis on differing perspectives from one's own.

Variable 6: *Participatory* is the characteristic wherein students develop their voice in the classroom, on social media, and in the community by interacting with others and actively engaging in the acquisition and sharing of knowledge.

Variable 7: *Productive* is the characteristic through which students organize resources around a particular topic to create something new.

Variable 8: *Reflective* is the characteristic wherein the individual is thinking about their own thinking, developing metacognitive habits, and building an understanding of what they do and do not currently know.

Variable 9: *Author* is the role wherein the learner writes or creates new texts or media.

Variable 10: *Collaborator* is the role wherein the learner works with a team to create or produce something new.

Variable 11: *Communicator* is the role wherein the learner carefully and thoughtfully engages with a variety of communities.

Variable 12: *Participant* is the role wherein students use their voice in the classroom, on social media, and in the community by interacting with others and actively engaging in the acquisition and sharing of knowledge.

Variable 13: *Producer* is the role wherein students organize resources around a particular topic to create something new.

Variable 14: *Publisher* is the role wherein students share the information that they create or remix with others beyond the self and the teacher or grader.

Variable 15: *Researcher* is the role wherein the learner engages in the skills needed in the research process, such as compiling information, assessing its trustworthiness, evaluating the content of sources, and using online databases.

Variable 16: *Teacher* is the role wherein students use their own skills, abilities, or acquired knowledge to educate others, including by sharing their learning.

Variable 17: *Translator* is the role wherein the learner takes content or information they have acquired, combined with their own skills or knowledge, and transforms it into another format of information.

Variable 18: *Affective* is the learning domain pertaining to the individual's attitudes and beliefs in technology-mediated environments.

Variable 19: *Behavioral* is the learning domain pertaining to skills and competencies individuals must develop to participate fluently in online and physical environments.

Variable 20: *Cognitive* is the learning domain pertaining to processes of higher-order thinking, such as evaluation, analysis, problem-solving, and creation, which are needed in the social uses of technology.

Variable 21: *Metacognitive* is the learning domain pertaining to self-regulation, critical reflection, and awareness of one's own thinking.

Variable 22: *Goal 1* is information matching the definition of Learning Goal 1, "Actively evaluate content while also evaluating one's own biases."

Variable 23: *Goal 2* is information matching the definition of Learning Goal 2, "Engage with all intellectual property ethically and responsibly."

Variable 24: *Goal 3* is information matching the definition of Learning Goal 3, "Produce and share information in collaborative and participatory environments."

Variable 25: *Goal 4* is information matching the definition of Learning Goal 4, "Develop learning strategies to meet lifelong personal and professional goals."

H_0: There is adequate presence of all 25 concepts of metaliteracy within the K-2 Georgia Standards of Excellence in Computer Science and English Language Arts.

H_1: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Adaptable.

H_2: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Civic-Minded.

H_3: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Collaborative.

H_4: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Informed.

H_5: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Open.

H_6: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Participatory.

H_7: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Productive.

H_8: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Reflective.

H_9: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Author.

H_{10}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Collaborator.

H_{11}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Communicator.

H_{12}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Participant.

H_{13}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Producer.

H_{14}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Publisher.

H_{15}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Researcher.

H_{16}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Teacher.

H_{17}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Translator.

H_{18}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Affective metaliterate learning domain.

H_{19}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Behavioral metaliterate learning domain.

H_{20}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Cognitive metaliterate learning domain.

H_{21}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Metacognitive metaliterate learning domain.

H_{22}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 1, "Actively evaluate content while also evaluating one's own biases."

H_{23}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 2, "Engage with all intellectual property ethically and responsibly."

H_{24}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 3, "Produce and share information in collaborative and participatory environments."

H_{25}: The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 4, "Develop learning strategies to meet lifelong personal and professional goals."

Appendix D

Full Results of Quantitative Content Analysis

Table D1

Frequencies of Concepts of Metaliteracy, K-2 CS and LA

Category	Code	Frequency of 0s	Frequency of 1s	Variable Presence Score	Percentage
Roles	Author	164	38	0.188	18.81
Roles	Collaborator	182	20	0.099	9.9
Roles	Communicator	157	45	0.223	22.28
Roles	Participant	145	57	0.282	28.22
Roles	Producer	157	45	0.223	22.28
Roles	Publisher	189	13	0.064	6.44
Roles	Researcher	190	12	0.059	5.94
Roles	Teacher	183	19	0.094	9.41
Roles	Translator	191	11	0.054	5.45
Characteristics	Adaptable	188	14	0.069	6.93
Characteristics	Civic-Minded	189	13	0.064	6.44
Characteristics	Collaborative	182	20	0.099	9.9
Characteristics	Informed	190	12	0.059	5.94
Characteristics	Open	197	5	.03	2.48
Characteristics	Participatory	145	57	.28	28.22
Characteristics	Productive	157	45	.22	22.28

Category	Code	Frequency of 0s	Frequency of 1s	Variable Presence Score	Percentage
Characteristics	Reflective	188	14	.07	6.93
Domains	Affective	189	13	.06	6.44
Domains	Behavioral	76	126	.62	62.38
Domains	Cognitive	115	87	.43	43.07
Domains	Metacognitive	187	15	.07	7.43
Goals	Goal 1	188	14	0.07	6.93
Goals	Goal 2	191	11	0.05	5.45
Goals	Goal 3	163	39	0.19	19.31
Goals	Goal 4	173	29	0.14	14.36

Table D2

Hypothesis Testing Process Results

Hypothesis	Statement	Variable Presence Score	Reject or Fail to Reject
H_1	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Author.	.19	Fail to Reject
H_2	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Collaborator.	.10	Reject
H_3	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Communicator.	.22	Fail to Reject

Hypothesis	Statement	Variable Presence Score	Reject or Fail to Reject
H_4	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Participant.	.28	Fail to Reject
H_5	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Producer.	.22	Fail to Reject
H_6	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Publisher.	.06	Reject
H_7	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Researcher.	.06	Reject
H_8	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Teacher.	.09	Reject
H_9	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner role of Translator.	.05	Reject
H_{10}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Adaptable.	.07	Reject
H_{11}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Civic-Minded.	.06	Reject
H_{12}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Collaborative.	.10	Reject
H_{13}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Informed.	.06	Reject

Hypothesis	Statement	Variable Presence Score	Reject or Fail to Reject
H_{14}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Open.	.03	Reject
H_{15}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Participatory.	.28	Fail to Reject
H_{16}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Productive.	.22	Fail to Reject
H_{17}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate learner characteristic of Reflective.	.07	Reject
H_{18}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Affective metaliterate learning domain.	.06	Reject
H_{19}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Behavioral metaliterate learning domain.	.62	Fail to Reject
H_{20}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Cognitive metaliterate learning domain.	.43	Fail to Reject
H_{21}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the Metacognitive metaliterate learning domain.	.07	Reject
H_{22}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 1, “Actively evaluate content while also evaluating one’s own biases.”	.07	Reject

Hypothesis	Statement	Variable Presence Score	Reject or Fail to Reject
H_{23}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 2, “Engage with all intellectual property ethically and responsibly.”	.05	Reject
H_{24}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 3, “Produce and share information in collaborative and participatory environments.”	.19	Reject
H_{25}	The K-2 Georgia Standards of Excellence in Computer Science and English Language Arts show adequate evidence of the metaliterate Learning Goal 4, “Develop learning strategies to meet lifelong personal and professional goals.”	.14	Reject

Table D3

Learner Roles and Characteristics, According to Subject

Code	CS 0s	CS 1s	CS Presence	ELA 0s	ELA 1s	ELA Presence
Author	81	15	0.156	83	23	0.217
Collaborator	88	8	0.083	94	12	0.113
Communicator	80	16	0.167	77	29	0.274
Participant	74	22	0.229	71	35	0.330
Producer	69	27	0.281	88	18	0.170
Publisher	86	10	0.104	103	3	0.028
Researcher	90	6	0.063	100	6	0.057

Code	CS 0s	CS 1s	CS Presence	ELA 0s	ELA 1s	ELA Presence
Teacher	83	13	0.135	100	6	0.057
Translator	88	8	0.083	103	3	0.028
Adaptable	85	11	0.115	103	3	0.028
Civic-Minded	86	10	0.104	103	3	0.028
Collaborative	88	8	0.083	94	12	0.113
Informed	84	12	0.125	106	0	0.000
Open	94	2	0.021	103	3	0.028
Participatory	74	22	0.229	71	35	0.330
Productive	69	27	0.281	88	18	0.170
Reflective	94	2	0.021	94	12	0.113

Table D4

All Variables, According to Grade

Codes	Kindergarten Frequency of 1s	First Grade Frequency of 1s	Second Grade Frequency of 1s
Author	12	11	15
Collaborator	4	6	10
Communicator	15	14	16
Participant	19	17	21
Producer	13	14	18
Publisher	5	3	5
Researcher	5	4	3
Teacher	5	6	8
Translator	3	3	5
Adaptable	4	4	6
Civic-Minded	4	5	4
Collaborative	4	6	10

Informed	3	3	6
Open	2	1	2
Participatory	19	17	21
Productive	13	14	18
Reflective	5	5	4
Affective	4	4	5
Behavioral	44	41	41
Cognitive	21	30	36
Metacognitive	4	6	5
Goal 1	6	4	4
Goal 2	3	4	4
Goal 3	10	11	18
Goal 4	9	10	10

Appendix E

Overall Results for Qualitative Content Analysis

Table E1

Overall Frequency Data for Qualitative Coding Frame

	Frequency	Proportion	Percent
1.1. Information Demonstration	36	0.178	17.82
1.2. Engaging Expression	25	0.124	12.38
1.3. Teaching and Learning Together	23	0.114	11.39
1. Collaborative Communication Total	84	0.416	41.58
2.1. Gathering Information	13	0.064	6.44
2.2. Digesting Information	9	0.045	4.46
2.3. Analyzing Information	22	0.109	10.89
2. Acquiring Toward Analysis Total	44	0.218	21.78
3.1. Utilization	12	0.059	5.94
3.2. Adaptation	12	0.059	5.94
3.3. Novel Creation	8	0.040	3.96
3. Employing Toward Innovation Total	32	0.158	15.84
4.1. Real-World Implications	11	0.054	5.45
4.2. Identity Development	3	0.015	1.49
4.3. Interaction of Identity & Environment	11	0.054	5.45
4. Meaning and Belonging Total	25	0.124	12.38

5.1. Reflecting on Information	10	0.050	4.95
5.2. Revising Creations	5	0.025	2.48
5.3. Retooling Inventions	2	0.010	0.99
5. Reflecting and Revising Total	17	0.084	8.42
Total	202	1	100