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Using Self-Assessment and Remediation to Raise Chinese Primary School Student Achievement in Reading

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ABSTRACT

Cognitive Structure Analysis (CSA) is an educational framework that helps students identify and address knowledge gaps through self-assessment and targeted remediation. Prior studies have shown its effectiveness in improving test scores across disciplines (math, reading, science, history and foreign language) and grade levels (elementary, middle, high school and college students), typically producing 1.5 to nearly 3 letter grade improvements in performance on average. Recent investigations (Sathiyamoorthy and Leddo, 2025; Chen and Leddo, 2025) have shown that self-assessment and remediation boosts performance in international students with both college students in Scotland and middle school students in China showing large increases in test score performance after learning to self-assess and remediate their own learning needs. The present study extended this international research to elementary school reading in China. 14 students participated in the study. Both groups read the story The Child Who Counts the Stars. Seven students were taught to self-assess their own learning needs and were told to self-assess their knowledge of the story. Both groups were told to reread the story. After the second reading, both groups were given a 10-item reading comprehension post-test. Students who were taught to self-assess scored, on average, 97.6% on the post-test, while those who were not scored on average 82.3%, a statistically significant difference. Results suggest that CSA-based self-assessment and remediation continues to be a powerful method for improving educational performance, even among international students.

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).

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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 a query-based 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.

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.

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To address this issue, Ravi and Leddo (2024) conducted a study in which high school 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 high school 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. 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. Individual scores also highlighted the disparity. The control group's lowest score was 6/20 (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, 2025c). 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 posttest than those who relearned material without first performing a self-assessment.

Following this, Prakash and Leddo (2025d) conducted a study 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. 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. Results showed that students in the self-assessment group scored 16 points higher on a posttest than those who re-read the material without self-assessment. Building upon these results, another

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study examined CSA's impact on middle school students' understanding of science concepts. Students in the experimental group were taught to self-assess their understanding of key science concepts using CSA and then engage in focused review based on their assessed gaps. In contrast, students in the control group reviewed the material without guidance or structured self-assessment. Students using self-assessment scored, on average 20 percentage points or two letter grades higher on a posttest than those who did not (Prakash and Leddo, 2025e). Then, Prakash and Leddo (2025f) extended the CSA methodology to middle school history, focusing specifically on students' understanding of the causes of the American Revolution. Again, those students using self-assessment scored higher on a posttest than those who did not, this time by 29 percentage points.

Following this, Prakash and Leddo (2025g) tested whether self-assessment and remediation would work with elementary school students. This research showed that elementary school students using self-assessment and remediation for math scored an average of 83% on a posttest while those who simply reread the material scored an average of 70%.

All of the above results were conducted with American students and students in K-12. Sathiyamoorthy and Leddo (2025) investigated whether self-CSA plus remediation would boost performance in college students in Scotland. Here, the testbed was college psychology. Students using self-assessment scored 15 percentages points higher than those who simply reread the material. To further examine whether the self-assessment and remediation paradigm generalized across both national contexts and different educational levels, Chen and Leddo (2025) conducted a study in China with middle school physics students using the same CSA-based framework. The treatment group significantly outperformed the control group, scoring 23.3 percentage points higher on the post-test. Building on this strong evidence from the Chinese secondary education system, the present study extended the investigation to a different subject domain, reading, as well as to a younger cohort of Chinese primary school students.

METHOD

Participants

The experiment involved 14 participants aged 8–9, all of whom were students in a Grade 2 reading class at a tutoring institution in China. The entire class took part in the study. Participants were randomly assigned to two groups: the treatment group (Group A, n = 7) and the control group (Group B, n = 7). All students participated voluntarily and received no compensation.

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Materials

The experiment focused on Chinese reading comprehension, using the narrative text The Child Who Counts the Stars, an official Grade 2 primary school passage. The materials used in the study can be categorized into four components: the reading passage, self-assessment materials, test materials, and scoring rubric.

First, both the treatment and control groups used the same reading passage, *The Child Who Counts the Stars*, which was selected from the national standard Grade 2 Chinese language curriculum. The passage describes how the young Zhang Heng observed the movement of stars, with a focus on curiosity, observation, and early scientific thinking. Using an official textbook text ensured age-appropriate vocabulary and alignment with students' existing reading proficiency.

Second, the self-assessment materials were distributed only to the treatment group and consisted of two parts: a self-assessment template and a self-assessment form. The example was based on the story *Little Red Riding Hood*, adapted to a Grade 2 reading level, and was designed to help students understand what self-assessment is and how to evaluate their own comprehension step by step. The self-assessment form was then used to guide students to reflect on their understanding of the reading passage before rereading. This template and form included facts, strategies, procedures, and rationales, see:

https://docs.google.com/document/d/1uy0_BbBxhZO-1cI9L14WhnhNh3TWxJGRXsbPZ3Cy_Do/edit?usp=sharing

The third material was the closed-book test, which was administered to both the treatment and control groups. It consisted of 10 objective questions across four sections, multiple-choice, true/false, matching, and sequencing, with a total score of 100 points. All test items were directly aligned with the content of the reading passage, with clear wording and moderate difficulty appropriate for Grade 2 students. See:

https://docs.google.com/document/d/14_dztTVW22n2E0IwJhjRc3ikX-Pn4r4LDCsiU8ECtX4/edit?usp=sharing

Finally, an answer key was developed as the scoring rubric, which ensured that all test papers were graded consistently according to a unified standard.

Procedure

The 14 participants from the Grade 2 reading class were randomly assigned to two groups of equal size: the treatment group (n = 7) and the control group (n = 7).The procedure for the

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treatment group began with students independently reading the passage*The Child Who Counts the Stars*. They were then asked to read the self-assessment template, which was designed to help them understand the concept of self-assessment and how to complete a self-assessment form. After reading the template, students completed the self-assessment form, through which they identified knowledge points that were unclear or not fully mastered, as well as areas where they needed further improvement. With these specific gaps in mind, students re-read the passage in order to clarify their questions and strengthen their understanding. Finally, they completed the closed-book test to assess their mastery of the material.

The control group followed a similar procedure, except that they did not engage in self-assessment. Instead, after their initial reading of *The Child Who Counts the Stars*, they simply re-read the same passage before taking the closed-book test. The total time allocated for the experiment was the same for both groups.

Upon completion of the test, the teacher collected the self-assessment forms and test papers from the treatment group, as well as the test papers from the control group. The papers were graded jointly by the teacher and the researcher using the standardized answer key.

RESULTS

The post-test data were analyzed by comparing the treatment and control groups' average scores. Results showed that the treatment group scored an average of 97.6 on the post-test, while the control group scored an average of 82.3. A two-tailed independent sample t-test confirmed that this difference was statistically significant, $t(12)=2.64$, $p=.022$. These findings suggest that students who engaged in CSA-based self-assessment performed substantially better in reading than those who simply reread the passage.

DISCUSSION

This study aimed to evaluate the effectiveness of self-assessment techniques in aiding Chinese Grade 2 students to identify and address comprehension gaps in reading. The results of this experiment demonstrate that the application of Cognitive Structure Analysis (CSA) combined with targeted remediation significantly enhances understanding and overall achievement among elementary school students. The treatment group, which employed self-assessment techniques to identify specific comprehension gaps and address them directly, outperformed the control group by an average of 15 percentage points. These results align with prior research. The present study further extends this line of research by confirming CSA's effectiveness in early elementary reading contexts within the Chinese educational setting.

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This significant improvement can be understood through the process of reading comprehension, which relies on both meaning construction and metacognitive monitoring. By teaching students to use CSA for self-assessment, educators can help learners identify specific gaps in their understanding where meaning construction breaks down, such as in unclear narrative links or overlooked details. This process promotes active metacognitive monitoring, guiding students to evaluate and repair their comprehension as they read. Through this structured approach, CSA enables young readers to build more coherent mental representations of the text and engage more deeply with its meaning, ultimately enhancing their inferential and interpretive reasoning.

The implications for reading instruction are substantial. In early elementary classrooms, comprehension is often taught through repetition and teacher-led questioning, which may limit students' awareness of their own understanding. By teaching students to use CSA for self-assessment, educators can help young learners take a more active role in monitoring and improving their reading comprehension. This reflective process allows teachers to identify common patterns of misunderstanding while guiding students to recognize how they construct meaning from text. As students learn to evaluate and adjust their own comprehension, they develop early habits of self-regulated learning that support long-term reading development and greater confidence as independent readers.

Beyond classroom practice, the effects observed here have a clear psychological pathway for young readers. CSA based self-assessment gives students concrete checkpoints and immediate feedback, which turns a vague sense of not understanding into a specific, solvable problem. When students locate a gap and repair it, they experience success at the task in front of them, strengthening task specific self-efficacy and a sense of control over reading. The routine encourages them to link progress to strategy and effort rather than fixed ability, which supports motivation and persistence when the text becomes more demanding. As uncertainty decreases, anxiety lessens and attention can remain focused on meaning construction, supporting more confident and engaged reading.

From an equity perspective, structured self-assessment allows all learners regardless of prior background knowledge to tailor their review process to their individual needs. This personalized remediation supports differentiated instruction and can help close achievement gaps, particularly in content-rich subjects like mathematics.

In conclusion, this study reinforces the value of CSA-driven self-assessment in instruction of Chinese elementary students. By enabling students to actively engage with reading content while reflecting on their understanding, CSA-based self-assessment fosters deeper learning and critical thinking. Introducing such practices early in schooling helps children take responsibility for their own learning construction and develop confidence in managing comprehension challenges.

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Embracing this approach can lead to more effective educational experiences, preparing students to thoughtfully engage with complex ideas and apply analytical skills to broader learning contexts.

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