

Web-Based Intelligent Tutoring for the Structure Strategy (ITSS)

Intervention Report | Adolescent Literacy Topic Area

WHAT WORKS CLEARINGHOUSE™
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Literacy skills are critical to students’ academic achievement and setting them on a path to successful high school graduation and readiness for college and careers. *Web-Based Intelligent Tutoring for the Structure Strategy (ITSS)* is a supplemental web-based program for students in grades K-8. It is designed to develop literacy skills needed to understand factual texts encountered in classrooms and everyday life. The program teaches students how to follow the logical structure of factual text and to use text structure to improve understanding and recall. In particular, *ITSS* highlights five main text structures that are used to (1) make comparisons; (2) present problems and solutions; (3) link causes and effects; (4) present

sequences; and (5) describe things, people, creatures, places, or events. The program helps students classify the structure of a passage by identifying certain key words, such as “solution” and “in contrast,” that clue readers in to the type of arguments the text is making.¹

This What Works Clearinghouse (WWC) report, part of the WWC’s Adolescent Literacy topic area, explores the effects of *ITSS* on comprehension. The WWC identified two studies of *ITSS* that meet WWC standards.² The evidence presented in this report is from studies of the impacts of *ITSS* on students in grades 4, 5, and 7 and a variety of school settings, including suburban and rural districts.³

What Happens When Students Participate in *ITSS*?⁴

The evidence indicates that implementing *ITSS* is likely to increase students’ comprehension.

Findings on *ITSS* from two studies that meet WWC standards are shown in Table 1. The table reports an effectiveness rating, the improvement index, and the number of studies

and students that contributed to the findings. The improvement index is a measure of the intervention’s effect on an outcome. It can be interpreted as the expected change in percentile rank for an average comparison group student if that student had received the intervention.

Table 1. Summary of findings on *ITSS* from studies that meet WWC Standards

Outcome domain	Effectiveness rating	Study findings	Evidence meeting WWC standards (version 4.0)	
		Improvement index (percentile points)	Number of studies	Number of students
Comprehension	Positive effects	+9	2	6,724

Note: The improvement index can be interpreted as the expected change in percentile rank for an average student in the comparison group if that student had received the intervention. For example, an improvement index of +9 means that the expected percentile rank of the average comparison group student would increase by 9 points if the student received *ITSS*. The improvement index values are generated by averaging findings from the outcome analyses that meet WWC standards, as reported by Wijekumar, Meyer, and Lei (2012, 2017). A positive improvement index does not necessarily mean the estimated effect is statistically significant. Comprehension outcomes include the Gray Silent Reading Test and 13 researcher-designed measures that test students’ ability to understand written text by identifying main ideas, problems and solutions, and assessing the use of structure to organize correct ideas. The effects of *ITSS* are not known for other outcomes within the adolescent literacy topic area, including alphabets, reading fluency, general literacy achievement, writing conventions, writing productivity, and writing quality.

BOX 1. HOW THE WWC REVIEWS AND DESCRIBES EVIDENCE

The WWC evaluates evidence based on the quality and results of reviewed studies. The criteria the WWC uses for evaluating evidence are defined in the [Procedures and Standards Handbooks](#) and the [Review Protocols](#). The studies summarized in this report were reviewed under WWC Standards (version 4.0) and the Adolescent Literacy topic area protocol (version 4.0).

To determine the effectiveness rating, the WWC considers what methods each study used, the direction of the effects, and the number of studies that tested the intervention. The higher the effectiveness rating, the more certain the WWC is about the reported results and about what will happen if the same intervention is implemented again. The following key explains the relationship between effectiveness ratings and the statements used in this report:

Effectiveness rating	Rating interpretation	Description of the evidence
Positive (or negative) effects	The intervention is <i>likely</i> to change an outcome	Strong evidence of a positive effect, with no overriding contrary evidence
Potentially positive (or negative) effects	The intervention <i>may</i> change an outcome	Evidence of a positive effect with no overriding contrary evidence
No discernible effects	The intervention <i>may result in little to no change</i> in an outcome	No affirmative evidence of effects
Mixed effects	The intervention <i>has inconsistent effects</i> on an outcome	Evidence includes studies in at least two of these categories: studies with positive effects, studies with negative effects, or more studies with indeterminate effects than with positive or negative effects

How is *ITSS* Implemented?

The following section provides details of how *ITSS* was implemented. This information can help educators identify the requirements for implementing *ITSS* and determine whether implementing this intervention would be feasible in their districts or schools. Information on *ITSS* presented in this section comes from studies that meet WWC group design standards (Wijekumar et al., 2012, 2017) and from correspondence with the developer.

- **Goal:** *ITSS* aims to improve comprehension of factual (nonfiction) text.
- **Target population:** *ITSS* is designed for students in grades K-8. The two studies that contribute to this intervention report included students in grades 4, 5, and 7.
- **Method of delivery:** *ITSS* is a web-based program, which students access on a personal computer with earphones. It is typically used during class to supplement the English language arts curriculum.
- **Comparison group:** In the two studies that contribute to this intervention report, students in the comparison group received the school's standard language arts curriculum. Additional information on these curricula is not available. Total daily and weekly amounts of language arts instruction were the same for both intervention and comparison classrooms.
- **Frequency and duration of service:** Developers recommend students use *ITSS* twice a week for about 30 minutes per session for 7 months to 1 year. Refer to Table 2 for additional details.
- **Intervention components:** *ITSS* includes several components (see Table 2).

Table 2. Components of ITSS

Key component	Description
Instruction	<i>ITSS</i> models how to use the structure of the factual text to improve understanding and recall. An animated person, called an Intelligent Tutor (I.T.), explains the five main text structures: comparisons, problems and solutions, cause and effect, sequences, and descriptions. Then, the I.T. displays and reads aloud a passage that illustrates a text structure, modeling appropriate techniques for understanding the displayed passage. Techniques include finding signaling words, identifying the text structure, understanding the main idea of the text, and summarizing the text in written form. <i>ITSS</i> provides approximately 12 lessons for each text structure.
Exercises with immediate feedback	<p><i>ITSS</i> offers practice exercises using passages from a variety of substantive areas, including science, social studies, sports, and current events. It assesses student progress and provides learners with immediate feedback. After completing a lesson, the program allows students to practice what they learned in a series of exercises, and students work at their own pace. Each exercise involves reading a passage and then completing a series of tasks, such as finding signaling words, describing the main idea of the text, and summarizing the passage.</p> <p>Most exercises in <i>ITSS</i> follow this sequence:</p> <ol style="list-style-type: none"> 1. Students read nonfiction text displayed on the screen. 2. Students identify the author's top-level text structure (i.e., comparison, problem and solution, cause and effect, sequence, or description). 3. Students select signaling words used in the text. 4. Students write a sentence summarizing the main idea of the text, which is displayed on the screen, using the structure strategy. 5. Students generate a thorough summary of the text using the <i>ITSS</i> comprehension tools, such as an annotated matrix, diagram, sequence texts, or texts with embedded text structures. 6. Students write a "recall" summary of the text after the text is removed from view. This recall exercise becomes more challenging as students progress through the lessons. In early lessons, students recall and summarize the text while having access to their (or the I.T.'s) main idea summaries from steps 4 or 5. Later practice lessons remove this aid, and students monitor their recall using the structure strategy. More specifically, students use the text structure as a retrieval and writing guide. They monitor their understanding and recall through summarizing the main points according to the recall pattern identified for a particular text structure. 7. Students receive feedback from the I.T. after each step above. In the two studies that contributed to this report, after several unsuccessful attempts, the I.T. offered students hints, showed a model summary of the text, and asked students to correct their work. The students were not allowed to copy the model summary but were asked to think about the text's structure and main idea and then revise their work. If students were unsuccessful after repeated feedback and increased help from the I.T., the I.T. told students to ask teachers for assistance. <p>The tasks can vary across lessons. Some lessons ask students to write or select a good title for a text based on text structure, write their own texts for each text structure by selecting signaling words from a specified short list, and correct a fictitious student's muddled use of the text structure strategy. As students complete the exercises, the passages become more difficult.</p>

What Does *ITSS* Cost?

This preliminary list of costs is not designed to be exhaustive; rather, it provides educators an overview of the major resources needed to implement *ITSS*. The program costs described below are based on the information available as of June 2019.

- **Personnel costs:** *ITSS* developers require that school staff who would like to implement the *ITSS* program participate in professional development. In particular, teachers are required to attend a 2-day session, while school administrators are required to attend a 1-day session. The cost of professional development sessions varies from \$2,500 to \$8,000 per session depending on the number of school staff attending the session and the location of the sessions. An additional 4 to 6 days of in-school coaching is also required. No cost information on in-school coaching is available.
- **Facilities costs:** No additional facilities costs are needed to run the *ITSS* program; however, computer labs might be necessary for classrooms without personal computers.
- **Equipment and materials costs:** The *ITSS* web-based program can be accessed by students and educators at no cost.
- **Costs paid by students or parents:** Students and their parents do not pay to access *ITSS*.
- **In-kind supports:** No information on in-kind supports is available.
- **Sources of funding:** School districts typically cover *ITSS* training costs.

For More Information:

About *ITSS*

Dr. Kausalai (Kay) Wijekumar, Texas A&M University, College of Education and Human Development, College Station, TX 77843

Web: <http://literacy.io/projects/itss/>

About the cost of the intervention

Cost information was provided by the developer.

Research Summary

The WWC identified two studies that investigated the effectiveness of *ITSS* (Figure 1):

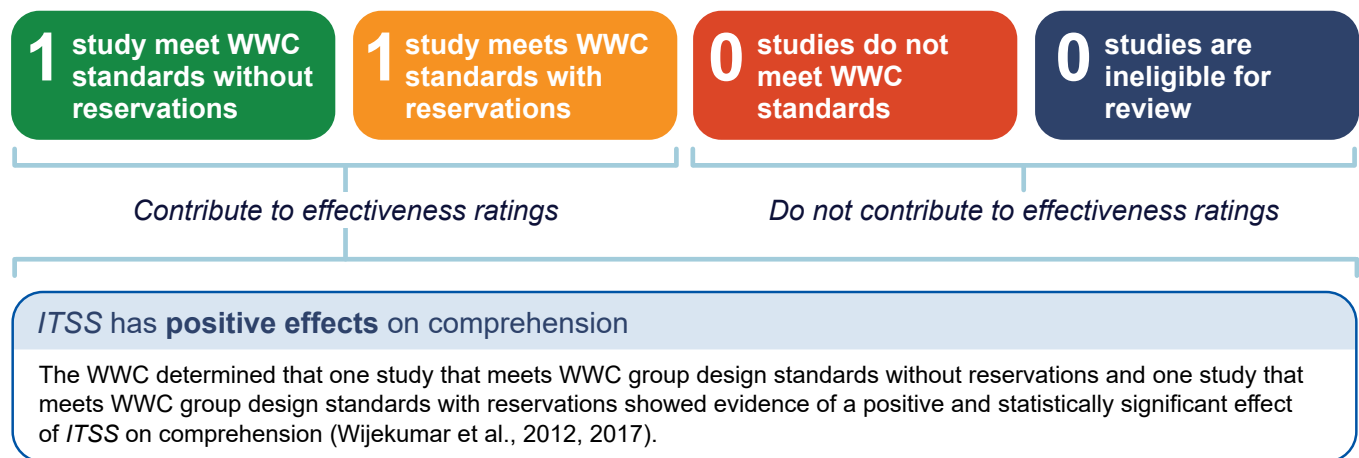
- 1 study meets WWC group design standards without reservations
- 1 study meets WWC group design standards with reservations

The WWC reviews findings on the intervention's effects on eligible outcome domains from studies that meet standards, either with or without reservations. Based on this review, the WWC generates an effectiveness rating, which summarizes how the intervention impacts, or changes, a particular outcome domain. The WWC reports additional supplemental

findings on the WWC website (<https://whatworks.ed.gov>), such as those the study authors reported separately for male and female students. These supplemental findings do not contribute to the effectiveness ratings.

The two studies of *ITSS* that meet WWC group design standards reported findings on comprehension outcomes. No other findings in the studies met WWC group design standards within any outcome domain included in the Adolescent Literacy topic area.⁵ Citations for the two studies reviewed for this report are listed in the References section, which begins on page 11.

Figure 1. Effectiveness ratings for *ITSS*



Main Findings

Table 3 shows the findings from two *ITSS* studies that meet WWC group design standards. The table includes WWC calculations of the mean difference, effect size, and performance of the intervention group relative to the comparison group. Based on findings from two studies that

meet WWC group design standards, the effectiveness rating for the comprehension domain is positive effects, indicating strong evidence of a positive effect with no overriding contrary evidence. These findings are based on 6,724 students.

Table 3. Findings from studies of ITSS by outcome domain

Measure (study)	Study sample	Sample size	Mean (standard deviation)		WWC calculations			p-value
			Intervention group	Comparison group	Mean difference	Effect size	Improvement index	
Gray Silent Reading Test (GSRT)	Fourth- and fifth-grade students	4,856	32.12 (11.52)	30.42 (11.37)	1.70	0.15	+6	<.01
Short Comparison Text: Competence Test	Fourth- and fifth-grade students	4,040	4.25 (2.39)	3.71 (2.38)	0.54	0.23	+9	<.01
Short Comparison Text: Main Idea Test	Fourth- and fifth-grade students	4,035	3.46 (1.58)	2.65 (1.58)	0.81	0.51	+20	<.01
Short Comparison Text: Total Recall Test	Fourth- and fifth-grade students	4,073	26.17 (16.98)	22.37 (16.53)	3.80	0.23	+9	<.01
Problem/Solution Text: Competence Test	Fourth- and fifth-grade students	4,084	3.54 (2.36)	3.21 (2.35)	0.33	0.14	+6	<.01
Problem/Solution Text: Total Recall Test	Fourth- and fifth-grade students	4,090	17.93 (11.66)	15.76 (11.60)	2.17	0.19	+7	<.01
Outcome average for fourth- and fifth-grade comprehension (Wijekumar et al., 2012)^a						0.24	+9	Statistically significant
Gray Silent Reading Test (GSRT)	Seventh-grade students	1,868	nr (11.57)	nr (13.41)	2.12	0.17	+7	<.01
Long Comparison Text: Competence Test	Seventh-grade students	1,717	nr (1.68)	nr (1.51)	0.31	0.19	+8	<.01
Long Comparison Text: Number of Issues Test	Seventh-grade students	1,717	nr (0.98)	nr (0.75)	0.17	0.19	+8	<.01
Short Comparison Text: Competence Test	Seventh-grade students	1,718	nr (2.25)	nr (2.24)	0.36	0.16	+6	<.05
Short Comparison Text: Number of Issues Test	Seventh-grade students	1,718	nr (1.49)	nr (1.28)	0.29	0.21	+8	<.05
Short Comparison Text: Main Idea Competence Test	Seventh-grade students	1,721	nr (1.42)	nr (1.33)	0.39	0.28	+11	<.01
Short Comparison Text: Main Idea Test, Number of Issues	Seventh-grade students	1,721	nr (1.50)	nr (0.58)	0.51	0.42	+16	<.01
Problem/Solution Text: Competence Test	Seventh-grade students	1,716	nr (2.58)	nr (2.51)	0.52	0.20	+8	<.01
Outcome average for seventh-grade comprehension (Wijekumar et al., 2017)^b						0.23	+9	Statistically significant
Outcome average for comprehension across all studies						0.23	+9	

Notes: For mean difference and effect size values reported in the table, a positive number favors the intervention group and a negative number favors the comparison group. The effect size is a standardized measure of the effect of an intervention on outcomes, representing the average change expected for all individuals who are given the intervention (measured in standard deviations of the outcome measure). An indicator of the effect of the intervention, the improvement index can be interpreted as the expected change in percentile rank for an average comparison group student if that student had received the intervention. For example, an improvement index of +9 means that the expected percentile rank of the average comparison group student would increase by 9 points if the student received ITSS. A positive improvement index does not necessarily mean the estimated effect is statistically significant. Some statistics might not sum as expected due to rounding. nr = Not reported.

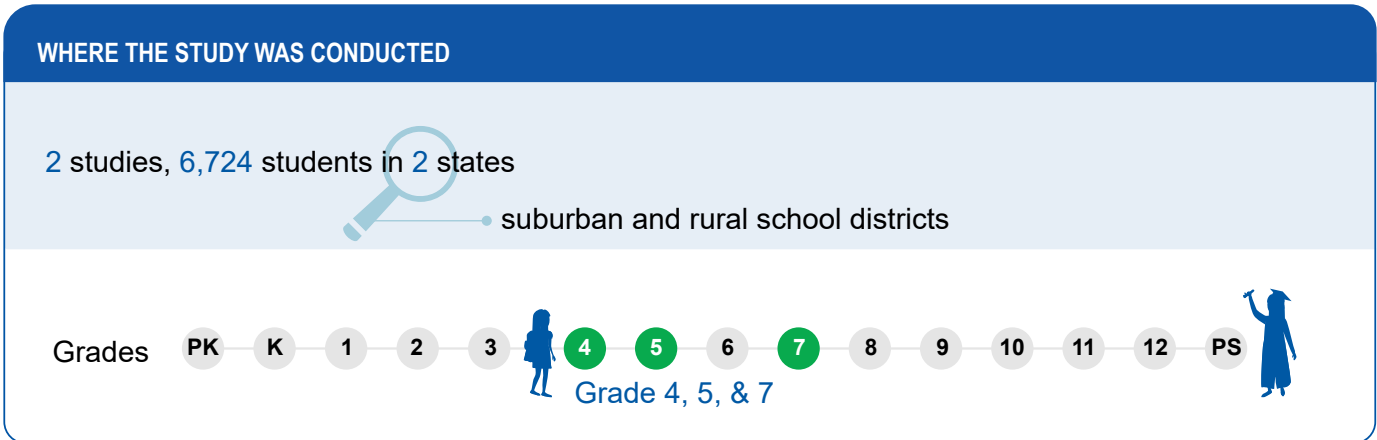
^a Wijekumar et al. (2012) did not require corrections for clustering or difference-in-differences adjustments. A correction for multiple comparisons was needed but did not affect whether any of the findings were found to be statistically significant. The authors provided analytic sample sizes for fourth-grade student samples in response to a question from the WWC to the authors. The WWC calculated the intervention group mean for each grade's analytic sample by adding the adjusted mean difference (an HLM level-2 coefficient) to the unadjusted posttest mean for the comparison group. Findings for the combined fourth- and fifth-grade analytic samples, including means, standard deviations, and p-values, were calculated by the WWC. For consistency, the WWC used pretest standard deviations from each grade to calculate effect sizes for the combined grade 4 and 5 findings because student-level posttest standard deviations were not reported for the fourth-grade sample. This study is characterized as having a statistically significant positive effect on comprehension because the WWC-calculated average effect size for the study is positive and statistically significant.

^b Wijekumar et al. (2017) did not require corrections for clustering or difference-in-differences adjustments. The p-values presented here were reported in the original study. A correction for multiple comparisons was needed but did not affect whether any of the findings were found to be statistically significant. Intervention and comparison group standard deviations presented for seventh-grade students were provided in response to a question from the WWC to the authors. However, the authors did not report posttest means for the analytic sample used in the HLM analysis, which were used to estimate the mean difference between the two study groups; thus, the WWC did not report intervention and comparison group means in this table. This study is characterized as having a statistically significant positive effect on comprehension because the WWC-calculated average effect size for the study is positive and statistically significant. For more information, please refer to the WWC Procedures and Standards Handbook, version 4.0, page 22.

In What Context Was *ITSS* Studied?

The following section provides information on the setting of the two studies of *ITSS* that meet WWC standards, and a description of the participants in the research. This

information can help educators understand the context in which the studies of *ITSS* were conducted, and determine whether the program might be suitable for their setting.



Details of Each Study that Meets WWC Standards

This section presents details for each study of *ITSS* that meets WWC standards. These details include the full study reference, findings description, findings summary, and description of study characteristics. A summary of domain findings for each study is presented below, followed by a description of the study characteristics. These study-level details include contextual information around the study setting, methods, sample, intervention group, comparison group, outcomes, and implementation details. For additional information, readers should refer to the original studies.

Research details for Wijekumar et al. (2012)

Wijekumar, K., Meyer, B., & Lei, P. (2012). Large-scale randomized controlled trial with 4th graders using

intelligent tutoring of the structure strategy to improve nonfiction reading comprehension. *Educational Technology Research & Development*, 60(6), 987-1013. Retrieved from <https://eric.ed.gov/?id=EJ986753>.

Findings from Wijekumar et al. (2012) show evidence of a statistically significant positive effect of *ITSS* in the comprehension domain (Table 4). These findings are based on six outcomes and 4,856 students.⁶ The findings and research details summarized for this study come from four related citations, including the primary study listed above. See the References section, which begins on page 11, for a list of all related publications.

Table 4. Summary of findings from Wijekumar et al. (2012)

Meets WWC group design standards without reservations				
Outcome domain	Sample size	Study findings		
		Average effect size	Improvement index	Statistically significant
Comprehension	4,856 students	0.24	+9	Yes

Table 5. Description of study characteristics for Wijekumar et al. (2012)

WWC evidence rating	Meets WWC Group Design Standards Without Reservations. This is a cluster randomized controlled trial with low attrition. ⁷ For more information on how the WWC assigns study ratings, please see the WWC Procedures and Standards Handbooks (version 4.0) and WWC Standards Briefs, available on the WWC website.
Setting	The study included fourth- and fifth-grade classrooms from 45 rural and suburban elementary schools, 12 school districts, and two states in the United States.
Methods	The study used a cluster randomized controlled trial design. A volunteer sample of 259 classrooms in participating schools were randomly assigned to either provide supplemental instruction using <i>ITSS</i> or to implement business-as-usual classroom instruction in the study year and to implement <i>ITSS</i> in the following academic year. Random assignment occurred within each grade level and school. If a school had an odd number of classrooms for a given grade level, it was matched to a similar school with an odd number of classrooms and random assignment then took place across these schools. Altogether, 130 classrooms were randomly assigned to the intervention group and 129 classrooms were randomly assigned to the comparison group. At baseline, the intervention group included 2,949 students and the comparison group included 2,848 students. ⁸ For all outcome measures, the sample loss after random assignment (attrition) was within the acceptable threshold for the review: at the classroom level, overall attrition ranged from 5.8% to 19.3%, and differential attrition ranged from 3.9% to 4.8%. Overall non-response at the student level ranged from 5.0% to 14.3%, and differential attrition ranged from 3.4% to 4.3%.
Study sample	The number of students in the analytic sample, including both fourth- and fifth-grade students, differs by outcome, ranging from 4,035 to 4,856 students. No demographic or sample characteristics were provided on the fourth-grade analytic sample; however, the authors stated that the intervention and comparison groups were balanced on student socioeconomic status, number of English learners, percentage of racial/ethnic minorities, and gender. The 45 schools in the fifth-grade sample are composed of 8% to 14% racial/ethnic minorities and 39% to 44% socioeconomically disadvantaged students.
Intervention group	Students in the intervention group received the <i>ITSS</i> program over the course of the 2009–10 school year. <i>ITSS</i> sessions took place for 30 to 45 minutes a week over 6 to 7 months, which was lower than the developer-recommended dosage, as a partial substitute for the regular language arts curriculum. In fourth-grade classrooms, the recall task of <i>ITSS</i> was removed from the lesson sequence after the first month of instruction because students had difficulty typing. In fifth-grade classrooms, the recall task was implemented as intended.
Comparison group	Students in comparison classrooms received the typical language arts curriculum, which was the same curriculum used by the intervention group classrooms within the same school except for the partial substitution of <i>ITSS</i> . Total daily and weekly amounts of language arts instruction were the same for both intervention and comparison classrooms.
Outcomes and measurement	<p>Study authors reported findings on six outcome measures that are eligible for review under the Adolescent Literacy topic area. All assessments were administered to both fourth- and fifth-grade students. For all measures, pretests were completed at the beginning of the school year and posttests were completed immediately after the end of the intervention implementation (in April or May 2010).</p> <p>All outcomes were reviewed in the comprehension domain and included a standardized test, the Gray Silent Reading Test (GSRT; Wiederholt & Blalock, 2000),⁹ which contained 15 passages and posed five questions for each passage to test students' comprehension, and five researcher-designed measures. For the researcher-designed measures described below, interrater agreement was within the acceptable threshold for the review and ranged from 86% to 99%:</p> <ul style="list-style-type: none"> • Short Comparison Text: Competence Test. This assessment measured whether students recalled the problem, its cause, and its solution described in the original text. Students were presented with one passage at pretest and a different passage at posttest that compared two ideas or things. Each passage in this assessment had 128 words, 15 sentences, and 98 idea units. Competency scores ranged from 1 to 8 and described a student's use of the structure strategy to organize correct ideas based on the recall task. • Short Comparison Text: Main Idea Test. This assessment asked students to write a two-sentence main idea after reading the passage from the Short Comparison Text: Competence Test. The assessment measured students' ability to understand and summarize the main ideas in the passage. This assessment was rated on a 6-point scale. • Short Comparison Text: Total Recall Test. This assessment measured students' recall ability by asking them to write down as many ideas as they could remember after reading the passage from the Short Comparison Text: Competence Test. • Problem/Solution Text: Competence Test. This assessment measured students' ability to recall the correct problem, its cause, and its solution after they read a passage using the problem/solution structure. Competency scores ranged from 1 to 8 and described a student's use of the structure strategy to organize correct ideas. Students were presented with one passage at pretest and a different passage at posttest. Each passage had 98 words and 72 idea units.

Outcomes and measurement (continued)

- **Problem/Solution Text: Total Recall Test.** This assessment measured students' recall ability by asking them to write down as many ideas as they could remember from a passage. The passage was the same as the one used in the Problem/Solution Text: Competence Test.

Supplemental findings were reported for male students, female students, students reading below grade level, and students reading above grade level. These supplemental findings were reported separately for fourth- and fifth-grade students and are available on the WWC website (<https://whatworks.ed.gov>). The supplemental findings do not factor into the intervention's rating of effectiveness.

The study also presented findings on a researcher-designed signaling test that did not meet WWC group design standards. The test instructed students to supply omitted signaling words within a short comparative text. Because instruction on signaling words was provided to students in the *ITSS* intervention group but not to students in the comparison group, and students were assessed on their use of appropriate signaling words, the WWC determined this test to be overaligned with the intervention.

The study reported findings for a subsample of fourth- and fifth-grade classrooms that implemented *ITSS* with high fidelity, as defined by the authors. Three criteria were used to identify high-fidelity implementation: (1) teachers contacted the research team to follow up on the progress of their students; (2) teachers were able to monitor and answer questions from students, as defined by observers; and (3) students used *ITSS* for at least 30 minutes per week for at least 6 months. These findings are not presented in this report because high-fidelity implementation is not an eligible subgroup of interest under the Adolescent Literacy protocol (version 4.0).

The study authors also report non-academic outcomes for the fifth-grade sample, including computer attitudes, learning self-efficacy, reading self-efficacy, and structure strategy self-efficacy. These findings were not eligible for review under the Adolescent Literacy protocol (version 4.0).

Additional implementation details

The research team conducted *ITSS* training sessions for the teachers of intervention classrooms during the 2009–10 academic year. Teachers in comparison classrooms were offered the same professional development after the study was completed.

Research details for Wijekumar et al. (2017)

Wijekumar, K., Meyer, B.J.F., & Lei, P. (2017). Web-based text structure strategy instruction improves seventh graders' content area reading comprehension. *Journal of Educational Psychology, 109*(6), 741-760. Retrieved from <https://eric.ed.gov/?id=EJ1149967>.

Findings from Wijekumar et al. (2017) show evidence of a statistically significant positive effect of *ITSS* on comprehension (Table 6). These findings are based on eight outcomes and 1,868 students.¹⁰ The findings and research details summarized for this study come from two related citations, including the primary study listed above. See the References section, which begins on page 11, for a list of all related publications.

Table 6. Summary of findings from Wijekumar et al. (2017)

Outcome domain	Sample size	Meets WWC group design standards with reservations		
		Study findings		
		Average effect size	Improvement index	Statistically significant
Comprehension	1,868 students	0.23	+9	Yes

Table 7. Description of study characteristics for Wijekumar et al. (2017)

WWC evidence rating	Meets WWC Group Design Standards With Reservations. This is a cluster randomized controlled trial with compromised random assignment that satisfies the baseline equivalence requirement for the individuals in the analytic intervention and comparison groups.
Setting	The study included seventh-grade classrooms from 25 rural and suburban middle schools across two states in the United States.
Methods	The study used a cluster randomized controlled trial design. A volunteer sample of 108 seventh-grade classrooms from 25 schools were randomly assigned to either provide supplemental instruction using <i>ITSS</i> (59 classrooms with 1,415 students) or to implement business-as-usual classroom instruction in the study year and implement <i>ITSS</i> the following academic year (49 classrooms with 1,074 students). Altogether, 2,489 students from 25 schools were subject to random assignment. Random assignment occurred separately within each school. If a school had an odd number of classrooms, it was matched to a similar school with an odd number of classrooms and the random assignment then took place across these schools. All students within study classrooms were then asked to provide consent to participate in the study. The random assignment was compromised because students were excluded from the analytic sample if they used <i>ITSS</i> for less than 30 minutes during the school year.
Study sample	The number of students in the analytic sample differs by outcome, ranging from 1,716 to 1,868 students. Across the 25 study schools, 42% of the student population was eligible for free or reduced-price lunch and 8% were racial/ethnic minorities. The analytic sample was about 48% female, and 53% were from rural school districts. The remainder were from suburban school districts.
Intervention group	Students in the intervention group received the <i>ITSS</i> program over the course of the 2010–11 school year. <i>ITSS</i> was used in intervention classrooms for 30 to 45 minutes a week over 6 to 7 months, which was lower than the developer-recommended dosage, as a partial substitute for the regular language arts curriculum.
Comparison group	Students in comparison classrooms received the typical language arts curriculum, which was the same curriculum used by the intervention group classrooms within the same school except for the partial substitution of <i>ITSS</i> . Total daily and weekly amounts of language arts instruction were the same for both intervention and comparison classrooms.
Outcomes and measurement	<p>Study authors reported findings on eight outcome measures that are eligible for review under the Adolescent Literacy topic area. All assessments were administered to seventh-grade students. For all measures, pretests were completed at the beginning of the school year and posttests were completed immediately after completing the study end of the intervention implementation (in April or May 2011).</p> <p>All outcomes were reviewed in the comprehension domain, and included the GSRT (Wiederholt & Blalock, 2000), and seven researcher-designed measures. For the researcher-designed measures described below, interrater agreement was within the acceptable threshold for the review and ranged from 86% to 100%:</p> <ul style="list-style-type: none"> • Long Comparison Text: Competence Test. This assessment measured whether students recalled the problem, its cause, and its solution described in the original text. Competency scores ranged from 1 to 8, and described a student's use of the structure strategy to organize correct ideas. The long comparison text used in this assessment contained 527 words, 33 sentences, and 134 idea units. • Long Comparison Text: Number of Issues Test. This assessment counted the number of issues that students correctly contrasted between two objects described in the passage presented in the Long Comparison Text: Competence Test. This assessment was scored on a 9-point scale. • Short Comparison Text: Competence Test. This assessment was also used in Wijekumar et al. (2012). It tested the student's ability to recall the correct problem, its cause, and its solution. Both pretest and posttest comparison passages used in this assessment had 128 words, 15 sentences, and 98 idea units. • Short Comparison Text: Number of Issues Test. This assessment counted the number of issues students correctly contrasted between two objects described in the passage presented in the Short Comparison Text: Competence Test. This assessment was rated on a 6-point scale. • Short Comparison Text: Main Idea Competence Test. This assessment was also used in Wijekumar et al. (2012); it was called the Short Comparison Text: Main Idea Test in the previous study. The assessment asked students to write a two-sentence main idea after reading a passage from the Short Comparison Text: Competence Test. The assessment measured students' competence using the comparison structure and their ability to organize ideas in the passage. It was rated on a 6-point scale.

<p>Outcomes and measurement <i>(continued)</i></p>	<ul style="list-style-type: none"> • Short Comparison Text: Main Idea Test, Number of Issues Test. This assessment asked students to write a two-sentence main idea after reading a passage from the Short Comparison Text: Competence Test. The assessment measured the number of issues compared. • Problem/Solution Text: Competence Test. This was the same assessment used in Wijekumar et al. (2012) and measured whether students recalled the problem, its cause, and its solution. The problem/solution text had two passages that each had 98 words and 72 idea units. <p>Wijekumar et al. (2017) presented findings on the same researcher-designed signaling test used in Wijekumar et al. (2012). Again, the WWC determined this test to be overaligned for the same reason. Four assessments that required students to identify the top-level structure (such as problem and solution) were also determined to be overaligned because students received higher scores if they used signaling words in their answers. Because these outcomes might not provide an accurate indication of the effect of <i>ITSS</i>, they do not meet WWC requirements.</p>
<p>Additional implementation details</p>	<p>Teachers in the intervention group received 3 hours of training at the beginning of the academic year. Teacher aides were hired at each school to assist with <i>ITSS</i> implementation at the computer lab.</p>

References

Studies that meet WWC group design standards

Wijekumar, K., Meyer, B., Lei, P. (2012). Large-scale randomized controlled trial with 4th graders using intelligent tutoring of the structure strategy to improve nonfiction reading comprehension. *Educational Technology Research & Development*, 60(6), 987-1013. Retrieved from <https://eric.ed.gov/?id=EJ986753>.

Additional sources:

Meyer, B.J.F., Wijekumar, K., & Lei, P. (2018). Comparative signaling generated for expository texts by 4th-8th graders: Variations by text structure strategy instruction, comprehension skill, and signal word. *Reading and Writing*, 31(9), 1937-1968. Retrieved from <https://eric.ed.gov/?id=EJ1193946>.

Wijekumar, K., Meyer, B.J.F., & Lei, P. (2013). High-fidelity implementation of web-based intelligent tutoring system improves fourth and fifth graders content area reading comprehension. *Computers & Education*, 68, 366-379.

Wijekumar, K., Meyer, B.J.F., Lei, P., Lin, Y.-C., Johnson, L.A., Spielvogel, J.A.,...Cook, M. (2014). Multisite randomized controlled trial examining Intelligent Tutoring of Structure Strategy for fifth-grade readers. *Journal of Research on Educational Effectiveness*, 7(4), 331-357. Retrieved from <https://eric.ed.gov/?id=EJ1041354>.

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Additional source:

Meyer, B.J.F., Wijekumar, K., & Lei, P. (2018). Comparative signaling generated for expository texts by 4th-8th graders: Variations by text structure strategy instruction, comprehension skill, and signal word. *Reading and Writing*, 31(9), 1937-1968. Retrieved from <https://eric.ed.gov/?id=EJ1193946>.

Studies that do not meet WWC group design standards

None

Studies that are ineligible for review using the Adolescent Literacy Protocol

None

Endnotes

¹The descriptive information for this intervention comes from Wijekumar et al. (2012, 2017). The What Works Clearinghouse (WWC) requests developers to review the intervention description sections for accuracy from their perspective. The WWC provided the developer with the intervention description in March 2019, and the WWC incorporated feedback from the developer. Further verification of the accuracy of the descriptive information

for this intervention is beyond the scope of this review.

²At the time of this report writing, two studies were available on the effectiveness of the web-based version of ITSS, which is the focus of this report. Research on other versions of the intervention teaching structure strategy, such as those using human tutors, has a longer history. Because these versions of the intervention might differ in effectiveness from the web-based version of ITSS, this literature did not contribute to the findings in this report.

³This report was revised in April 2021 to incorporate feedback on the definitions of outcome measures provided by the authors of Wijekumar et al. (2017). These revisions did not result in any changes to the data and conclusions presented in the original report.

⁴The literature search reflects documents publicly available by March 2019. Reviews of the studies in this report used the standards from the WWC Procedures and Standards Handbook (version 4.0) and the Adolescent Literacy review protocol (version 4.0). The evidence presented in this report is based on available research. Findings and conclusions could change as new research becomes available.

⁵The effects of ITSS are not known for other outcome domains within the Adolescent Literacy topic area, including alphabets, reading fluency, general literacy achievement, writing conventions, writing productivity, and writing quality.

⁶The WWC conducted a [single study review](#) of Wijekumar et al. (2012) in July 2013. This study presented findings on fourth-grade students only. For the present review, the WWC combined ITSS findings from fourth- and fifth-grade students reported in Wijekumar et al. (2012, 2014), respectively, because they met WWC group design criteria for being part of the same study. Specifically, findings reported for fourth- and fifth-grade students shared the same group formation procedures, the same data collection and analysis procedures, and the same research team. For more information, please see page 9 of the WWC Procedures Handbook (version 4.0).

⁷The combined findings for the fourth- and fifth-grade students (Wijekumar et al., 2012, 2014) meet WWC group design standards without reservations because they are based on a randomized controlled trial with low attrition. Separate findings for fourth-grade students (Wijekumar et al., 2012) and fifth-grade students (Wijekumar et al., 2014) also meet WWC group design standards without reservations. Although the authors reported the findings separately for each grade, the WWC combined findings from both grades because they are based on the same study as defined by the WWC. The WWC reviewed findings for each grade level as supplementary findings that are available on the WWC website (<https://whatworks.ed.gov>).

⁸The number of fifth-grade students in the study at the time of random assignment is unknown. Authors reported that 98% of the students subject to random assignment provided consent to participate, so even under the most conservative assumptions, this subgroup has low attrition by WWC standards.

⁹Wiederholt, J. L., & Blalock, G. (2000). GSRT: Gray Silent Reading Tests. Austin, TX: Pro-Ed.

¹⁰ The WWC had conducted a previous review of Wijekumar et al. (2017), as this was a Department of Education-funded evaluation. This previous review resulted in the same rating as the present review, although there were some differences in which findings were reported as primary and supplementary due to differences in the review protocols used to guide these reviews.

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