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Using Self-Assessment and Remediation to Raise Middle School Student Achievement in Reading Comprehension

Prathima Prakash and John Leddo

MyEdMaster, LLC, Virginia, USA

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ABSTRACT

Cognitive Structure Analysis (CSA) is an educational framework designed to help students identify and address knowledge deficits through self-assessment, enabling them to remediate gaps in understanding. Previous studies have demonstrated the reliability of teaching students to use CSA to assess their own knowledge in various academic disciplines, including calculus (Cynkin and Leddo, 2023) and chemistry (Dandemraju, Dandemraju, and Leddo, 2024). These studies, however, primarily focused on the identification of knowledge gaps rather than their remediation. As accurate assessment does not inherently address deficiencies, later studies began to investigate CSA's role in addressing the gap. Ravi and Leddo (2024) conducted a study in which students learned an advanced chemistry topic by watching a video. Half of the students rewatched to reinforce their understanding, while the other half were trained to use CSA to self-assess their knowledge and then rewatched the video specifically to remediate assessed knowledge gaps. The CSA-trained group outperformed the control group by 15 points (1.5 letter grades) on a post-test. Similarly, Nehra and Leddo (2024) replicated this approach in Spanish instruction, finding that CSA-trained students scored an average of 25 percentage points (2.5 letter grades) higher than those who simply reread the material without self assessing. Prakash and Leddo (2025a) built on the findings of Ravi and Leddo (2024) and Nehra and Leddo (2024) by investigating CSA's plus remediation's applicability to reading comprehension; post-test results displayed that the CSA-trained group scored an average of 93%, outperforming the control group's 69%. Prakash and Leddo (2025b) built on prior research by investigating the applicability of CSA in learning Bayes' Theorem, a foundational concept in probability theory and statistics. Post-test results revealed that the experimental group significantly outperformed the control group, scoring an average of 85.5% compared to the control group's 58.5%. These findings underscore CSA's potential to improve understanding of abstract mathematical concepts while fostering self-directed learning. The investigation of CSA was continued through analyzing its impact in history, where post-test results revealed the significant statistical

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difference between the control and experimental groups, the control scoring an average of 65.8% compared to the experimental group's 87.5% (Prakash and Leddo, 2025c). Leddo, Clark and Clark (2025) extended the previous work on high school students and found that self-assessment using CSA plus remediation improved math scores by 18 percentage points compared to remediation without self-assessment. This study continues this investigation of CSA plus remediation applicability in the context of middle school students' ability to comprehend a reading passage, particularly that of To Kill a Mockingbird, a literary classic discussing ethical implications and societal constructs in the realm of prejudice. Twenty middle school students were randomly assigned to either the control or experimental group. Post-test results revealed the control scoring an average of 61.7% as opposed to the experimental's 78.3% (t=3.31, df = 18, p = .004).

INTRODUCTION

Throughout history, assessment has served as a measure of students' learning. Traditionally, "learning" has been defined by the number of correct answers on tests, as per classical test theory, which assumes that a student's total correct responses reflect their knowledge level (de Ayala, 2009).

Assessment methods typically fall into two categories: selecting correct answers from choices or constructing answers independently. Multiple-choice tests, widely used for their efficiency in grading, allow for guessing, which can inflate scores (Chaoui, 2011; Elbrink and Waits, 1970; O'Neil and Brown, 1997). Constructive response tests require students to provide their own answers, encouraging logical reasoning and offering a more accurate measure of knowledge (Herman et al., 1944; Frary, 1985). However, both methods rely on the assumption that correct answers signify learning. This assumption is problematic, as incorrect answers may point to underlying knowledge gaps, while correct answers might result from memorization or guessing, not true understanding.

Cognitive Structure Analysis (CSA) is an assessment method designed to uncover the underlying knowledge concepts a student possesses, identifying the source of errors for targeted remediation (Leddo et al., 2022; Ahmad and Leddo, 2023; Zhou and Leddo, 2023; Dandemraju, Dandemraju, and Leddo, 2024). CSA is rooted in cognitive psychology research, which identifies various knowledge types, such as semantic nets (Quillian, 1966), production rules (Newell and Simon, 1972), scripts (Schank and Abelson, 1977) and mental models (de Kleer and Brown, 1981). Together, these form the INKS framework (Integrated Knowledge Structure), developed by John Leddo (Leddo et al., 1990). This framework suggests that expert knowledge is organized around scripts and principles that enable predictions and explanations.

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CSA, which integrates INKS principles, has shown strong correlations with problem-solving performance: 0.966 in Algebra 1 (Leddo et al., 2022), 0.63 in scientific method problem-solving (Ahmad and Leddo, 2023), and 0.80 in precalculus (Zhou and Leddo, 2023). By assessing students' conceptual understanding, CSA enables educators to address knowledge gaps effectively, leading to significant improvements in student performance (Leddo and Ahmad, 2024).

Although CSA has proven effective, the responsibility for diagnosing and remediating students' knowledge gaps lies primarily with teachers, who often manage large numbers of students. Teaching students to self-assess their knowledge could alleviate this burden. Unlike self-explanation, which involves generating explanations for learned material, self-assessment involves evaluating one's knowledge after learning.

Cynkin and Leddo (2023) demonstrated that high school calculus students could accurately self-assess their knowledge using CSA, while Dandemraju, Dandemraju, and Leddo (2024) extended this finding to chemistry. These studies, however, addressed only the identification of knowledge gaps, not their remediation. Accurate assessment does not equate to addressing deficiencies, just as diagnosing a medical issue does not equate to treating it.

To address this issue, Ravi and Leddo (2024) conducted a study in which students learned an advanced topic in chemistry by watching a video. Half the students were told to rewatch the video to fill in any knowledge gaps, while the other half were taught to self-assess their knowledge using CSA and then told to rewatch the video to fill in any assessed knowledge gaps. The group that was taught to self-assess scored 15 points or 1.5 letter grades higher on a post-test than students who simply rewatched the video without self-assessment. Nehra and Leddo (2024) replicated the Ravi and Leddo study to the learning of Spanish. They found that students performing self-assessment plus remediation scored, on average, 25 percentage points or 2.5 letter grades higher than those re-reading the material without performing a self-assessment. Prakash and Leddo (2025a) extended the Ravi and Leddo (2024) and Nehra and Leddo (2024) findings to another subject area: reading comprehension. The results revealed a mean post-test score of 8.3 out of 12 (69.17%) for the control group and 11.2 out of 12 (93.33%) for the experimental group. This difference in averages was statistically significant ($t = 3.75$, $df = 11.07$, $p < .01$). Notably, individual scores further illustrated the disparity: the lowest score in the control group was 41.67%, whereas the lowest in the experimental group was 83.33%. This is the difference between an F letter grade and B letter grade. Following this, another study conducted by Prakash and Leddo (2025b) examined CSA's effectiveness in teaching math, specifically, the topic of Bayes' Theorem, and found a 27-point improvement. Statistical analysis yielded a t-value of 4.38 ($df = 18$, $p = 0.0004$), confirming the significance of the difference. Individual scores also highlighted the disparity. The control group's lowest score was 6/20

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(30%), whereas the experimental group's lowest score was 15/20 (75%). Following this, a history assessment revealed that students who utilized CSA for self-assessment and remediation significantly outperformed their peers in the control group (Prakash and Leddo, 2025). Post-test results demonstrated that the experimental group achieved an average score of 87.5%, whereas the control group scored 65.8%, indicating a substantial difference in comprehension and retention of historical concepts. These results on high school students were further extended by Leddo, Clark and Clark (2025) in their investigation of middle school math. Leddo, Clark and Clark found that middle school students who self-assessed using CSA and then remediated their knowledge gaps scored 18 percentage points higher on a post test than those who relearned material without first performing a self-assessment.

Building upon these results, this study aims to examine CSA's impact on middle school students' reading comprehension, specifically through an analysis of *To Kill a Mockingbird*, a novel that explores complex themes of ethics and social structure. Reading comprehension is a fundamental skill that extends beyond literature into critical thinking, problem-solving, and the ability to engage with complex ideas across various disciplines. Given the importance of textual analysis in both academic and real-world contexts, it is crucial to explore whether self-assessment and remediation strategies can enhance students' ability to process and interpret literary texts more effectively.

Students in the experimental group were trained to evaluate their own knowledge gaps and use targeted remediation strategies, while those in the control group engaged with the text without structured self-assessment. By comparing the two groups' performance, this research seeks to determine if CSA can bridge comprehension gaps that often hinder students' ability to grasp deeper literary meanings. Beyond its immediate implications for reading comprehension, this study also aims to explore the broader applicability of CSA in improving students' confidence and autonomy in learning. If self-assessment and remediation prove effective in helping students navigate the nuanced themes of *To Kill a Mockingbird*, it may suggest that similar strategies could be applied to other complex texts and subjects. This could have significant implications for educational practices, particularly in middle school settings where students are transitioning to more advanced reading and analytical skills. By validating CSA's role in improving reading comprehension, this study contributes to ongoing research on effective learning strategies and the potential for self-directed education to enhance student outcomes.

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METHOD

Participants

20 male and female Loudoun County Public Schools students were selected to participate in this study. All students were middle school students, and they were not paid for their participation.

Materials

A Google Form for the control group with the *To Kill a Mockingbird* excerpt and 12 comprehension questions is provided below.

https://forms.gle/3k47jFQneWs2mik29

A self-assessment was created in order to help students in the experimental group re-evaluate their understanding of the content provided in the guide. It showed an example of a student self-assessing knowledge of a reading comprehension concept that included facts, strategies, procedures, and rationales. It was modeled after the self-assessment template previously reported in Prakash and Leddo (2025a).

Self-Assessment: Reading

I want to teach you to assess your own knowledge that you have about something you read. Let's do this by taking an example that you already know. Suppose you wanted to assess your own knowledge about the story Little Red Riding Hood. If I want to be able to understand stories, I need four types of knowledge. These are facts, strategies, procedures and rationales. Facts are concepts you have that describe objects or elements. For example, in reading, facts can be characters or elements of the setting such as location or time period. Strategies are the general plot sequences of events that authors use to make the points or express the themes or conflicts they write about. Procedures are the specific events in the story that are part of the overall strategy or plot. Finally, I need to know rationales which are the reasons behind the plot elements or events. Rationales could include things like the author's purpose, the character's goals (why the characters act the way they do) and how elements of the story reinforce the points the author is trying to make. You can think of facts as telling you "what", strategies and procedures as telling you "how" and rationales as telling you "why".

With this in mind, this is how I might assess my own knowledge of the story Little Red Riding Hood. For facts, I need to know the characters, setting and time period. The main characters are Little Red Riding Hood (protagonist), the wolf (antagonist), the mother, the grandmother and the woodsman. The story is set long ago in a forest and near the forest for Little Red Riding Hood's home and the Grandmother's home.

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For the general plot, a little girl is asked by her mother to give a basket of goodies to her sick grandmother. Even though she's told not to talk to strangers, she does and is almost killed because of it.

For specific events, a mother tells Little Red Riding Hood that her grandmother is sick and to bring the grandmother a basket of goodies. The mother warns Little Red Riding Hood not to talk to strangers. While walking through the woods to get to the grandmother's house, Little Red Riding Hood meets a wolf who asks where she's going. Little Red Riding Hood tells the wolf, who then takes a shortcut to the grandmother's house and impersonates the grandmother. When Little Red Riding Hood arrives, she notices something odd about the grandmother and after a series of questions, the wolf reveals himself and says he'll eat Little Red Riding Hood. Fortunately, a nearby woodsman hears Little Red Riding Hood's screams for help and saves Little Red Riding Hood.

For rationales, I believe the author wrote the story to warn children about the dangers of talking to strangers. The protagonist is a little girl because the story is aimed at children. The wolf has to attack Little Red Riding Hood because the story needs to show the danger of talking to strangers. Little Red Riding Hood has to be saved in the end because it may be too scary for children to read stories about a little girl who gets eaten by a wolf.

When I look over what I wrote, I see that I am good with my facts. I know who the characters are, and I know that the story is set long ago and in and near a forest. In my story plot and events, I forget whether the wolf ate the grandmother or just locked her in a closet because Little Red Riding Hood was coming. Also, I'm not sure what happened to the wolf at the end. For rationales, I'm not sure why the setting had to be in a forest or why the antagonist was a wolf as opposed to a person or other animal. I don't think I left anything out.

A Google Form for the experimental group with the *To Kill a Mockingbird* excerpt, reading self-assessment, and 12 comprehension questions is provided below.

https://forms.gle/MNg1diG6hyUGKykG6

In addition to the reading assessment, an answer key was created in order to evaluate each participant's answer to each question. There was no partial credit, with 1 point for each correct response and 0 for each incorrect response.

Procedure

Participants were randomly assigned to one of two groups: control (MSRA1) and experimental (MSRA2). Both groups received a short passage from *To Kill a Mockingbird*, which emphasized

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the moral and ethical implications of prejudice and quick judgment. The control group was instructed to study the material, review the same material if there were any additional inquiries, and complete a post-test, with no structured guidance on how to address knowledge gaps. The experimental group was trained to use CSA for self-assessment. After studying the document, participants in the experimental group evaluated their understanding using CSA and revisited the material to address knowledge gaps before taking the same post-test as the control group. The post-test included 12 questions assessing conceptual understanding and rationales. Participants were not permitted to access the excerpt when answering the questions.

RESULTS

The participants' data were analyzed by examining the number of correct responses on the post-test. The results revealed a statistically significant difference in performance between the two groups. The control group (RA1) achieved a mean score of 7.4/12 (61.7%), while the experimental group (RA2) scored an average of 9.4/12 (78.3%). Statistical analysis yielded a t-value of 3.31 ($df = 18$, $p = .004$), confirming the significance of the difference. Individual scores further emphasized this disparity, with the lowest score in the control group being 5/12 (41.7%), whereas the lowest score in the experimental group was 8/12 (66.7%). The experimental group demonstrated both a higher mean and a higher floor in performance.

Additionally, participants in the experimental group reported a greater ability to identify and correct their own misconceptions after engaging in the self-assessment process. Many expressed increased confidence in their understanding of long-term implications of concepts presented in the excerpt, highlighting the method's effectiveness in reinforcing critical reasoning. In contrast, control group participants largely relied on prior knowledge and struggled to pinpoint specific knowledge gaps, suggesting that traditional study methods may be less effective in encouraging deeper reading comprehension.

DISCUSSION

This study aimed to evaluate the effectiveness of self-assessment techniques in aiding high school students to identify and address knowledge gaps in education. The findings indicated a significant improvement in the experimental group's performance, with a mean score that was 16.6% higher than that of the control group. These results were consistent with previous research, such as Prakash and Leddo's (2025a) study on high school reading comprehension, which reported gains of 24 percentage points through self-assessment methodologies, and Ravi and Leddo's (2024) chemistry research, which observed a 15-point improvement. This study extended the application of self-assessment to middle schoolers in the realm of reading comprehension, a field that benefits from critical thinking and contextual understanding.

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Building upon these findings, the present study examined the effectiveness of self-assessment in improving middle school students' reading comprehension. The 16.6 percentage point increase found in the present study suggests that CSA may enhance students' ability to analyze and interpret complex literary texts. Given that *To Kill a Mockingbird* explores intricate themes such as morality, justice, and social inequality, the ability to assess and remediate comprehension gaps could be particularly beneficial in fostering deeper literary engagement and critical thinking.

The implications of these findings are significant for educational practices. Reading comprehension is frequently taught through generalized strategies rather than personalized remediation. Self-assessment empowered students to take an active role in their learning journey, fostering autonomy and self-regulation. This approach aligned with the goals of formative assessment, which emphasized continuous feedback and adjustment to improve learning outcomes. By integrating self-assessment into literature curricula, educators could create more interactive and personalized learning environments.

Psychologically, the use of self-assessment techniques has been shown to enhance students' self-efficacy and confidence in their academic abilities. Participants in the experimental groups of reading comprehension studies reported a greater sense of control over their learning process and an increased ability to critically evaluate sources, arguments, and literary texts. This aligns with Nehra and Leddo's (2024) findings that self-assessment builds self-efficacy, a critical component of long-term academic and professional success. This empowerment is crucial in developing independent learners who can navigate complex information and construct well-informed perspectives. Such skills are essential not only for academic success but also for informed citizenship and lifelong literacy.

From a broader perspective, implementing self-assessment strategies in reading comprehension education can contribute to educational equity. Students from diverse backgrounds bring varied prior knowledge and experiences to the classroom. Self-assessment allows for differentiation, enabling each student to identify and address their unique learning needs. This personalized approach can help bridge achievement gaps and support all students in reaching their full potential.

Future research should explore CSA's long-term effects on students' critical thinking, literary analysis, and retention of knowledge. Investigating the integration of self-assessment with other instructional strategies, such as collaborative learning, digital literacy tools, and AI-based tutoring systems, could provide insights into creating comprehensive educational approaches. Additionally, examining the impact of self-assessment on diverse populations can inform inclusive teaching and learning practices that address the needs of all learners.

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In conclusion, this study reinforced the effectiveness of self-assessment in reading comprehension education, highlighting its potential to transform traditional teaching methods. By enabling students to actively engage with historical content and literary texts while reflecting on their understanding, self-assessment fosters deeper learning and critical thinking. Embracing this approach can lead to more equitable and effective educational experiences, preparing students to thoughtfully engage with the past, interpret complex narratives, and apply analytical skills to real-world contexts.

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