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Project of Excellence

Computational Thinking in 5th Grade Social Studies Curriculum

INTRODUCTION.

Current trends in social studies education are not providing enough attention and vital classroom time to create the "next generation of young people that are informed, active, and responsible global citizens", even though this is touted to be one of the most important pillars of American education (Pugh et.al, 2022) . A survey of primary social studies teachers stated that only 29% of all teachers responded saying their school thought civics and government were important (Leming, 2006). This indifferent approach to social studies education is reflected in the test score of students. According to the NAEP, "the average U.S. history score for eighth-grade students in 2022 was 5 points lower than in 2018, the previous assessment year" demonstrating a sharp decline since 2014. In addition, "The average civics score for eighth-grade students in 2022 was 2 points lower compared to 2018, the previous civics assessment year" the first time scores have ever declined since starting to administer the test (NAEP, 2022).

However, beyond the lack of attention social studies curriculum receives, there could be other catalysts for students' lack of knowledge. The same survey of elementary social studies teachers indicated that while the majority of teachers surveyed used mostly student-centered teaching, ninety percent had used a lecture/ whole group presentation instruction in their most recent lesson (Leming, 2006). The instructional techniques used in the classroom are equally as important to students' understanding of content as compared to how often or how much social studies curriculum is emphasized in the classroom. Teachers can help make the most out of the time allotted to them by utilizing computational thinking, referred to as CT, with their social studies lesson. The aim for this literature review is to evaluate the use of CT in elementary classrooms, and demonstrate how it can be utilized within elementary level lessons. Research was conducted through the TAMUCC library databases and only sources pertaining to the keywords ``computational thinking " "social studies" and "elementary" and sources from 2013 and later are used for research into the world of CT. As the political environment in the country continues to remain contentious and the ease with which students' can reach information continues to grow, the remaining pillar of education to create educated citizens is confronted with new challenges. CT in social studies curriculum could help students make deeper, more meaningful connections to concepts and aid in critical thinking development.

OVERVIEW OF THE TOPIC.

Computational thinking first made waves within the education sphere when Jennete Wing's article " Computational Thinking " came out in 2006. Her assertion that students should " use heuristic reasoning to discover a solution'' altered how educators teach and students learn in all subjects and introduced researchers to an interesting new idea within educational discourse. However, continuing to define CT proves to be challenging as parameters continue to change and perspectives are shifted. Listed below in Table 1.1 are a few definitions from various sources which help provide a more specific overview of the term.

Table 1.1

DEFINITION:	**SOURCE:**
Computational thinking is explained as the reconstruction of data through abstractions such as models and simulations, use of the data and producing appropriate solutions to existing problems by considering the limits of computing.	*Bringing Computational Thinking to K-12: What is Involved and What is the Role of the Computer Science Education Community*? Barr, Valerie; Stephenson, Chris. ACM Inroads Vol. 2, Iss. 1, (Mar 2011): 48-54.
Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on	*Wing, J.M. Computational Thinking. Communications* of the ACM, 49, (2006) 33-35.

the concepts fundamental to computer science. Computational thinking includes a range of mental tools that reflect the breadth of the field of computer science.	
Computational thinking is knowing what steps to take to solve a problem and to apply that skill across disciplines. Another expectation is that students will become not just tool users, but tool creators, a skill useful in their personal lives as well.	Sykora, C.(2021, April 23). Computational Thinking for All. ITSE. https://iste.org/blog/computational-thinking-for-all

From these definitions, CT is commonly broken up into several different components. In the context of its application to specifically the social studies curriculum, there are 5 major components addressed within the associated example curriculum. Table 1.2 below breaks up and addresses these components, all of which are from the most recent CT definitions provided from ITSE:

COMPONENT:	DEFINITION:
Data Collection/ Data Analysis	•Logically organizing and analyzing data.
Data Representation	•Representing data through abstractions such as models and simulations.
Decomposition	•Breaking down tasks into smaller, manageable parts.
Abstraction	•Reducing complexity to define the main idea.
Algorithms/ Procedures	•Series of ordered steps taken to solve a problem or achieve some end.

ISTE CT Teacher Resources, (2021)

Controversies surrounding the topic of CT within education, and more specifically social studies education, seems to be scarce. Majority of educators agree integration of CT could yield students who use their critical thinking skills more often. Nevertheless, how to go about this integration seems to be up for debate. How, when, and where to integrate CT into curriculum is one criticism, as not every student is interested in CT, not every subject seems to naturally fit with CT, and there is no major effort to create it into a general topic. More so, where will teachers get the time to cover these topics in already packed school curricula? The lack of clarity behind the term seems to draw some criticism as well, if educators can not properly define it then how can students understand it themselves (Grover & Pea, 2013).

METHODOLOGY.

The methodology used for conducting this literature review involved a systematic and comprehensive search of TAMUCC academic databases for reputable sources to identify relevant studies and articles related to the topic. The review focused on examining the integration of CT in K-5 classrooms.

1. Search Strategy: To ensure a thorough search, a combination of keyword and controlled vocabulary (subject headings) searches was utilized. The primary databases utilized were ERIC (Education Resources Information Center) and Academic Search Complete. The following search terms were used in different combinations:

- Elementary education
- Primary education
- Computational Thinking
- K-12 education
- Social Studies curriculum
- Computational Thinking integration
- Elementary curriculum

2. Inclusion and Exclusion Criteria:

The inclusion criteria for selecting studies were as follows:

- Published in peer-reviewed journals

- Written in English.

- Focused on computational thinking in K-5 educational settings.

- Empirical research, case studies, or systematic reviews.

The exclusion criteria were:

- Non-English language publications.

- Studies not directly related to computational thinking integration in K-12 education.

- Editorials, opinion pieces, or book reviews (unless suited to explain context or history of computational thinking)

-Only discusses coding/programming education, rather integration into core subjects

-Only discussing integration into math

3. Study Selection:

The initial search yielded a total of 36 articles. After removing duplicates and screening the titles and abstracts, 14 articles remained. These articles were then subjected to a text review, resulting in a final selection of 7 relevant sources that met the inclusion criteria. The sources selected are represented in the data table 1.3 below.

Table 1.3

Sources	**Authors**	**Year**	**Key Findings**
Source 1 *Computational Thinking in K—12: A Review of the State of the Field*	Shuchi Grover, Roy Pea	2013	Provides an overview of the academic research up until 2013 on computational thinking and provides insight into how the subject has developed over time.

Source 2 *Integrating Computational Thinking into Social Studies*	Ismail Güven & Yasemin Gulbahar	2020	Provides further discussion on how CT can be integrated specifically to social studies in an understandable and concise manner.
Source 3 *The Impact of Problem-based Learning Models on Social Studies Learning Outcomes and Critical Thinking Skills for Fifth Grade Elementary School Students*	I Made Aditya Dharma1, Nyoman Ayu Putri Lestari2*	2022	Demonstrates how problem-based learning allows for further critical thinking, similar to what is needed for computational thinking
Source 4 *How to Develop Computational Thinking: A Systematic Review of Empirical Studies*	Elif Taslibeyaz , Engin Kursun , Selcuk Karaman,	2020	This provides a review of how students, specifically elementary age, think about computational thinking strategies.
Source 5 *Using Computational Thinking to Explore the Past, Present, and Future*	Thomas C. Hammond, Julia Oltman, and Shannon Salter	2019	Provides examples of lessons involving CT and provides a table of adapted social studies questions integrating CT.
Source 6 *A K-6 Computational Thinking Curriculum Framework: Implications for Teacher Knowledge*	Charoula Angeli, Joke Voogt , Andrew Fluck, Mary Webb, Margaret Cox , Joyce Malyn-Smith and Jason Zagami	2016	The summarization of the computational thinking curriculum framework is helpful for describing how it can be implemented into existing curriculum from the perspective of teacher knowledge.
Source 7	Hennessey, Eden J. V.; Mueller, Julie;	2017	Provides a comprehensive

Hiding in Plain Sight: Identifying Computational Thinking in the Ontario Elementary School Curriculum	Beckett, Danielle; Fisher, Peter A.		content analysis of existing curriculum and identifies the frequency of 44 CT-related terms.

4. Data Extraction:

Data from the selected studies were extracted. The following information was collected from each source and will be utilized in the discussion/analysis portion:

- Authors and publication year
- Participants (grade levels, subject areas, etc.)
- Key findings related to computational thinking and social studies
- Limitations and implications

6. Data Synthesis:

The data were synthesized through thematic analysis, identifying common themes and patterns across the selected studies. The findings were presented in a discussion/analysis format below, highlighting the various aspects of CT in elementary classrooms and how it can be properly integrated.

The methodology employed in this literature review aims to provide a comprehensive analysis of the existing research on CT in K-5 social studies education, offering valuable insights for educators in the classroom and researchers in the field.

DISCUSSION/ANALYSIS.

Why haven't we already implemented CT in schools?

Computational thinking can not be simplified to computer programming or having people think like a computer, the entire field makes students use multiple levels of thinking abstractly

(Wing, 2006). How this complicated field, and the principles behind them, find their way into elementary school curriculum is a topic which has been discussed since the Wing's influential article in 2006. However, implementation has not been ubiquitous or quick due to many factors, but most prominently because of "evolving technology [which] provides constant innovation . . . which can be to the detriment of schools that may struggle to keep up" (Grover & Pea, 2013). In addition, the majority of the research conducted around CT curriculum is concerning undergraduate classrooms, not elementary or even middle school students. Furthermore, much of the curriculum available for primary students focuses "the development of CT skills. . . with programming content tools, such as Scratch and robotics for K-12 students" (Taslibeyaz, 2020). These examples of CT curriculum narrow the robust definition of CT to just those two topics, and do not provide adequate learning opportunities to students without the resources necessary to acquire these applications. Consequently, the ability to integrate CT strategies into an elementary level classroom and into an existing core subject seems to have many obstacles to prevent it coming to fruition. In addition to these practical concerns surrounding CT integration, students' cognitive ability may also not be up to par with some of the abstract concepts contained within the prominently used programming/coding applications. From a Piagetian perspective, children before the age of seven cannot fully understand concrete logic, whereas children between seven and eleven years old can solve problems that apply to concrete objects, but not problems that apply to abstract concepts or phenomena. Conversely, it is argued high school is too late for exposing students to computer science for the first time, and early exposure during kindergarten is necessary (Given, Gulbahar 2020).

CT is already present in the social studies curriculum.

While having opportunities for utilizing coding and programming should be available to students, proper prior background knowledge should be established to ensure proper understanding. This introduction to CT strategies cannot just jump straight into using a student-friendly programing/coding software and doing a content-related project, because students will not have the sufficient schema, or prior background knowledge, to adequately comprehend how to use CT strategies within the application. Research has found young children can think abstractly when concrete reference systems are used to situate their thinking" (Given, Gulbahar 2020). These concrete references may be already present, as a study of the Ontario School District curriculum demonstrated. Some of the interesting connections made from CT to established core subjects illuminated in the study present opportunities for teachers to provide students with CT background knowledge before introducing them to CT applications. After a content analysis of the existing curriculum, the study showed the "majority of the CT p*erspectives* and *practices* connections were found in technology, science or math, [but] there are still many that can be applicable to social studies". In addition, the study found CT *concepts* were most common in mathematics and social studies (Hennessey et.al, 2017). Introductions to CT concepts in congruence with the preexisting concepts in social studies could prove to be a way to begin building students' CT schema through concrete, real-life connections.

The opportunities for social studies skills to connect CT strategies can possibly prove to be effective in teaching students CT strategies, as it is "argued the sources of the computational thinking curriculum ought to be problems, issues, and concerns directly related to life itself. A curriculum of this kind will result in usable knowledge . . . and not inert knowledge". This provides an interesting avenue for computational thinking to connect directly to many of the skills for social studies, a subject which is intuitively connected to CT. In addition, researchers have found a curriculum focused on problem solving around real-world problems can result in greater "intellectual curiosity, motivation, improved attitude toward schooling, and higher achievement in college"(Angeli et al., 2016). Real-world connections and applications allow students to see the relevancy to their own lives, hopefully ensuring an increased student engagement in the subject. The opportunities for real-world applications for CT within social studies are ceaseless. From an implementation point of view, a curriculum designed around real-life problems demands a wider range of content, simply because authentic real-world problems are usually multidisciplinary in nature (Güven, Gulbahar, 2020). The assorted disciplines that are part of social studies, such as citizenship, geography, history, philosophy, art, ect. and provide that large variety of real-world problems for CT connections to be developed from.

So, how do we actually implement CT in social studies?

Actually implementing CT strategies within social studies can still prove to be difficult even when the connections to social studies are present. Teachers, because they have not been properly trained, struggle in "embedding real-life applications and examples and creating analogies [that] can be used . . . to sustain the understanding of CT's fundamentals in the social studies curricula" (Güven & Gulbahar, 2020). When CT terms are already present in a school's curriculum, it is easier for educators to adapt existing instruction to emphasize a deeper understanding of CT without having to allocate significant time or knowledge to CT as an individual subject. A framework to do just this has been created by North Carolina State University and The Citadel called PRADA. PRADA is an acronym that stands for Pattern Recognition, Abstraction, Decomposition, and Algorithms. PRADA has several advantages in implementing CT into social studies, primarily because it is" a mindset not bound by content area or tools, that helps people solve problems in a systematic and generalizable way". PRADA is a framework that has generalized CT concepts to be memorable and distinguished, allowing each to be taught in separate class activities. Because they can be taught separately, rather than all at once while coding/programming, teachers can explicitly introduce and reinforce these ideas in their existing social studies curriculum allowing for a more seamless integration into the practices and materials that are already in use. (Dong et. al, 2019). While not a part of the PRADA framework, an example of how CT concepts can be adapted into social studies questions is presented below in Table 1.4.

Table 1.4

Selected Elements of Computational Thinking	**Adapted and Explained for Social Studies**
• Symbol systems & representations • Abstractions & pattern generalizations • Algorithmic notions of flow control • Structured problem decomposition • Debugging & systematic error detection	Data definition: What is being included? What is being excluded? Pattern recognition & generalization: What do I see? Does it apply elsewhere? Abstraction: Can I remove details to make it easier to see patterns or connections? Rule-making: Does a pattern always apply? Can it predict what will happen in a new situation? Automation: Can technology help me identify or confirm a pattern? Decomposition: Can I break this question or dataset into smaller parts? Outlier analysis: Which parts of the data do not follow the pattern? What can they tell us?

Hammond, T. C., Oltman, J., & Salter, S. (2019). Using Computational Thinking to Explore the Past, Present, and Future. Social Education, 83(2), 118–122.

While teachers could easily apply questions similar to these in their everyday instruction, the problem-based learning model has shown in research to "stimulate students' ability to think critically and was able to improve student learning outcomes and critical thinking skills. The model can be categorized as student-centered and emphasizes collaboration in solving problems given by the teacher or encountered by students in everyday life under the guidance of a teacher" (Dharma & Lestari, 2022). Problem-based learning provides students with the opportunities to use CT strategies while interacting with instructional content. Beyond this, ITSE operational definition of computational thinking for K-12 educators has a list of dispositions and attitudes that can enhance CT skills. Problem based learning allows students to develop the following dispositions:

- Confidence in dealing with complexity,
- Persistence in working with difficult problems,
- Tolerance for ambiguity,
- The ability to deal with open ended problems,
- The ability to communicate and work with others to achieve a common goal or solution. (ITSE,2022)

Not only are these dispositions helpful for students when using CT strategies, the attitudes are indicators of responsible global citizens.

CT strategies could empower students to confront future issues head on. CT provides students with the tools to thrive in the ever changing world landscape. CT can endow teachers with an approach to social studies which is up to date, something that becomes increasingly critical as we dive deeper into the informational age. Summarized nicely by the article *Computational Thinking in the Past, Present and Future ;* "As students become familiar with the techniques identified and demonstrated above, they will be able to think across time and space, using social studies to explore not only the past and present but the future as well" (Hammond et.al, 2019).

IMPLICATIONS AND APPLICATIONS.

The integration of CT into elementary education, at various levels and subjects, can prove to be an efficient way to have students use more critical thinking in the classroom. Detailed below is an example unit of curriculum which integrates major CT components outlined in Table 1.3, using the PRADA framework for integration in problem-based learning projects. The example curriculum is for the fifth grade and covers history of the "modern era" (1970's- current events)is in Table 1.5. However, the project examples could be applied to various other topics within the social studies TEKS, these are only grouped together for continuity.

(5) History. The student understands important issues, events, and individuals in the United States during the 20th and 21st centuries. The student is expected to:

(B) analyze various issues and events of the 21st century such as the War on Terror and the 2008 presidential election; and

(C) identify the accomplishments and contributions of individuals and groups such as Susan B. Anthony, Martin Luther King Jr., Rosa Parks, Cesar Chavez, Franklin D. Roosevelt, Ronald Reagan, the Tuskegee Airmen, and the 442nd Regimental Combat Team in the areas of civil rights, women's rights, military actions, and politics.

(23) Social studies skills. The student applies critical-thinking skills to organize and use information acquired from a variety of valid sources, including technology.

(A) differentiate between, locate, and use valid primary and secondary sources such as technology; interviews; biographies; oral, print, and visual material; documents; and artifacts to acquire information about the United States;

(B) analyze information by applying absolute and relative chronology through sequencing, categorizing, identifying cause-and-effect relationships, comparing, contrasting, finding the main idea, summarizing, making generalizations and predictions, and drawing inferences and conclusions;

(C) organize and interpret information in outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps;

(D) identify different points of view about an issue, topic, historical event, or current event; and

(E) identify the historical context of an event.

(25) Social studies skills. The student communicates in written, oral, and visual forms.

(A)use social studies terminology correctly; +

(B) incorporate main and supporting ideas in verbal and written communication;

(C) express ideas orally based on research and experiences; and

(D) create written and visual material such as journal entries, reports, graphic organizers, outlines, and bibliographies.

(26) Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others. The student is expected to use problem-solving and decision making processes to identify a problem, gather information, list and consider options, consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.

Table 1.5

Pattern Recognition - **Sculpting Data** -Introduce data representation and analysis using data and trends from the 1990s. Students have to create a 3D model out of self-selected material, Google Sheets, or another program. Students then discuss how this data can demonstrate a part of 1980s history and put on a timeline.
Abstraction- **Presidential Speech**- Students will learn about the major events and themes of the 1980s by researching and preparing a presidential speech as if they were in that era. Students must research and write a speech, in which they must reduce the complexity of a selected 1980s issue to define the main idea and then discuss hypothetical solutions.
Decomposition- **Fishbowl discussion**-Students will engage in a structured fishbowl discussion to explore current events through breaking down various sources to find the important information. Students then must analyze, logically organize, and express their opinions on news articles and topics relevant to their world.
Algorithms/ Procedures- **Game Board**- Students will learn about the major events and cultural trends of the 2000s by researching and creating a board game that represents this decade. To create a functioning, interesting board game that coordinates to a specific topic of the 2000s students must have a board game with a series of ordered steps taken to achieve some end. This can be done on paper or on a website called Scratch.

This website links to the full lessons of the projects listed above. CT in 5th Grade Social Studies

CONCLUSION.

In this comprehensive literature review the multifaceted landscape of computational thinking in education was discussed. Through a systematic analysis of diverse sources spanning various educational contexts, we uncovered a detailed picture of the effects, examples, and application of CT in the social studies classroom.

Our examination of the literature revealed a clear trend: CT, when thoughtfully integrated, has the potential to significantly enhance student engagement and learning outcomes. CT has been shown to foster active participation and provide real world applications problems. However, it is equally crucial to acknowledge the challenges illuminated by this review. The lack of uniformity in CT's definition, lack of teacher education, and lack of support from other educational agencies continues to strain teacher's ability to fully integrate CT strategies. Furthermore, while CT can amplify learning in social studies, it is not a panacea; pedagogical approaches and teacher guidance remain essential in harnessing its full potential.

Looking ahead, the insights gathered from this literature review suggest avenues for future research and practice. The need for equitable access to CT strategies, professional development for educators, and the development of evidence-based strategies for integrating CT into the curriculum are. Moreover, exploring the long-term impact of CT on skills beyond subject-specific knowledge, such as critical thinking and digital literacy, warrants further investigation.

In conclusion, this literature review underscores the transformative role CT can play in elementary education. It highlights the need for a balanced approach that aligns critical thinking with effective pedagogy and equitable access. As we navigate the evolving landscape of education, this review provides valuable insights for educators, policymakers, and researchers, offering a foundation upon which to build meaningful and impactful strategies for CT integration in the social studies classroom.

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