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Examining the Efficacy of SSCS and Think-Talk-Write Intervention on High School Students' Problem-Solving and Learning Achievement in Probability

Thipsuda Khonwai
Faculty of Education, Mahasarakham University, Thailand

Kanyarat Cojorn (Corresponding Author)
Faculty of Education, Mahasarakham University, Thailand
Email: Kanyarat.c@msu.ac.th

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Abstract

Mathematical problem-solving is a core competency in mathematics education, serving not only as a means of mastering content but also as a foundation for logical reasoning, decision-making, and lifelong learning. Accordingly, this study aimed to: 1) examine students' levels of problem-solving ability, 2) compare their problem-solving ability after receiving instruction through the SSCS learning model combined with the Think–Talk–Write technique to a 70% criterion, and 3) compare their learning achievement after receiving the same instructional approach to a 70% criterion. The sample comprised 38 of Grade 11 students which selected through cluster sampling. The results indicated that: 1) a majority of students (68.42%) demonstrated a high level of problem-solving ability; 2) students who received the SSCS learning model with the Think–Talk–Write technique demonstrated significantly higher problem-solving ability, with a mean score of 47.87, exceeding the 70% criterion at the .05 level of statistical significance; and 3) students' learning achievement under this instructional model also significantly surpassed the criterion, with a mean score of 15.32 at the .05 significance level. These findings highlight the effectiveness of integrating structured problem-solving models with collaborative writing strategies to enhance both mathematical proficiency and overall learning outcomes, offering practical implications for improving mathematics education at the secondary level.

Keywords: SSCS Learning Model, Think-Talk-Write Technique, Mathematical Problem-Solving Ability

1. Introduction

Mathematics is crucial to 21st-century learning because it fosters critical and systematic thinking, problem analysis, and decision-making—skills that apply directly to real-life and professional contexts. Furthermore, mathematics is an essential tool for studying science, technology, and other subjects. It is a critical basis for building a high-quality national workforce and propelling the country's economy to global competitiveness. As a result, mathematics education must be constantly updated to keep up with the fast-changing economy, society, science, and technology of the globalization period (Ministry of Education Thailand, 2017). Mathematics is an important topic for improving people's quality of life since it teaches essential reasoning and creative thinking abilities that are needed in everyday life and for training pupils to be responsible members of society. It encourages students to improve themselves, master problem-solving techniques, and make informed career choices based on their aptitudes, interests, and abilities. The use of mathematical knowledge in problem solving is essential in many professions, including business, science, architecture, engineering, meteorology, medicine, and economics. Therefore, school mathematics curricula should emphasize innovative learning experiences that extend beyond traditional classroom approaches, providing students with opportunities to engage in novel and meaningful mathematical activities. Additionally, math professors' roles need to change. With the advent of calculators, students no longer have to complete complex calculations manually. They still need to be able to think critically and solve problems, though (Institute for the Promotion of Teaching Science and Technology, 2013).

Although mathematics is essential for daily life and future careers, persistent deficiencies in students' mathematical performance are evident across international, national, and school-level assessments. Results from TIMSS and PISA indicate that most students perform poorly in mathematics, with scores declining as cognitive demands increase (Al-Mutawa et al., 2021; Bernardo et al., 2022). Similarly, Grade 12 students in northeastern Thailand consistently achieve average O-NET scores far below the national benchmark—19.11 in 2021, 19.86 in 2022, and 19.77 in 2023 out of 100 (NIETS, 2021, 2022, 2023)—revealing weaknesses in comprehension, procedural competence, and mathematical reasoning. Internal data from one secondary school confirm that Grade 11 students continue to underperform, while the school's 2023 self-assessment highlights deficits in analytical thinking, critical reasoning, communication, and problem-solving (School Assessment Report, 2023). Interviews with mathematics teachers further reveal that many students cannot analyze problems, identify core issues, plan solutions, or connect concepts systematically, suggesting fundamental gaps in conceptual understanding and the integration of mathematical ideas.

As aforementioned problems, it is essential to develop students' mathematical knowledge and problem-solving skills. Strengthening these areas will enable students to approach mathematical situations with effective thinking strategies. As a result, students will be able to think critically, act effectively, solve problems independently, and interact harmoniously with others. Learning emphasizes the development of thinking processes helps students better understand problems and identify their root causes (Sirarojanayotin & Areerat, 2016). Problem-solving is important to mathematics and serves as the goal of curriculum and instruction. It is regarded as a fundamental foundational skill (Polya, 1980). It is a fundamental talent that is consistent with the Basic Education Core Curriculum B.E. 2551 of Thailand (Ministry of Education, 2017), which recognizes problem-solving as the most significant and necessary mathematical process skill. Mathematical problem-solving helps pupils develop their analytical skills, promotes learning, and nurtures creativity. Furthermore, it enables pupils to gain mathematical knowledge, abilities, concepts, and principles. Successful problem-solving results in the development of desirable characteristics in learners. As a result, mathematical problem-solving abilities are an important aspect of mathematics education. Based on this perspective, the researcher is interested in enhancing instructional approaches to assist students in learning and problem-solving through critical thinking, analysis, and reasoning. This strategy encourages systematic learning, which improves student efficiency and learning outcomes.

The development of students' mathematical problem-solving abilities is a crucial goal of instructional practice, as these skills not only form the foundation for learning mathematics but also serve as essential life skills for analytical thinking and rational decision-making. One instructional model specifically designed to foster such skills is the SSCS model (Search, Solve, Create, Share), developed by Pizzini et al. (1989). This learning process emphasizes students' independent discovery of solutions by engaging with problem situations, with teachers acting as designers of problems and facilitators. Students take the central role in carrying out a four-step process: Search—gathering information and identifying key issues; Solve—planning and executing solutions; Create—summarizing and clearly explaining solution methods; and Share—presenting and discussing the solutions collaboratively in class. Instruction based on the SSCS model, therefore, helps students to acquire systematic and rationality thinking skills and confidence in making decisions. However, Jainan and Art-in (2019) indicates that, in practice, students still face significant challenges. During the Solve step, most students cannot think of various solutions strategies, fail to trust their capabilities of choosing the right methods, and do not give clear reasons as to why they choose a particular method. During the Create step, students also commonly experience the problem of explaining and communicating mathematical concepts in a system and in a clear way. To counteract these constraints, collaborative learning is yet another possible strategy to integrate. Collaborative learning gives students a chance to share problem solving strategies, consider thoughts and learn to appreciate the views of others hence developing confidence and enhancing problem solving skills (Angkanaphattrakhon, 2012). One technique that aligns well with this purpose is Think-Talk-Write (Huinker & Laughlin, 1996), which consists of three sequential steps: Think-students think about the problem and possible solution strategies individually; Talk-students think about the problem and share ideas in small groups to elaborate and refine their knowledge; and Write-students syntactically summarize solutions based on the experience of group discussion. This method would be consistent with the Share phase of SSCS model and has a high possibility of promoting mathematical reasoning and communication ability of students.

From the related literature, several studies have examined the use of the SSCS model and the Think-Talk-Write (TTW) technique separately, each demonstrating effectiveness in developing certain aspects of mathematical thinking and communication (Huinker & Laughlin, 1996; Jainan & Art-in, 2019; Pizzini et al., 1989). However, a significant gap remains: there is a lack of empirical research on systematically integrating the two approaches to address the specific weaknesses of each. In particular, it is still unclear how incorporating TTW into the Solve and Create steps of the SSCS model might enhance students' reasoning ability, communication of mathematical ideas, and confidence in selecting problem-solving strategies based on evidence. Therefore, this study aims to bridge this gap by developing and examining an integrated instructional approach that combines the TTW technique with the SSCS model. particular, it is still unclear how incorporating structured TTW activities into the Solve and Create steps of the SSCS model might synergistically enhance students' reasoning ability, their communication of mathematical ideas, and their confidence in selecting and justifying problem-solving strategies based on evidence. Consequently, this research will specifically investigate how this integration can be designed to overcome existing limitations and more effectively enhance students' comprehensive problem-solving abilities.

2. Methodology

2.1. Population and sample group

The population for this study consisted of 198 Grade 11 students enrolled in the Science–Mathematics curriculum across five classrooms at a secondary school in Mahasarakham, Thailand. Students in each classroom demonstrated comparable academic levels and were organized into mixed-ability groups to promote balanced learning opportunities. For the sample, cluster random sampling was employed: first, all five classrooms were treated as clusters, and then one classroom was randomly selected as the study cluster. All 38 students in the selected classroom participated in the study, ensuring that the sample was manageable while still representative of the overall population, given the similar academic characteristics across classrooms. This approach allowed for a relatively unbiased subset while maintaining feasibility for classroom-based interventions.

2.2. Research Instruments

The 10 lesson plans on probability using SSCS learning with the Think-Talk-Write technique, consisting of four steps are as following:

Step 1 Search (S): searching for information about the problem and distinguishing the issues of the problem, what the problem requires, and finding out what the problem provides.

Step 2 Solve(S): planning and solving problems in various ways, using the Think-Talk-Write technique in the Think step, analyzing the problem and considering possible solutions by yourself, including planning to properly solve the problem, and the Talk step, exchanging opinions about the problem with friends.

Step 3 Create(C): taking the results from the problem-solving process in Step 2 and organizing them into steps, using the Think-Talk-Write technique in the Write step to make it easy to explain and check the answers.

Step 4 Share(S): exchanging opinions on problem-solving methods and checking your own and others' answers.

In addition, five experts reviewed the instructional plans' appropriateness. The results revealed that the appropriateness scores ranged from 4.48 to 4.52, with a standard deviation of 0.29, indicating that the lesson plans were useable.

A mathematical problem-solving test on probability, consisting of five problems, was employed in this study. The index of item–objective congruence (IOC) ranged from 0.60 to 1.00, indicating that the test was suitable for use. The difficulty indices ranged from 0.44 to 0.72, while the discrimination indices ranged from 0.36 to 0.53, with an overall reliability coefficient of 0.87. This subjective assessment was designed based on Polya (1973) four-phase problem-solving process, which includes:

1. Understanding the problem: analyzing the problem to determine how it operates and what it requires.
2. Devising a plan: using the facts identified in Step 1 to develop a strategy, making connections between given information and relevant conditions by applying theories, principles, formulas, and definitions.
3. Carrying out the plan: executing the chosen strategy or procedure until a solution is obtained.
4. Looking back: reviewing the completed solution to assess its accuracy, appropriateness, and reasonableness.

After students completed the test, their responses were evaluated using the scoring rubric presented in Table 1.

Table 1. Mathematical Problem-Solving Ability Scoring Criteria

Evaluation list	Criteria for consideration	Score
Understanding the problem	Identify what the problem defines and what the solution requires correctly.	3
	Identify what the problem can supply or what method is employed to address the incomplete problem.	2
	Identify what the problem specified or what method was employed to address it wrong.	1
	There is no hint of what the problem presents or what the solution entails.	0
Devising a plan	Completely designed and executed correctly within the given parameters.	3
	The strategy is conditionally accurate, which may result in the correct response, but the order of the resolution steps is uncertain.	2
	The plan is wrong.	1
	Nothing was planned or shown.	0
	Show the proper solution.	3

Evaluation list	Criteria for consideration	Score
Carrying out the plan	Demonstrates how to tackle the problem appropriately. There are flaws or malfunctions in the calculations.	2
	It shows how to solve the problem somewhat correctly but cannot be done until it is completed.	1
	Does not demonstrate how to address the problem.	0
Looking back	Check the accuracy and appropriateness of the correct response.	3
	Confirm the accuracy. There is a little inaccuracy, which may summarize the meaning of the incorrect answer.	2
	Check the correctness of the wrong response.	1
	No response was verified.	0

An achievement test was employed, consisting of 20 multiple-choice probability questions, each with four answer options. The Index of Item–Objective Congruence (IOC) ranged from 0.60 to 1.00, confirming the test's suitability for use. The difficulty indices ranged from 0.29 to 0.65, the discrimination indices from 0.24 to 0.59, and the overall reliability coefficient was 0.92.

2.3. Data Collection Procedures

This study was conducted with approval from the relevant institutional review boards, and formal permission was obtained from the school. Informed consent was obtained from administrators, teachers, students, and their guardians prior to data collection, ensuring that all participants were fully informed of their rights, including voluntary participation and the confidentiality of their responses. The intervention employed the SSCS learning model combined with the Think–Talk–Write technique, focusing on the topic of probability. After completing the final lesson, students were asked to complete a mathematical problem-solving test and the achievement test. All data were anonymized, securely stored, and analyzed using appropriate statistical procedures, including a one-sample t-test, to evaluate the research hypotheses, ensuring both data integrity and participant confidentiality throughout the process.

2.4. Data analysis.

Examining the students' problem-solving ability, their scores were first calculated as percentages and then categorized into levels of problem-solving ability using the criteria proposed by Muhassanah and Winarni (2023), as shown in Table 2.

Table 2. Categories of Mathematical Problem-Solving Ability

Categories	Achievement Percentage
$75 < P \leq 100$	High
$60 < P \leq 75$	Moderate
$0 < P \leq 60$	Low

Moreover, one-sample t-tests were conducted to evaluate the effectiveness of the SSCS learning model combined with the Think–Talk–Write technique. Specifically, the tests examined whether Grade 11 students' problem-solving abilities and academic achievement met the 70% criterion following instruction.

3. Results

The analysis of students' problem-solving ability revealed that most students performed at a high level, as presented in Table 3.

Table 3. The Students' Problem-Solving Ability

No.	Score	Percentage	Level	No.	Score	Percentage	Level
1	46	76.67	High	20	52	86.67	High
2	41	68.33	Moderate	21	44	73.33	Moderate
3	43	71.67	Moderate	22	55	91.67	High
4	44	73.33	Moderate	23	43	71.67	Moderate
5	41	68.33	Moderate	24	51	85.00	High
6	41	68.33	Moderate	25	51	85.00	High
7	53	88.33	High	26	54	90.00	High
8	47	78.33	High	27	45	75.00	Moderate
9	57	95.00	High	28	32	53.33	Low
10	55	91.67	High	29	46	76.67	High
11	55	91.67	High	30	56	93.33	High

No.	Score	Percentage	Level	No.	Score	Percentage	Level
12	51	85.00	High	31	48	80.00	High
13	44	73.33	Moderate	32	58	96.67	High
14	37	61.67	Moderate	33	47	78.33	High
15	46	76.67	High	34	54	90.00	High
16	44	73.33	Moderate	35	47	78.33	High
17	53	88.33	High	36	46	76.67	High
18	49	81.67	High	37	46	76.67	High
19	50	83.33	High	38	47	78.33	High
students at a high level = 26 (68.42%)							
students at a moderate level = 11 (28.95%)							
students at a low level = 1 (2.63%)							

Table 3 revealed that many pupils showed strong problem-solving abilities. There were 26 (68.42%) students at a high level, 11(28.95%) at a moderate level, and only 1 (2.63%) at a low level. This suggests that most pupils performed at a comparatively high level on problem-solving ability.

In addition, to examine the average scores for each phase of Polya's problem-solving process, the details are presented in Table 4, which classifies the process according to students' mathematical problem-solving abilities.

Table 4. Polya's Problem-Solving Process Categories for Problem-Solving Ability

Mathematical Problem-Solving Ability	$\bar{x}$	Percentage	Level
Understanding the problem	14.11	94.04	High
Devising a plan	11.21	74.74	Moderate
Carrying out the plan	11.37	75.79	Moderate
Looking back	11.18	75.56	Moderate

Table 4 revealed that, using Polya's process, students' problem-solving skills had the greatest average in understanding the problem, with 94.04%, which is regarded as high. This shows that pupils have a strong ability to analyze, comprehend, and interpret the problem's conditions. However, the remaining three components, namely devising a plan with an average of 74.74%, carrying out the plan with an average of 75.79%, and looking back with an average of 75.56%, were all moderate. This suggests that, while students grasp the subject well, they still have limitations in planning, implementing problem-solving strategies, and reviewing the accuracy of their replies.

The results of the analysis of Grade 11 students' problem-solving ability, following instruction using the SSCS learning model combined with the Think–Talk–Write technique and compared with the 70% criterion, are presented in Table 5.

Table 5. Comparison of Students' Problem-Solving Scores Against the 70% Benchmark

Mathematical Problem-Solving Ability	n	full score	Criterion (70%)	S.D.	$\bar{x}$	t	p
Understanding the problem	38	15	10.5	1.18	14.11	18.82	.000*
Devising a plan	38	15	10.5	1.76	11.21	2.49	.008*
Carrying out the plan	38	15	10.5	2.43	11.37	2.20	.001*
Looking back	38	15	10.5	2.23	11.18	1.89	.033*
Total Score	38	60	42	5.77	47.87	6.27	.000*

* $p < 0.05$

Table 5 shows that students who received instruction using the SSCS learning model combined with the Think–Talk–Write technique were able to solve mathematical problems effectively. The problem-solving ability scores were analyzed across four phases: Understanding the Problem (M = 14.11, SD = 1.18), Devising a Plan (M = 11.21, SD = 1.76), Carrying Out the Plan (M = 11.37, SD = 2.43), and Looking Back (M = 11.18, SD = 2.23). The total score averaged M = 47.87 (SD = 5.77). A one-sample t-test indicated that students' problem-solving ability was significantly higher than the 70% criterion, t = 18.82, $p < .05$, suggesting that Grade 11 students effectively developed problem-solving skills at the .05 significance level.

Analysis of the mathematical problem-solving test indicated that while most students could understand the problems well, they encountered difficulties in planning, executing, and especially reviewing their solutions. Many students lacked understanding of proper procedures for evaluating their results, as illustrated in Figure 1.

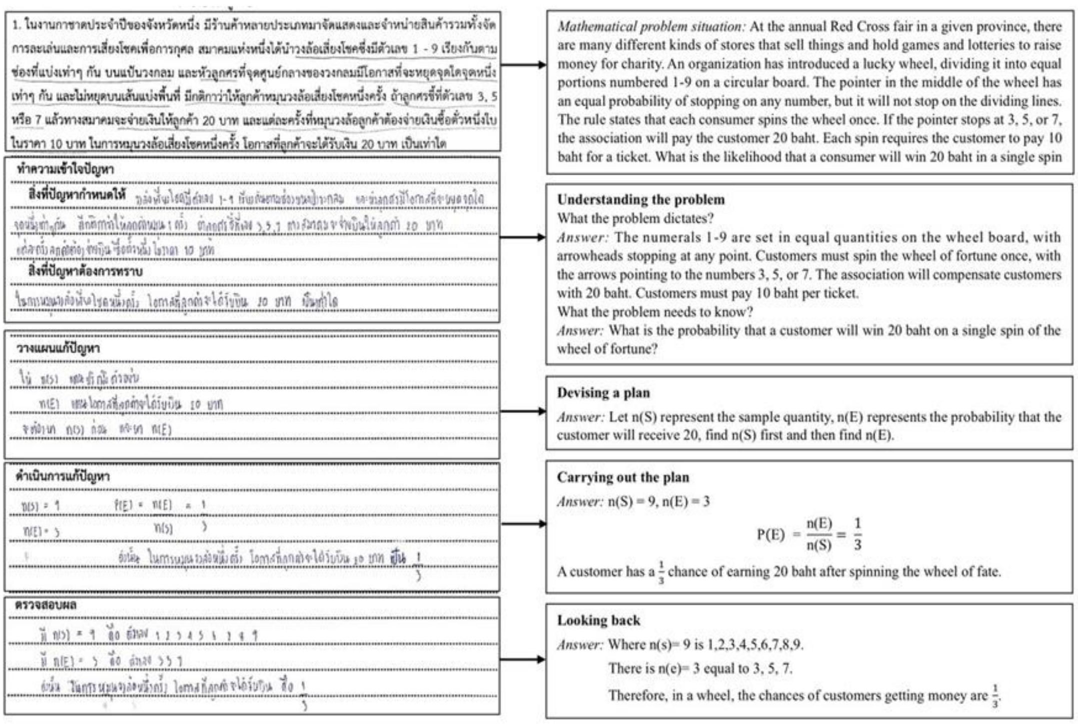

Figure 1. Examples of Students' Answers

According to Figure 1, the study of students' answers regarding their problem-solving abilities revealed that the students were able to accurately analyze the problem situation, identify the provided information, and explain what the problem required. This made it possible for them to choose the right mathematical formula to solve the problem. However, during the devising of a plan phase, a minor inaccuracy was discovered: the students did not clearly state which approach would be employed to achieve the solution. During the carrying out the plan phase, students demonstrated the ability to substitute values and compute correctly using mathematical principles. Nonetheless, their explanation of the calculating procedures was disorganized, and they were unable to completely explain the logical thinking that underpinned their conclusion. For example, if n(E) = 3, then there are 3, 5, and 7 occurrences that result in money. In the looking-back phase, even the student can verify the answer but still lacks an explanation of the result for a reasonable reason.

The analysis of Grade 11 students' learning achievement following instruction using the SSCS learning model combined with the Think–Talk–Write technique, compared to the 70% criterion, is presented in Table 6.

Table 6. Comparison of Students' Learning Achievement Scores with the 70% Criterion

variable	n	full marks	Criterion (70%)	S.D.	$\bar{x}$	t	p
Academic Achievement	38	20	14	2.63	15.32	3.08	.002*

* $p < 0.05$

Table 6 shows that the mean learning achievement score on probability was 15.32, with a standard deviation of 2.63. A one-sample t-test indicated a p-value less than .05, demonstrating that Grade 11 students who received instruction using the SSCS learning model combined with the Think–Talk–Write technique achieved significantly higher academic scores than the 70% criterion at the .05 significance level.

4. Discussion

The survey of students' problem-solving ability revealed that the majority of students (68.42%) demonstrated a high level of competence, 28.95% were at a moderate level, and only one (2.63%) student was at a low level. These results indicate that the SSCS learning model combined with the Think–Talk–Write technique is highly effective in developing students' problem-solving skills. These findings are consistent with the concepts and results of several related studies. Specifically, the integration of the SSCS model—a systematic problem-solving process (Search, Solve, Create, and Share)—with the Think–Talk–Write (TTW) technique, which promotes deep thinking, group discussion, and written expression (Huda, 2013), significantly enhances students' problem-solving abilities. The Think phase enables students to carefully analyze problems and plan solutions. The Talk phase provides opportunities for students to articulate their ideas and consider diverse perspectives, thereby testing and refining their understanding (Cobb et al., 1993; Cojorn, 2016). The Write phase helps students organize their thoughts and present solutions in a structured, step-by-step manner. Together, these processes cultivate essential skills for effective mathematical problem-solving. In addition, the SSCS model provides students with a clear framework, beginning with understanding and exploring the problem (Search), applying various strategies to solve it (Solve), creating or transferring knowledge to new situations (Create), and sharing the results and processes with others (Share) (Syafri et al., 2020). The combination of these two learning frameworks creates a learner-centered environment that emphasizes active participation and knowledge construction, leading to deeper and more lasting understanding compared with traditional teacher-centered approaches.

Moreover, Analysis of students' problem-solving ability according to Polya(1973) problem-solving steps revealed varying levels of competence across the phases. Students demonstrated a high level of ability in the Understanding the Problem phase, while the Devising a Plan, Carrying Out the Plan, and Looking Back phases were at a moderate level. Notably, the Looking Back phase had the lowest average score. These results can be interpreted in light of the instructional approach used. The high scores in the Understanding the Problem phase align with the nature of the learning activities, which incorporated the Think–Talk–Write technique. The initial Think and Talk steps encouraged students to pause, reflect carefully on the problem, and discuss with peers to clearly understand the given conditions and the required outcomes (Huda, 2013). This process directly corresponds to Polya's first step of understanding the problem. Regarding the Devising a Plan and Carrying Out the Plan phases, which were at a moderate level, this may be explained by the fact that although students understood the problem well, selecting appropriate strategies (e.g., drawing diagrams, creating tables, identifying patterns) to develop a plan still requires experience and practice (Schoenfeld, 1992). Additionally, errors in calculations or the execution of mathematical procedures may occur due to carelessness or a lack of procedural fluency. Regarding the Devising a Plan and Carrying Out the Plan phases, which were at a moderate level, this may be explained by the fact that although students understood the problem well, selecting appropriate strategies (e.g., drawing diagrams, creating tables, identifying patterns) to develop a plan still requires experience and practice (Schoenfeld, 1992). Additionally, errors in calculations or the execution of mathematical procedures may occur due to carelessness or a lack of procedural fluency. Considering the learning process, the Create process of SSCS and the Write process of TTW help stimulate students' creative thinking and translate problem-solving methods into written form, transforming abstract ideas into computational or practical implementation remains an area where students require continuous practice. Previous research has confirmed that writing and discussions promote mathematical and scientific thinking skills, but the ability to connect knowledge to practical application still needs further development (Pugalee, 2001). Therefore, enabling learners to transition from conceptual thinking to computational and practical implementation necessitates supplementary activities. These include using real-world problem scenarios, engaging students in hands-on activities, and incorporating post-problem-solving reflection sessions. These measures allow learners to verify whether their expressed ideas can indeed be effectively applied to solve problems (Jonassen, 2011; Papaneophytou & Nicolaou, 2025).

The most noteworthy finding is that the Looking Back phase had the lowest average score. This aligns with numerous studies indicating that students often neglect or perform poorly in this step (Fernández et al., 1994). This phenomenon aligns with the concept proposed by Polya (1973), which indicates that learners often overlook such steps because they prioritize finding answers over reviewing and verifying the completeness of their solutions. Meanwhile, metacognitive skills, which involve thinking about one's own thought processes, need to be systematically and continuously developed (Schoenfeld, 1985). Possible reasons include classroom cultures that emphasize obtaining correct answers over evaluating the reasonableness of solutions, exploring alternative strategies, or extending the problem to new contexts (Schoenfeld, 1987). Although the Share stage in the SSCS process provides opportunities for students to explain their concepts and present solutions to peers or teachers, this type of exchange often focuses more on presenting methods or answers rather than self-critique or error checking. As a result, the Share stage may not significantly stimulate students to engage in Looking Back. Students may perceive presenting their answers as the conclusion of the problem-solving process and thus do not prioritize revisiting or comparing their solutions with alternative methods (Jonassen, 2011). Therefore, to enhance the Share stage as a key mechanism for communication and mutual verification of understanding in the classroom, and to foster genuine Looking Back, teachers should design supplementary activities. These may include using scaffolded questions, having students compare multiple solution approaches, or facilitating reflective discussions. Such strategies can help students recognize the importance of verifying answers and exploring new alternatives more deeply (Lawson, 2001; Jonassen, 2011).

In addition, analysis of students' problem-solving ability revealed that their mean scores were significantly higher than the 70% criterion. When students engage in systematic problem-solving processes and work independently, they develop structured thinking, logical reasoning, and decision-making skills, which collectively enhance their problem-solving ability. This aligns with Pizzini et al. (1989), who describe the SSCS learning model as a systematic problem-solving process that guides students to identify problems through analysis, clearly define key issues, plan solutions using multiple strategies, implement the plan, and collaboratively share learning methods to reach conclusions. This finding is also consistent with Presseisen (1985), who emphasizes that essential thinking skills for problem-solving include organizing information, making decisions, integrating information for clear explanations, and verifying the correctness of chosen solutions. When this methodological task is combined with the Think-Talk-Write methodology which entails students to think, talk, share ideas and get the ideas out through writing, it also serves to support the students to organize their thinking in a systematic way. This aligns with Huinker and Laughlin (1996), who note that Think–Talk–Write promotes reflective thinking, organizes knowledge, and allows students to test ideas through discussion prior to writing. Communication using familiar language about ideas and opinions further strengthens understanding and supports effective mathematical problem-solving. The integration of the SSCS model with the Think–Talk–Write technique has been shown to effectively enhance students' problem-solving abilities. Consistent with previous research, the students who were taught with the help of either Think-Talk-Write or SSCS-based instructions showed considerably better problem-solving abilities compared to those taught in conventional classrooms (Chaisriha &Intasena, 2022; Susanto et al., 2018; Syafri et al., 2020; Yasin et al., 2020; Zulkarnain et al., 2021). Furthermore, combining SSCS with concept mapping further improved problem-solving performance compared with discovery-based learning (Tiara et al., 2024).

Additionally, the students who received instruction using the SSCS learning model combined with the Think–Talk–Write technique achieved significantly higher academic scores than the 70% criterion. The method of systematic problem-solving and structured thinking enabled the students to systematize their thoughts, discuss and represent them under the form of writing, thus enhancing the understanding and performance. According to Chin (1997) and Aungkanaphatkajorn (2012), the SSCS model encourages students to independently solve problems, think and build knowledge, whereas the Think-Talk-Write strategy helps the student to reflect, engage in discussion and write, which helps to deepen the understanding and reasoning (Hidayati et al., 2019; Muis & Priawasana, 2022). These findings align with previous studies show that structured learning models and TTW techniques improve academic outcomes. As an illustration, Photharam and Thongmoon (2024) reported higher achievement using the MACRO model with TTW in sequences and series, Khantasupa et al. (2018) have reported high probability scores when using SSCS with questioning, Maimun and Bahtiar (2022) have reported better mathematics performance when using SSCS as opposed to traditional instruction and Amanda (2024) has confirmed the improvement of physics achievement by using SSCS.

In conclusion, implementing mathematics learning activities using the SSCS model combined with the Think–Talk–Write technique is an effective approach that significantly enhances students' problem-solving abilities. This method encourages students to actively engage in thinking, communication, and collaboration, which is essential 21st-century skills.

5. Conclusion

The study demonstrated that the SSCS learning model combined with the Think–Talk–Write technique was highly effective in enhancing Grade 11 students' problem-solving abilities in the topic of probability. Analysis of the mathematical problem-solving test revealed that the majority of students achieved a high level of competence, particularly in understanding problems, although some difficulties remained in planning, executing, and reviewing solutions. Learning achievement scores similarly exceeded the 70% criterion, indicating a significant improvement in students' mastery of mathematical concepts. According to these results, teachers are encouraged to implement the SSCS learning model using the Think-Talk-Write technique by means of explaining its steps and the related processes of solving the problem. Adequate time allocation and continuous encouragement are essential to ensure smooth learning. The teachers are expected to become facilitators whereby guiding questions are used to elicit reasoning as opposed to giving direct answers so that students learn more. Moreover, further research also ought to take into account the extension of SSCS and Think-Talk-Write interventions to develop more comprehensive mathematical skills such as critical thinking, communication, and cross-topic links. Action research methods may trace the long-term progress of the students and give them a chance to adjust the instructional activities to improve the phases of problem-solving and academic performance. Moreover, it should design Share-phase activities that stimulate verification and reflective thinking—such as error analysis or comparing multiple solution pathways—to enhance Looking Back. Additionally, it should incorporate activities that bridge abstract concepts with practical applications, such as real-world scenarios or hands-on experiments, to develop skills in Devising a Plan and Carrying Out the Plan. Systematic metacognitive skills should also be fostered through tools like reflection portfolios or scaffolded questioning. Furthermore, teachers could structure classrooms to encourage regular peer exchange, collaborative error analysis, and group reflection, thereby strengthening sustained metacognitive habits and Looking Back practices.

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