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Improving SAT Test Performance by Having Students Engage in Self-assessment and Remediation

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ABSTRACT

Millions of students take the SAT and other high-stakes tests that influence what colleges or other programs they get into or graduate from. Test preparation has become a multibillion dollar global business, but evidence suggests that SAT programs lead to minimal improvement on average. The present study explores whether teaching students to self-assess and remediate their SAT subject knowledge using Cognitive Structure Analysis while they prepare for the SAT test can lead to higher SAT test scores. 25 students enrolled in a commercial SAT preparation program participated in the study. 12 students engaged in self-assessment and remediation for SAT Math but not SAT Reading, while 13 students engaged in self-assessment and remediation for SAT Reading but not SAT Math, leading to an experimental design with between-subjects and within-subjects comparisons. Students began by taking a full SAT test, engaged in an instructional session and then took a second full SAT test. These events occurred in three separate sessions over the course of a week. Those students who did not use self-assessment for SAT Math showed no improvement in the math scores between the two tests, and those who did not use self-assessment for SAT Reading showed no improvement in the reading scores between the two tests. Students using self-assessment and remediation for SAT Math improved their math scores, on average, by 45.83 points, which was statistically higher than their change in their SAT Reading scores and statistically higher than the change in SAT Math scores for those students who did not uses self-assessment and remediation for SAT Math. Students using self-assessment and remediation for SAT Reading improved their reading scores, on average, by 33.33 points, which was statistically higher than their change in their SAT Math scores and statistically higher than the change in SAT Reading scores for those students who did not uses self-assessment and remediation for SAT Reading.

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INTRODUCTION

Standardized testing is pervasive in education. Such testing is used to determine whether students have successfully mastered course material, graduate, or gain admission into schools. In the United States, for example, the SAT and ACT tests are weighed heavily as admission criteria for most colleges. As a result, test preparation has become a substantial industry, one that offers to help students increase their test scores.

Given the expense associated with test preparation classes, a major question arises as to how effective such test preparation services are. Indeed, there is some empirical evidence that most test preparation services produce very little effect. For example, Becker (1990) reports that test preparation typically raises SAT scores by only nine to 20 points, a negligible amount. Such nominal improvement may be attributable to the fact that many test preparation services focus largely on test taking skills such as time management and evaluating answer choices and less on core skills such as reading comprehension and mathematical concepts. This low increase in test scores is plausible since most test preparation courses are of limited duration, while reading, writing and mathematical skills are typically developed over a period of years.

In recent years, we have been exploring different methods of improving SAT performance. These methods fall into different categories, each of which has shown to improve SAT scores. One series of studies focused on using metacognitive strategies in order to help students understand the types of problems that were on the test, the types of answers that were correct vs. not correct, and the types of knowledge a student would need to answer the questions. This was done for reading (Leddo et al., 2019), math (Leddo et al., 2021) and SAT Writing (Leddo, et al., 2020). Using metacognitive strategies had an effect size of about 50 points improvement per subject used.

A second category of strategy involved helping test takers to decide between multiple plausible answers. Since the SAT test tells students to select “the best answer”, it is easy to imagine that such instructions may induce a Confirmation Bias that results in students selecting answers that appear right but are flawed in some way. By instructing students to consider what is wrong with answer choices as well as what is right about them, students were able to score about 50 points higher on SAT (Leddo et al., 2018).

A final intervention invoked the reward system used in videogames. Here, students were given points for correct answers, much the way they earn points for positive actions when playing videogames. Results showed that students receiving points for correct answers answered nearly 47% more SAT math questions correctly than those who did not (Leddo et al., 2024).

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These methods arguably focus on test taking skills: reasoning about the types of questions on the test, choosing between multiple plausible answers or getting rewards for correct answers rather than improving actual subject matter knowledge needed to answer the questions themselves.

In parallel, we have been working on improving subject matter knowledge by teaching students to self-assess and remediate what concepts they know and do not know about a subject. This work is based on a knowledge assessment method called Cognitive Structure Analysis.

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; Challagulla and Leddo, 2025).

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 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

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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 self-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 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,

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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%. They also showed that using self-assessment and remediation raised elementary students' reading scores by an average of 20.5 percentage points (Prakash and Leddo, 2025h).

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.

The studies done in the US and other countries all involved a similar format in which the experimenters administered the instructional sessions and/or prepared the instructional materials and post-test to be used. This is appropriate to establish experimental control when exploring a new topic and engaging in systematic replication. However, for the self-assessment and remediation technique to be useful in the classroom, it must also work when incorporated into a classroom's normal mode of operation without the participation of the experimenters. This was addressed by testing whether self-assessment and remediation would raise physics scores of 8^{th} grade students in China (Chen and Leddo, 2025a). In that study, those students using self-assessment and remediation scored 23 percentage points higher than students who did not. Chen and Leddo (2025b) followed up that study with 2^{nd} grade reading students in China and found that those using self-assessment and remediation scored 15 percentage points higher on a post-test than those who did not. Challagulla, Challagulla and Leddo (2025) found that elementary school students in India who used the self-assessment method scored 22 percentage points higher on a reading post-test than those who did not.

These investigations in classrooms included having the teachers explain self-assessment to the students. While this is a reasonable activity for teachers to perform, we wanted to explore whether reducing teacher workload to the simple requirements of handing the students the self-

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assessment templates and checking to make sure the students filled them in (without actually analyzing the content) would still produce educational gains. Such an investigation was conducted by Gajula and Leddo (2026). In that study, an elementary school math teacher taught a unit on arithmetic operations. Prior to introducing self-assessment, the teacher gave an interim test. After that, half the students were given the self-assessment templates and told to fill them out, including what they learned after remediating their self-identified knowledge gaps, and half were not given self-assessment templates. Instruction continued for three more weeks, with self-assessment students filling out their templates once a week and the teacher checking to make sure they did. At the end of the three-week period, the teacher gave a final exam. Results showed that students in the self-assessment condition scored, on average, 18.5 percentage points higher on the final exam than did the students in the control condition. Moreover, control condition students showed no improvement, on average, over the three-week period. On the other hand, students in the self-assessment condition improved, on average, by 16.5 percentage points with all but one student raising their scores (the one student who did not show increased performance scored 90% on both the interim and final tests).

The Gajula and Leddo (2026) study was followed up by one involving high school reading (Bajwa, Leddo and Verdu, 2026). In that study, the teacher gave a reading assignment. Afterwards, half the students received the self-assessment for reading and filled it out. Both the self-assessment and no-self-assessment students had an opportunity to review the material before a test was given the next day. Those doing the self-assessment scored on average 96% on the test and improved, on average, by 29 percentage points over their previous averages in that class with each student showing score improvement. The lowest test score in the self-assessment group was 80%, which represented 40 percentage points improvement over the student's previous class average of 40%. That student did not have the largest improvement. Another student who also had a 40% average in the class scored 100% on the test given after the reading assignment. On the other hand, those who did not receive the self-assessment template, scored on average 82% on the test and showed no improvement, on average, compared to their previous averages in the class.

The next series of field trials involved a high school in Nigeria (Ifenatuora et al., 2026). The effectiveness of self-assessment was tested in five subjects: math, chemistry, business, government and grammar. In all cases, students using the self-assessment method showed improved test performance. Average test scores for students using the self-assessment method vs. those who did not were 82% vs 64% for chemistry, 97% vs. 78% for math, 87% vs. 79% for business, 85% vs. 52% for government and 91% vs. 81% for grammar. The lowest test score for any student using the self-assessment method was 70%, which occurred in the government class-the class that had the lowest average test score for students not using the self-assessment method.

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Moreover, in the government class, the highest test score achieved by a student not using the self-assessment method was 68%, which meant the lowest performing student who used the self-assessment method did better than the highest performing student who did not. Additionally, a Levene's test showed that for the subjects of math, chemistry and business, the variability in scores was lower in the self-assessment group than it was in the no self-assessment group. This suggests that, in some cases, the self-assessment method not only raises student achievement but reduces the difference in performance between high and low performing students, thus helping to close the achievement gap.

Bajwa, Rutz and Leddo (2026) extended this further by testing self-assessment and remediation in a high school AP Psychology class. Not only did students using CSA-based self-assessment score substantially higher on the teacher's unit test (81% vs. 42%), but Black/Hispanic students who used self-assessment and remediation scored statistically equally to White/Asian students who used them and two letter grades higher, on average, than White/Asian students who did not use self-assessment and remediation.

The goal of the present study is to test whether CSA-based self-assessment and remediation can improve SAT performance.

METHOD

Participants

Twenty five high school students enrolled at Ramana Learning Center, an SAT tutoring program in Charlotte, North Carolina, participated in the present study. Students attended Ramana's regular SAT summer intensive preparation sessions and were drawn from multiple local schools in the Charlotte Mecklenburg area. Students were divided into two instructional conditions based on subject area: the SAT Math self-assessment condition (12 students) and the SAT Reading self-assessment condition (13 students).

Materials

Instructional content for the study was drawn from Ramana Learning Center's standard SAT curriculum, which students regularly use during tutoring sessions. The curriculum includes both Math and English components aligned with College Board SAT expectations. The Math materials covered topics such as algebraic manipulation, linear equations, functions, quantitative reasoning, and SAT style problem solving. The English materials covered grammar conventions, sentence structure, rhetorical skills, reading comprehension strategies, and SAT evidence-based reasoning.

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Students completed two full SAT practice tests, Test 1 and Test 2, each containing both Math and English sections. These tests were Ramana's standard diagnostic assessments and used the same scoring scale as official SAT practice tests. Test 1 served as the baseline measure of student performance, and Test 2 served as the post intervention measure.

Two templates were used in the study. The Math Self-Assessment Template taught students how to evaluate their understanding of mathematical concepts by identifying their knowledge of facts, strategies, procedures, and rationales. The template included a worked example using two step equations and guided students to list what they understood, what they were unsure about, and what they learned after rereading the material. The English and Grammar Self-Assessment Template followed the same structure but used grammar and reading examples. It taught students how to assess their knowledge of grammar rules, sentence structure, rhetorical strategies, and the reasoning behind correct usage. Like the math template, it required students to identify what they knew, what they did not know, and what they learned after reviewing the lesson material. The math template is reproduced below:

"I want to teach you how to assess your own knowledge that you have about a subject area. Let's do this by taking an example that you already know. Suppose you wanted to assess your own knowledge about solving 2-step equations of the form $ax + b = c$. An example of this type of problem is $2x + 3 = 15$. If I want to be able to solve problems like these, I need four types of knowledge. These are facts, strategies, procedures and rationales. Fact are concepts you have that describe objects or elements. For example, for two step equations, I need to know what variables, constants, coefficients, equations, and expressions are. Strategies are general processes I would use to solve a problem. For two-step equations, this would be reverse order of operations. Procedures are the specific steps that I would use in a strategy. So, if I am using reverse order of operations, I need to know additive and multiplicative inverses. Finally, I need to know rationales, which are the reasons why the strategies or the procedures work the way they do. For example, this could include things like the subtraction or the division property of equality that says that when you do the same operation to both sides of an equation, you preserve the value of the equation. 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 solving two step equations. For facts, I need to know what variables, constants, coefficients, equations and expressions are. A variable is an unknown quantity, usually represented by a letter. A constant is a specific number. A coefficient is a number that you multiply a variable by like $2x$. An equation is an expression that is equal to another expression and the two expressions are joined by an equal sign. An expression is one or more terms that are combined by mathematical operations like addition, subtraction, multiplication and division. For strategies, I need to know reverse order of

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operations, which is SADMEP. This stands for subtraction, addition, division, multiplication, exponents and parentheses. I know that I'm supposed to do these in order, but I don't remember whether I'm supposed to do subtraction always before addition or which one goes first. The same is true for division and multiplication. For procedures, I need to know additive inverse and multiplicative inverse. The additive inverse is taking the number with the opposite sign as the constant and adding it to both sides of the equation. The multiplicative inverse is taking the inverse of the coefficient of the variable and multiplying both sides of the equation by it. However, if the coefficient is negative, I'm not sure if the multiplicative inverse is supposed to be negative as well. For rationales, I believe the two rationales I need are the subtraction property of equality and the division property of equality. The subtraction property of equality says that if I subtract the same number from both sides, which is what I'm doing with the additive inverse, I preserve the equality. Similarly, the division property of equality says that if I divide both sides of the equation by the same number, which is what I'm doing with the multiplicative inverse, I preserve the equality.

When I look over what I wrote, I see that I am good with my facts. On my strategy, I'm not sure about the order of steps in reverse order of operations when it comes to subtraction and addition or multiplication and division, so I need to learn those. On procedures, I'm not sure what to do with multiplicative inverses when the coefficient is negative, so I need to learn that as well. For rationales, I think I'm OK. I don't think I have any missing facts/concepts that I left out that I should know or I didn't list any facts/concepts where I didn't know what they were. For the strategy, I believe I listed the correct strategy and parts of the strategy, but I wasn't sure about some of the ordering of steps in the strategy. For procedures, I was good on the additive inverse but had a question on carrying out the multiplicative inverse when the coefficient was negative. For rationales, I think I had all the rationales that were important and that I understood them as well. I don't think I left anything out.

Please use the form below to assess your own knowledge about a math topic. Fill in all the sections. Then when you are done, look at what you said you don't know about the topic or are unsure about and reread your lesson material to fill in your gaps.

Topic you are learning:

Facts about the topic you know:

Procedures about the topic you know:

Strategies about the topic you know:

Rationales about the topic you know:

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This is what you don't know about the topic or what you are unsure about

Now reread the material or the lesson and try to fill in what you don't know.

Write what you learned after rereading the material to learn what you don't know:"

Procedure

On Day 1 all 25 students completed a full SAT practice test consisting of both Math and English sections. These scores served as the baseline (Test 1) for evaluating student performance prior to any intervention. No self-assessment templates were given on this day.

On Day 2 students returned to class and reviewed their Test 1 results with the instructor. The review included going over missed questions, identifying common error patterns, and discussing the reasoning behind correct answers. Immediately following the review, students were given their assigned self-assessment template. Students in the SAT Math condition received the math template, students in the SAT Reading condition received the English/grammar template. Student performed self-assessment and remediation for their assigned conditions using the templates they were provided. Because students did self-assessment on only one subject (SAT Math or SAT Reading), they served as their own control. Because one group did self-assessment on each subject and one did not, there was a between-subjects comparison available as well.

On Day 3 students completed a second full SAT practice test (Test 2) containing both Math and Reading sections. These scores were used to measure changes in performance following the self-assessment intervention.

RESULTS

Each Participant used self-assessment for one section and did not use self-assessment for the other. Therefore, it is possible to compare students' scores to each other as a within-subjects variable and students' scores on a section to those of students in the other condition as a between-subjects variable. Students started with a pre-test of SAT Math and Reading sections to establish baseline scores. The pre-test math and reading scores of both groups were not statistically significantly different from each other, suggesting that the groups started with comparable baseline performances.

For the students who used self-assessment for only the math section of the SAT, the improvement in SAT Reading scores from pre-test to post-test was 1.67 points on average. This was not statistically significant. For the SAT Math section, students improved between pre-test and post-test, on average by, 45.83 points, $t(11) = 9.79$, $p < .0001$, using a paired t-test. The difference in improvement of 45.83 points in SAT Math vs. 1.67 points in SAT Reading was

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itself statistically significant, t(11) = 5.26, p = .003, using a paired t-test. It should be noted that 100% of the individual Participants who used the self-assessment for math brought their math scores up.

For the students who used self-assessment for only SAT Reading, the improvement in math scores was, on average, -.42 points between pre-test and post-test. This was not statistically significant. For the SAT Reading section, students improved, on average by, 33.33 points between pre-test and post-test, t(12) = 6.73, p < .0001, using a paired t-test. The difference in improvement of 33.33 points vs. -.42 points was itself statistically significant, t(12) = 5.43, p = .002, using a paired t-test. It should be noted that only one of the individual students who used the self-assessment for reading failed to bring up his/her SAT Reading score.

For the between-subjects variables, those who did not use self-assessment for SAT Math had an average post-test – pre-test score of -.42, while those who did use self-assessment had an average post-test – pre-test score of 45.83. This difference was statistically significant t(23) = 5.78, p < .0001. Those who did not use the self-assessment for SAT Reading had an average post-test – pre-test score of 1.67, while those who did use self-assessment had an average post-test – pre-test score of 33.33. This difference was statistically significant t(23) = 4.14, p = .0004.

DISCUSSION

This program aimed to evaluate the effectiveness of self-assessment and remediation using Cognitive Structure Analysis (CSA) in helping students improve their SAT scores. Rather than focusing on test-taking skills themselves, the emphasis is on improving subject matter knowledge needed to answer the SAT questions. While previous research we have conducted shows that self-assessment and remediation using CSA boosted math, reading, and grammar scores (the subject area components of the SAT test), the use of self-assessment for the SAT introduces a new element. In our previous studies, self-assessment was paired with school-based teaching. School-based teaching typically focuses on a single topic at a time and the knowledge components required for mastery are limited and well-defined. Moreover, through the teaching process, students were exposed to the subject matter by the instructor, so students had a sense of what concepts the teacher was trying to impart to them.

The SAT is different from classroom teaching in the sense that the topics covered are varied. Moreover, since the SAT is designed to be a reasoning test, the problems given are typically not straightforward. This places additional burden on the student who must also figure out not only how to solve the problem but also what concepts/topic the problem relates to. This makes the self-assessment process harder because the student needs to also figure out what topic area to self-assess in addition to conducting the self-assessment.

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The present study suggests that students can benefit from self-assessment in studying for the SAT. Students improved their performance by roughly 45 points in SAT Math and 33 points in SAT Reading in just one week, which is substantially higher than the typical nine to 20-point improvement that most SAT preparation courses provide (Becker, 1990). Given that applying self-assessment to SAT study requires the additional step of first figuring out what topic/concept needs to be self-assessed, the question arises whether SAT performance can be further improved by combining it with the metacognitive techniques reported in our previous work.

Metacognitive reasoning and self-assessment can go hand in hand. Metacognitive reasoning can be used to inform the student as to what topic or set of concepts a particular problem involves. The student can then use CSA-based self-assessment to determine what knowledge s/he possesses that pertains to identified set of concepts. Any identified knowledge gaps can then be remediated.

There is one area of further research that would be most interesting. Currently, after self-assessing, students perform their own remediation, which means that they have to review their instructional materials and find the relevant information to fill in their knowledge gaps. Our body of research in self-assessment shows that students can do this very well. However, in recent years, we have seen a proliferation of large language models (LLMs) and their use by students for their schoolwork. While LLMs are very powerful, they are inherently language models that provide answers to the questions they are asked. If 100 people ask the same question, it is still the same question and therefore, these people will get the same answer. However, people do not talk to each other the same way. We do not talk to children the same way we talk to adults. We do not talk to people with little knowledge of a subject area the way we talk to people who know a lot about it. LLMs do not make these distinctions.

Recently, we have been conducting experiments in which we incorporate self-assessment into LLM-based chatbots. Students perform an initial self-assessment on the topic they wish to learn about, and that information is fed to the chatbot with the instructions to tailor answers to students' questions to focus on filling self-assessed knowledge gaps. We have tested this approach on a variety of subject areas (Ganne and Leddo, 2026; Rapolu and Leddo, 2026a; Maviti and Leddo, 2025; Maviti, Leddo and Prakash, 2025; Wang and Leddo, 2025). In these tests, students learn a new subject by using either our self-assessment chatbot or a standard LLM like ChatGPT or Gemini. The instruction is followed by a post-test. We find that those using the self-assessment chatbot score, on average, the equivalent of one to four letter grades (roughly 10 to 40 percentage points) higher on the post-test than those who use a standard LLM.

A recent study we conducted (Rappolu and Leddo, 2026b) found that students using a self-assessment chatbot scored, on average, about 10 percentage points higher than those using slef-

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assessment without the aid of a chatbot. This raises the question of whether a self-assessment chatbot can improve student performance on the SAT test even more than self-assessment without a chatbot.

CONCLUSION

The present study, along with others cited in the Introduction of this paper, demonstrates that a simple and free self-assessment technique that takes 10 minutes for students to learn dramatically raises student achievement. There is no apparent downside to implementing this self-assessment method. It produces large educational gains across the board, it takes only 10 minutes to implement and is completely free.

We have established a non-profit called METY Foundation in order to disseminate the self-assessment method free of charge to all who want to use it (www.metyfoundation.org). When fully implemented, students will be able to access self-assessments in any subject, grade and language. They will be able to print or email self-assessment reports to parents and teachers. If teachers register their classrooms, analytics on students' knowledge strengths and learning needs will be provided to support teaching. Ultimately, the self-assessment chatbot technology will be included as well to provide personalized remedial instruction.

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