International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 4, pp. 52-71, April 2025
https://doi.org/10.26803/ijlter.24.4.3
Received Feb 9, 2025; Revised Apr 7, 2025; Accepted Apr 14, 2025

Integration of Web-Based Intelligent Tutoring System (TuinLec) into Text Structure Strategy to Improve Text Strategy Memory and Reading Comprehension Skills

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Abstract. Text strategy memory is an essential element in students' reading comprehension level, so the function of this element must be optimized through the right strategy. This study aimed to investigate the impact of a web-based intelligent tutoring system (TuinLec) integrated with text structure strategy on text strategy memory and reading comprehension skills. TuinLec emphasizes procedural strategies or approaches that emphasize content so that various discussion variations are created. This study used a quasi-experimental method involving 300 elementary school students who focused on grades four and five because they were transitioning to understand more complex texts. Multinomial logistic regression data analysis with Statistical Analysis System to investigate whether students in the intervention group showed an increase in organized memory structures better than students in the control group. The results showed that integrating a web-based intelligent tutoring system (TuinLec) in a text structure strategy proved effective in improving text strategy memory and reading comprehension skills. The improvement of memory structure is seen in the organization of the written reading memory structure from the beginning, which was random, and only a list of memories was written to be well organized. In addition, the improvement of reading comprehension skills and text strategy memory skills is also seen in several competencies, namely the problem and solution memory structure, the ability to analyze the issues and solutions, the memory structure of comparison, the ability to analyze comparisons, the main idea memory structure, and the ability to identify main ideas. This study implies that text structure can be used as an alternative strategy for understanding text comprehensively. Through this study, text structure can become a strategy by integrating it with technology to facilitate students in gaining a comprehensive understanding.

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Keywords: reading comprehension skills; text strategy memory; text structure strategy; web-based intelligent guidance system (TuinLec)

1. Introduction

Hierarchical strategic memory is one of the most critical aspects supporting academic achievement, professionalism, and personality. Based on previous studies, one of the distinguishing features among experts from various domains is hierarchical strategic memory. Some evidence that hierarchical strategic memory is a success factor among chess athletes can vary movements and strong photographic memory to choose and respond to movements (Hoffman et al., 2024; Kortecamp & Peters, 2024). This is reinforced by a physicist's statement that when a problem is given, novice readers are trapped in the details of the situation and the bottom-up process but rely less on hierarchical strategic memory abilities. The aspect of hierarchical memory structure is essential in helping students master the field of science (Scholes, 2024; Stangeland et al., 2023). Based on previous studies, expert readers have a memory structure that is interrelated hierarchically and logically (Kim et al., 2021; Lenhart et al., 2022; Nevo & Vaknin-Nusbaum, 2018). The findings are also called the integration construction model and strategic memory in the reading comprehension text structure model. One of elementary school students' main competencies is reading comprehension, which includes identifying essential ideas, activating schemata, confirming with new knowledge, and encoding vital strategic memory (Dong et al., 2022; Hebbecker et al., 2019). However, the ability to create hierarchical strategy memory is not easy to achieve in reading comprehension in students.

Based on the results of a study from the National Education Assessment from 2020-2023 at the elementary school level, more than 50% of students do not have hierarchical strategy memory skills that support reading comprehension skills (Almadhi & Alanazi, 2024; Hadianto et al., 2021). Of course, this is a challenge for teachers in facilitating students to acquire reading comprehension skills that are much needed at higher school levels. This reading comprehension challenge needs to be addressed as early as possible so that students can achieve a good academic level. An important aspect that supports upper elementary school reading skills is a more complex type of text. Expository text needs to be understood by grades 4 and 5 of elementary school, who are starting to switch from narrative text types. However, the transition of reading mastery from one type to a more complex type of text requires a method to bridge it (Alireza & Karimnia, 2019; Peura et al., 2018). The expository text type has different characteristics from the narrative text type, starting from the organization, use of vocabulary, and complexity of ideas. This text no longer contains the elements contained in the narrative (Mekuria et al., 2024; Vidal-Abarca et al., 2014). Students in upper elementary grades must face aspects of facts, information, and complex text organization. Previous studies have revealed that a web-based intelligent guidance system integrated into a text structure strategy has proven effective in rearranging mental functions that support increased reading comprehension skills (Ong'ayi et al., 2020; Torr, 2019). This guidance system is interpreted as a derivative concept of cognitive technology and mind tools. This software plays a role in modifying the content and flow of cognitive processes that

occur to facilitate students in solving problems, and the device also plays a role in rearranging students' mental functions.

This web-based intelligent tutoring system (TuinLec) contains instructions for five text structures presented with interactive, practical, evaluative, and quality feedback models to improve the quality of the learning process (Altun et al., 2022; Sirén & Sulkunen, 2023). This study focuses on the ability to identify and code strategic memory in reading comprehension of elementary school students in grades 4 and 5. Teaching uses a web-based intelligent tutoring system (TuinLec) to present learning through demonstrations, provide practical instructions, assess student responses, and provide feedback on student work results (Mekuria et al., 2024; Vidal-Abarca et al., 2014). The instructional teaching model with TuinLec presents interactions between teachers and students recorded in video form. This teaching approach is one form of strategy that emphasizes content, which is called a structured strategy (McNally et al., 2024; Zhang et al., 2024). The difference between this study and previous studies is that the researcher integrated TuinLec technology into text structure strategies as an intervention. In addition, this study focuses on reading comprehension skills and memory structures that greatly support reading comprehension. So, in this study, students receive instructions through TuinLec to identify text structures, such as identifying main ideas, coding strategic memory structures, concluding, and monitoring student understanding. Based on the background explanation, this study aims to explore the impact of the web-based intelligent tutoring system (TuinLec) on students' strategic memory and reading comprehension skills. Based on this explanation, the formulation of the problem in this study is:

1) Can the web-based intelligent tutoring system (TuinLec) with a text structure strategy improve students' strategic memory?
2) Can the web-based intelligent tutoring system (TuinLec) improve students' reading comprehension skills using text structure strategies?

2. Literature Review

2.1 Reading Comprehension

Reading skills for text comprehension require several efforts, including selecting important ideas, connecting between ideas, activating previous schemata, and integrating new information (Galea et al., 2024; Kortecamp & Peters, 2024). Teachers must make various efforts to facilitate students in mastering reading comprehension skills, one of which is content-based or strategy-based instruction in the curriculum. Some of the instructions in the intelligent guidance system are summarizing, asking questions, determining reading purposes, and discussing reading content (Alramamneh et al., 2023; Pfost & Heyne, 2023). This approach emphasizes reading instruction but does not provide direct scaffolding from strategic memory structures. The reading comprehension text structure model focuses on producing hierarchical and strategic memory, especially in identifying essential ideas and encoding memory structures through five text structures (Stocker et al., 2024; Yan & Pan, 2023). The five text structures include comparative analysis, problems, getting solutions, causal analysis, sequencing, explaining, and nested structures. The text structure strategy is a strategy that applies instructions

from the model developed by Meyer (2010). The Student Reading Development institution has recognized this text structure model. Currently, this model is also a concern of the Common Core State. The text structure is presently one of the core aspects of the curriculum and books.

Furthermore, the text structure strategy focuses on the text structure as the basis for strategic memory, depicted in a summary, conclusion, and elaboration of the reading (Muhammadpour & Khalili, 2024; Young-Suk et al., 2024). Understanding the term check structure is not enough to master reading comprehension skills. Still, strategic and metacognitive text structure abilities are needed to understand the reading comprehensively. This has been proven by previous studies showing that mastery of the names and concepts of the five text structures is not enough to be an effective structure strategy.

Students need further instruction to demonstrate strategic text structures, select and analyze text ideas, and create practical and strategic memory (Alqahtani, n.d.; Giazitzidou et al., 2024). Practice and feedback are required so that students can use metacognitive knowledge and text structure cues in expository texts. Instruction in (TuinLec) is designed to teach students how to use text structures strategically to create hierarchical memory and integrate important ideas effectively with previous schemata (Reading & Maghsoudi, 2021; Viersen et al., 2024). The text structure strategy integrates content with strategic instruction. Several previous studies have revealed how expert readers use the memory of texts they have read (Alqahtani, n.d.; Muhammadpour & Khalili, 2024; Stocker et al., 2024). Expert readers can select information from texts to create hierarchically organized strategic memories in a text. Hierarchical structures can be used to understand reading more efficiently through classification and logical correlation between ideas in the text. The text structure model owns most of the reading comprehension component processes (Lee et al., 2021; Maghsoudi et al., 2020). The process is identified by integrating construction and reading comprehension landscape models. All of these models emphasize the role of memory structures. The purpose of the model is to connect text ideas with previously owned schemata (Aro et al., 2024; F. Chen et al., 2021).

2.2 Text Structure Strategy

Text structure strategy is a reading strategy that directs students to focus on instructions for selecting essential ideas in the text based on explicit or implicit correlations in five text structures. Several signal words can guide reading, analyzing text structures, and integrating ideas into memory structures (Alramamneh et al., 2023; Ismail et al., 2023). When students encounter an essential concept, there are two choices: memorizing the idea or using a strategic approach to comparing concepts. The approach used by a reader replaces the concept with a simple interpretation and must be understood. However, strategic readers will use the parallel structure of the text to create a tree memory structure that is broken down and connected to other ideas. This hierarchically organized memory, like a tree, becomes a strong foundation of initial knowledge and is compared with new concepts in the future. The memory structure can also monitor understanding by identifying incomplete information (Hoover, 2024;

Young-Suk et al., 2024). The memory structure tree can also be used as an example for students and to explain the form of a strategic memory structure for novice readers. Instruction focusing on content encourages students to analyze ideas, create questions, and be asked to discuss. The strategy-based approach to the structure facilitates students to discuss as a discussion guide, for example, through queries and instructions (Megard et al., 2024; Özdemir & Tosun, 2024). This process is a characteristic of the structure strategy that can produce strategic memory that can function to develop reading comprehension skills. The difference between readers with a text structure strategy and those without is that the pattern that describes each critical idea in the text is more organized and not random.

2.3 Web-Based Intelligent Tutoring System (TuinLec)

Web-Based Intelligent Tutoring System (TuinLec) was developed to teach students consistent text structure strategies. This web-based tutor is considered capable of overcoming students' varying knowledge backgrounds. In addition, TuinLec can also present high-quality learning models, consistently presenting various practical tasks, evaluations, as scaffolding, and providing powerful feedback according to student needs (Lee et al., 2021; Vidal-Abarca et al., 2014). TuinLec is a development that results from observations of the expert reader process. The interaction model was developed so that students and teachers get an overview of various activities in the guidance process. The scaffolding and feedback process are also designed based on the results of observations of interactions during the reading process (Hoffman et al., 2024; Torr, 2019). The TuinLec system uses good signals, single text structure sections, nested text structures, and actual life sections. This process aims to give students an overview of the expert reader's process in understanding information.

Students are grouped based on their reading ability level. According to their ability level, this is done to adjust to the reading topic, such as science, social studies, sports, and reading assignments. Reading assignments include identifying the reading's main idea or nature/purpose. A teacher will read the reading, demonstrate the selection of essential ideas, create a draft of the main idea, instruct students to participate in answering several questions, and guide students during the learning process (Chen et al., 2019; Kim et al., 2024). Instruction begins by presenting a video first and inviting students to participate in various practical tasks. Based on the student's answers, the teacher will provide scaffolding by adding other instructions through feedback or other reading alternatives. Student responses and logic are coded (F. Chen et al., 2021; Maghsoudi et al., 2020). Furthermore, this response pattern will be updated when new student responses are received on a more extensive research scale.

3. Methodology

3.1 Design and Participants

This study used a quasi-experimental design involving 250 fourth-grade students and 300 fifth-grade elementary school students. The gender percentage of the participants involved was 60% female and 40% male. The experimental group received the web-based intelligent tutoring system (TuinLec) intervention, while the control group received teaching according to the language curriculum at

school. The intervention time used ranged from 30-45 minutes. Participants who participated in this study were confirmed to be compatible with computers and internet devices supporting them. Participants were recruited by filling out a willingness form in advance, so that participants participated in all activities in this study voluntarily. This study also received permission from the participating universities and children's schools. Participating schools are in rural and urban areas with low, middle, and high socioeconomic status. This study also involved 150 fourth and fifth-grade teachers who were participants.

3.2 Instrument

Reading comprehension ability was assessed using a reading comprehension test in the form of a multiple-choice test. Reading comprehension was assessed using a memory and primary idea test designed by the researcher. The reading comprehension ability test adopted the standard reading comprehension test from Wiederholt and Blalock (2000). This test was used in both pretest and posttest phases. The pretest score for reading comprehension ability was used for data analysis as covariates and to investigate the effects of TuinLec on reading comprehension ability. The analysis showed that Cronbach's Alpha on reading comprehension was relatively high, with an alpha value of 0.90. The results of this assessment serve as a guideline for researchers in grouping students with low, middle, or high reading comprehension abilities. Furthermore, researchers designed an instrument to assess students' strategic memory by adopting a test developed by Meyer (2010). This test is conducted to test students' level of understanding through the test structure and presentation of problems, solutions, and comparisons.

Problems and solutions are designed with two texts with the same number of words and idea units. In addition, the values on the aspects of readability, text structure, and use of traditional signs are also equal. The texts created present problems and solutions. This text is about a mouse and a cat. The mouse article is taken from a real newspaper. Students are instructed to write all readings containing problems and solutions that must be stored in an envelope.

Furthermore, the results of the analysis of inter-rater agreement on the series of problem and solution texts are in the percentage range of 88%-97%. Two other texts are presented as comparison texts: a) Pygmy monkeys versus emperor monkeys and (b) Adélie versus emperor penguins. Each comparison text has 130 words, 16 sentences, and 97 units. In addition, there are two comparison structure tasks, namely the problem and solution memory task and the comparative primary idea analysis. In the main idea task, students are asked to write the main idea in two sentences. The results of the analysis of the inter-rater reliability coefficient on the memory task and the comparative main idea showed a percentage of 87%-98%. The results of students' writing with the main idea and free recall tasks were analyzed to strengthen the organized memory structure. The hierarchical text structure was given a top-level structure code of 1-3. Memory structure 1 means a text memory structure without evidence.

Furthermore, memory structure 2 has the characteristics of the main idea, and memory is already loaded by covering problems and solutions, comparisons,

cause and effect, and systematics. Memory structure 3 means a memory structure with a good organization that already contains the main idea and organized memory in the same way as the text structure, such as comparison, problems, solutions, cause and effect, and systematic problem. Examples of the three categories of memory structure are presented in Table 1.

3.3 Procedure

This study began with a pretest at the beginning of the school year to determine students' initial abilities (strategic text memory ability and reading comprehension ability). Reading ability assessment was carried out using Gray Silent Reading (GSRT). Experimental group students received a TuinLec intervention three times a week, with 30–45 minutes each session. At the end of the intervention, it was carried out for six months. Furthermore, the study ended with a posttest after receiving the intervention. The posttest was carried out simultaneously with the end of one school semester.

3.4 Data Analysis

The researcher used several data analyses, including multinomial logistic regression data analysis with Statistical Analysis System, to investigate whether students in the intervention group showed an increase in better-organized memory structure than students in the control group. The analysis was carried out on each memory structure, including problem and solution memory, memory comparison, and main idea analysis comparison. Student gender code (1=female and 0=male), reading level (1=below grade level at pretest, 0=at or above grade level), memory structure code (1=low, 2=middle, 3-high at posttest), and school location code (1=rural, 0=urban) were all controlled in the analysis model. The odds ratio of the TuinLec intervention is used to control conditions to achieve medium and high levels of organized memory structure group. Data analysis was conducted with two- and three-level models to accommodate the multilevel nature of the data. Next, interaction terms between the two groups (1=TuinLec intervention, 0=control) and codes for reading ability level and memory structure at the initial phase. Statistically significant interactions will be used as examples to check the interaction pattern. The memory structure assessment is presented in Table 1.

Table 1: Organized memory structure assessment with hierarchical logic

Logical and hierarchical organized memory structure assessment scale	**Student writing samples: text structure, text topic, and task or activity**
1=No evidence attached: Just wrote a list	The text structure presents problems and solutions (Topic: Rats and Cats) and writes complete memories without looking at the text (aspects of the problem and solution memory structure, and the ability to analyze problems and solutions). a) Humans become friends with rats and mice. Humans use animal urine samples b) Psychiatrists tested allergies on mice, and the person was an allergy expert c) Kania likes the taste and aroma of chocolate beans d) Based on my memory, caramel and chocolate have a relationship or something that makes kittens run or something with a chocolate flavor. The structure of the comparison text (Topic: Penguins and Monkeys) is with the task of writing complete memories of the text without looking. Analysis of the variables of the memory structure, comparing and the ability to compare: a) Penguins weigh approximately 92 pounds and can be up to 5 feet tall b) Penguins grow up to 5 feet tall and weigh 92 pounds. In my opinion, all penguins are all over the world c) When there is a rainforest, there must be monkeys d) Pygmy monkeys can grow up to 6 inches. This monkey has a V-shaped jaw, which is all that can be remembered Comparison of main ideas (penguin or monkey topics) on the variables of the main idea memory structure and the ability to identify main ideas: a) Monkeys can eat bananas. Monkeys can also sometimes eat fleas from other monkeys b) The main idea in the text is that dwarf monkeys[Ed1]
2=Partially organized	Memory of problems and solutions (topic: mice or cats) a) There are people who keep mice and do not give them urine to create allergies. There are scientists who are studying mice b) Cats will be colored if they get cocoa beans. If cats are colored, they will be studied. Cats are walking with black feet in the park. Cats can be poisoned if they eat cocoa beans. Cats should eat other foods that do not contain poison. Comparative memory (Topic: Penguins or Monkeys) a) Adélie penguins and other penguins are different. Their food is krill. Both of these penguins can only grow to 2 feet. They have short beaks and fur, their eyes are like beads

Logical and hierarchical organized memory structure assessment scale	Student writing samples: text structure, text topic, and task or activity
	b) I remember pygmy monkeys are the smallest monkeys in the world. They live in warm rainforests in the South American region. Their food is fruit. That's all I remember. Comparative Main Ideas (Topic: Penguins or Monkeys) a) The emperor penguin is larger than the others b) The emperor penguin is different from the Adélie penguin. Both have strange characteristics c) The type of dwarf monkey is different from the emperor monkey
3= Evidence of well-organized memory structures	Problem and solution recall (rat or cat topic) a) Doctors often get allergic to cocoa shells when handling rats and mice. This is dangerous because they spend 1-2 weeks. Doctors advise being more careful. b) These rats and mice can make doctors sick. This doctor is allergic to rats and mice. This is caused by the protein in the animals. Doctors hold a meeting to discuss the problem to solve it c) Dogs that like the taste and smell of cocoa bean shells will have digestive problems. This is dangerous because the food is poisonous. Comparison recall (penguin or monkey topic) a) The text discusses two different types of penguins. The emperor penguin weighs about 92 pounds and is 5 feet tall. The Adélie penguin has a smaller body size and can grow up to 2 feet. These penguins can weigh up to 11 pounds. b) The pygmy monkey type has differences from the emperor monkey. The difference is in the jaw, with a V shape, while the emperor is U-shaped. Both live in the rainforests of South America Comparison of main ideas (penguins or monkeys) a) The comparison of emperor and Adélie penguins is the color and body parts that have differences b) The main idea of the text is the difference between the types of emperor and Adélie penguins. The differences lie in their height, weight, and habitat c) Emperor monkeys have larger bodies than pygmy monkeys. Pygmy monkeys do not like to be slaves like emperor monkeys

3.5 Missing Data

There was missing data before the analysis was carried out, but the amount did not matter because the size was tiny. Missing data in the fourth grade was around 0.4%, while missing data in the fifth grade was 0.3%. Based on the results of the missing data test, the Little test revealed that the fourth grade showed a value of

X2 = 38.642, df = 25, p =.053, and the value in the fifth grade showed a value of X2 = 49.675, df = 27, p =.004. Students not taking the initial reading test tended to show low memory structure values. Based on the missing data, the percentage of missing data was less than 5% with a relatively large sample; the data was not included in the analysis model to optimize sample analysis on each variable. The researcher used data on the initial reading ability level and organized memory structure as covariates in the analysis model used to minimize biased data.

4. Results

The results of the descriptive statistical analysis in the fourth grade are presented in Table 2, and the descriptive statistical analysis in the fifth grade is presented in Table 3. The analysis was carried out on all variables. The variables analyzed included the memorization structure of problem and solution texts, the ability to analyze problem and solution texts, the memory structure of comparative texts, the ability to analyze comparative texts, the memory structure of main ideas, and the ability to identify main ideas. TuinLec had a statistically significant impact on the posttest phase except for the memory structure of problems and solutions in both classes, which was influenced by the gender of the students, the initial reading level, and the level of the initial memory structure. Thus, students who received the intervention (TuinLec) showed better strategic memory improvements than students in the control group by controlling for covariates. The logical estimates in the TuinLec group and the odds ratios of the primary effect model are presented in Table 4. Based on these data, the strategic memory abilities of students in the intervention group have a better chance of being at the high and intermediate levels of organized memory structure than the control group at the following levels. Comparison of fourth-grade competencies in each aspect assessed, namely (odds ratio = 1.4 at high level with medium; 1/.763 = 1.4 at medium level with low), strategic memory of main ideas has an odds ratio = 2.3 at high level with medium; 1/.521 = 1.10 at medium level with low), and the ability to identify main ideas ((odds ratio = 2.2 at high level with medium; 1/.512 = 2.2 for medium vs. low); and in the ability to analyze main ideas of fifth grade (odds ratio = 2.3 at high level with medium; 1/.57 = 1.9 at medium level with low).

Table 2: Fourth-grade memory structure skills in both groups

Posttest levels	**Pretest low**		**Pretest middle**		**Pretest high**	
Memory structure problems and solutions						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	80.02	88.70	60.12	77.21	54.91	62.24
Middle level	7.06	5.71	6.72	4.82	9.64	9.92
High level	16.90	7.70	35.31	20.45	38.72	31.45
Ability to analyze problems and solutions						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	50.82	57.31	34	32.62	25.52	28.82
Middle level	36.02	38.21	42.6	38.83	38.61	52.61

Posttest levels	**Pretest low**		**Pretest middle**		**Pretest high**	
High level	16.31	7.45	31.6	31.50	38.83	22.71
Memory structure comparison						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	32.42	44.41	16.72	22.71	9.82	11.72
Middle level	29.31	27.50	22.73	29.78	22.41	23.61
High level	42.42	31.21	63.46	50.61	70.84	67.81
Ability to compare						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	51.20	62.51	29.07	28.91	23.81	27.61
Middle level	18.43	15.72	24.51	27.31	21.10	18.60
High level	33.51	24.89	49.48	46.89	58.15	56.87
Main idea memory structure						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	36.31	56.89	23.08	40.89	16.85	32.20
Middle level	42.40	33.03	58.23	52.61	54.07	58.12
High level	24.41	13.08	21.83	9.45	32.13	13.82
Ability to identify main ideas						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	43.50	67.2	26.72	44.41	23.60	40.56
Middle level	38.89	26.06	51.26	48.10	50.61	51
High level	20.62	9.78	25.13	9.61	28.76	11.40

Table 3: Fifth-grade memory structure skills in both groups

Posttest levels	**Pretest low**		**Pretest middle**		**Pretest high**	
Memory structure problems and solutions						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	71.82	78.82	56.40	67.17	42.72	52.05
Middle level	8.73	6.60	6.82	7.31	6.42	5.78
High level	22.61	17.82	39.89	27.73	55.02	44.20
Ability to analyze problems and solutions						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	42.20	46.50	22.91	26.13	18.20	21.87
Middle level	38.91	38.42	39.89	45.78	32.27	37.82
High level	22.97	18.15	40.31	31.06	52.61	43.41
Memory structure comparison						
	TuinLec	Control	TuinLec	Control	TuinLec	Control

Posttest levels	**Pretest low**		**Pretest middle**		**Pretest high**	
	(n=150)	(n=150)	(n=150)	(n=150)	(n=150)	(n=150)
Low level	27.41	33.52	11.70	16.34	5.91	9.36
Middle level	18.82	27.81	20.58	33.21	12.80	14.89
High level	56.91	42.85	70.31	53.50	84.40	78.81
Ability to compare						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	39.85	52.72	19.89	24.78	13.80	18.41
Middle level	19.41	17.34	25.41	24.89	17.89	19.29
High level	43.80	32.89	57.74	53.25	71.31	65.39
Main idea memory structure						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	34.41	45.50	15.60	27.75	11.89	23.51
Middle level	46.45	42.78	60.44	59.15	54.42	66.29
High level	22.15	14.70	26.89	16.13	36.81	13.28
Ability to identify main ideas						
	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)	TuinLec (n=150)	Control (n=150)
Low level	36.31	53.41	21	36.1	14.72	30.09
Middle level	46.72	37.31	54.78	52	51.80	61.81
High level	19.78	12.35	27.19	14.6	36.7	11.14

The intervention group showed opportunities at the high and medium levels of organized memory structure compared to the control group. However, the opportunities at the medium and low levels were not different from the control group. The differences were seen in several measurements as follows. The ability to analyze problems and solutions in fourth grade showed an opportunity ratio value = 1.8 at the high and medium levels; the ability to analyze the issues and solutions showed an opportunity ratio value = 1.6 at the high and medium levels. In addition, the comparison of memory structures showed an opportunity ratio value = 1.9 at the high and medium levels. However, the opportunities at the medium and low levels of organized memory structures were more significant and higher in the intervention group compared to the control group. Several opportunities at the high and medium levels did not show significant differences, especially in the fourth-grade comparison competency, with an opportunity ratio value = 1 /.772 or 1.4 at the medium and low levels. In addition, the comparison competency in fifth grade showed an opportunity ratio value = 1 /.732 or 1.5 at the medium and low levels and the ability of the main idea memory structure with an opportunity ratio value = 1 /.64 or 1.7 at the medium and low levels.

Table 4: Results of the multinomial logistic regression effect estimation analysis in the intervention group

	Logit estimate (SE)		**Odds ratio [95% CI]**	
Outcomes	Low vs. Middle	High vs. Middle	Low vs. Middle	High vs. Middle
Grade 4				
Memory structure of problems and solutions	_0.35 (0.20)	0.23 (0.22)	0.821 [0.572, 1.043]	1.352 [0.831, 1.973]
Ability to analyze problems and solutions	_0.04 (0.12)	0.55** (0.15)	0.981 [0.889, 1.302]	1.734 [1.420, 2.341]
Memory structure of comparing	_0.31* (0.15)	0.25* (0.13)	0.763 [0.682, 0.976]	1.281 [1.021, 1.567]
Ability to compare	_0.28* (0.14)	0.09 (0.14)	0.872 [0.689, 0.989]	1.089 [0.840, 1.510]
Memory structure of main ideas	_0.68** (0.12)	0.73** (0.15)	0.621 [0.524, 0.752]	3.052 [1.663, 2.782]
Ability to identify main ideas	_0.74** (0.12)	0.71** 0.16)	0.572 [0.482, 0.683]	3.012 [1.534, 2.701]
Grade 5				
Memory structure of problems and solutions	_0.18 (0.22)	0.35 (0.21)	0.951 [0.682, 1.352]	1.510 [0.952, 2.125]
Ability to analyze problems and solutions	_0.08 (0.12)	0.39** (0.12)	0.942 [0.762, 1.271]	1.561 [1.173, 1.832]
Memory structure of comparing	_0.02 (0.18)	0.61** (0.13)	0.985 [0.720, 1.481]	1.770 [1.491, 2.251]
Ability to compare	_0.42* (0.15)	0.21 (0.13)	0.741 [0.564, 0.957]	1.215 [0.852, 1.632]
Memory structure of main ideas	_0.47** (0.13)	0.91 (0.13)	0.642 [0.489, 0.784]	2.541 [1.925, 3.086]
Ability to identify main ideas	_0.72** (0.12)	0.82** (0.14)	0.562 [0.451, 0.692]	2.351 [1.842, 2.892]

Based on the explanation, the TuinLec intervention significantly improved the organized memory structure of grades four and five in every aspect assessed, except for memory structure and solutions. Students with demographic backgrounds, reading skills, and memory structures that were equivalent in the TuinLec intervention group tended to show higher improvements in organized memory structures than in the control group. Another finding was a significant interaction between the experimental group and early organized memory structures on the competence of main idea memory structures and the ability to analyze main ideas in the posttest phase. A significant interaction pattern was also found between the pretest conditions and memory structures that were at a high level. This interaction showed that students who received the TuinLec intervention showed a more significant increase in organized memory structures compared to the control group. So, TuinLec was also able to promote students' hierarchical memory structures and improve reading comprehension skills. Improvements in students' memory structures and reading comprehension skills

were found at all levels of students' early reading. These results indicate that the TuinLec intervention consistently improved reading comprehension and memory structures regardless of all levels of reading literacy in the pretest phase.

Table 5: Improvement in organized memory structures in the pretest and posttest phases

Pretest Condition	Posttest Condition
1=No evidence attached: Just wrote a list Cocoa beans can cure dogs	3= Well-organized Memory Structure Psychologists who often work and study rats or mice will be more susceptible to disease. Doctors advise to be kind to rats and mice. People who speak and behave kindly to rats are less susceptible to disease.
1=No evidence attached: Just wrote a list I only remember the psychologist. Lots of cocoa, death atmosphere, and canines	3=Evidence of Well-Organized Memory Structure Many doctors are allergic because they do experiments on mice. Dr. Andri said that mice will not pee on you.
1=No Evidence Attached: Just Write a List The pygmy monkey is the smallest type of monkey, eats tree sap, and has V-shaped teeth that function to bite hard	3=Evidence of Well-Organized Memory Structure Emperor penguins are tall, can reach 4 feet tall and weigh up to 90 pounds. Adélie penguins are small, 2 feet tall and 11 pounds.
2=Partially organized indication There are two types of monkeys that have some differences	3=Evidence of Well-Organized Memory Structure Emperor and Adélie penguins have differences. In my opinion, emperor penguins are tall and eat fish. They live in the Antarctic ice sheet. Unlike emperor penguins, Adélie penguins are small in size and eat krill and live in the Antarctic ice sheet.

5. Discussion

The study's results indicate that reading comprehension skills are primarily determined by the ability to find, select, and encode text strategy memory. TuinLec, in this study, was developed to demonstrate, present various activities, assess, and provide organized feedback to improve text structure strategy skills so that students can improve text strategy memory and reading comprehension skills. Previous studies have revealed that students' mental processes greatly influence students' reading comprehension skills in reconstructing the knowledge information obtained and integrating it with existing schemas through strategic memory skills (Mekuria et al., 2024; Vidal-Abarca et al., 2014). Through this study, researchers prove that students who use text structure strategies can select and encode important ideas and integrate them with their memory. The chances of

students who receive the TuinLec intervention to achieve high-level strategic memory are more significant than students who do not receive intervention. This indicates that TuinLec's integrated text structure can explore the ability to identify correlations of essential ideas and incorporate them with previously owned schemas (Cheung et al., 2024; Li et al., 2024).

The integration of technology in language learning is currently experiencing very rapid development. The integration of TuinLec technology must be adjusted to the theoretical basis and learning objectives (Dong et al., 2022; Hebbecker et al., 2019). Integrating TuinLec into the text structure strategy helps teachers teach students to find and incorporate essential information components in the text and combine them. This process facilitates students' getting comprehensive information from reading activities. This finding aligns with previous studies that revealed that reading comprehension skills can be improved by optimizing the ability to analyze essential ideas in text structures (Kanonire et al., 2020; Stocker et al., 2024). The results of this study also support the idea that this web-based intelligent guidance system (TuinLec) can rearrange mental functions to create strategy memory during reading activities. Furthermore, TuinLec can help elementary school students understand expository texts with more complex structures and ideas with text structure strategies (Muhammadpour & Khalili, 2024; Yan & Pan, 2023). So, this study is expected to be able to expand further studies using computer scaffolding and other reading strategies.

Based on the findings of this study, the TuinLec intervention was also able to improve students' reading strategies so that they were able to get better reading comprehension. Improving reading comprehension skills and text strategy memory includes problem and solution text memory structure, problem and solution text analysis ability, comparative text memory structure, comparative text analysis ability, main idea memory structure, and the ability to identify main ideas. This finding is in line with previous studies that revealed that good reading strategies are strongly correlated with a more comprehensive level of reading comprehension (Gok et al., 2023; Kiss et al., 2024; Muhammadpour & Khalili, 2024). Several other studies have also proven that reading comprehension strategies are strongly associated with understanding text structure (F. Chen et al., 2021; Hoffman et al., 2024). This study also uses text structure as a discourse marker in reading strategy training in TuinLec with a larger sample size.

Memory structure is an essential element in intervention strategies to improve reading skills. However, most reading approaches separate this text structure as a separate activity in reading comprehension. Learning this text structure is often divided by teachers and becomes a separate learning topic (Almadhi & Alanazi, 2024; Kortecamp & Peters, 2024). Through this study, TuinLec, which is integrated into the text structure strategy, becomes a very effective intervention in facilitating elementary school students' understanding of more complex texts. For example, one of the text structure strategies analyzes the essential components of the main idea and other important ideas and summarizes the text based on the text structure. This study illustrates that using text structure strategies can improve reading comprehension skills (Alqahtani, n.d.; Maghsoudi et al., 2020). In

addition, this study also adds evidence that a web-based intelligent tutoring system (TuinLec), if appropriately designed and modified to provide instructions as needed, can significantly impact students' reading comprehension skills. In addition, TuinLec can also be used in other fields of study to improve other language skills, such as writing and speaking skills.

6. Conclusion, Implication, and Recommendation

Based on the study's results, integrating a web-based intelligent tutoring system (TuinLec) into the text structure strategy has improved text strategy memory and reading comprehension skills. Text strategy memory is an essential element in the level of students' reading comprehension, so the function of this element must be optimized through the right strategy. Improvement in reading comprehension and text strategy memory skills is seen in several competencies, namely problem and solution memory structure, problem and solution analysis ability, comparison memory structure, comparison analysis ability, main idea memory structure, and central idea identification ability. Text structure strategy integrates content and strategy through pragmatic, transparent, and structured instructions. This web-based intelligent guidance system, or TuinLec, is designed and packaged as consistent and quality instructions to train several reading strategies, such as identifying main ideas, coding strategic memory structures, concluding, and monitoring student understanding. So, the integration of TuinLec integration in this text structure strategy can optimize and rearrange mental functions to create strategic memory during reading activities.

The implication of this study is that text structure can be used as an alternative strategy for understanding text comprehensively. Most text structure learning becomes separate learning and is only used to recognize text types. Through this study, text structure can be a strategy to help students gain a comprehensive understanding. This study has several limitations, including the sample that only focuses on fourth and fifth-grade elementary school students, focusing on quantitative data analysis, focusing on text strategy memory and reading comprehension skills, concentrating on expository text types, and using memory as a proxy. Based on these limitations, this study recommends several aspects for further research, including trying to involve higher-level participants; data analysis needs to be complemented with qualitative analysis; the variables studied can be added; investigating several types of texts, and higher cognitive levels must be involved. Researchers also recommend several things in the educational aspect, including the need to adopt technology in language learning, integrating teaching text structure into text-based language teaching, and using web-based teaching as an alternative to avoid boredom in the learning process.

7. References

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