Research article

Development of an Instructional Model to Enhance Systematic thinking skills for Mathayom 2 Students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office

Suphaphit Udonsan[1*], Vijittra Vonganusith[1] and Yatawee Chaiyamat[1]

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Abstract

This study aimed to 1. develop an instructional model to enhance systematic thinking skills among Mathayom 2 students, 2. evaluate its effectiveness, and 3. compare students' systematic thinking skills before and after implementing the model. This study is a research and development (R&D) study. The research instruments used in this study included 1) The instructional model for developing systematic thinking skills for Mathayom 2 students 2) Lesson plans 3) A questionnaire assessing the consistency and appropriateness of the model and 4) A systematic thinking skills assessment. Data were analyzed using mean, standard deviation, efficiency criteria, and t-test.

Research Results

1. The developed teaching model for enhancing systematic thinking skills for Students consists of four components: 1) Introduction to the teaching model, 2) A six-step process for organizing learning activities: Step 1 - Presenting the situation, Step 2 - Developing thinking strategies, Step 3 - Analyzing the problem, Step 4 - Engaging in discussions and exchanges, Step 5 - Learning from group work, Step 6 - Concluding the findings, 3) Implementation of the teaching model, and 4) Evaluation of the outcomes from using the model.

[1]Curriculum and Instruction Research, Faculty of Education, Sakon Nakhon Rajabhat University

[*]Corresponding Author email : suphapit.ud65@snru.ac.th

2. The model demonstrated an effectiveness rating of 94.16/95.15, exceeding the established criterion of 80/80.

3. After using the teaching model, the students' systematic thinking skills showed significantly higher scores than before using the model, with statistical significance at the level of .05.

Keywords: Instructional Model, Enhance thinking skills, Systematic thinking skills

Introduction

The 21st century is an era of rapid and complex transformations driven by technology, innovation, and globalization. Artificial intelligence (AI), big data, and automation have become integral to various aspects of human life, while emerging challenges such as climate change, economic inequality, and shifts in social structures continue to redefine development and security paradigms. As the world transitions into the 22nd century, significant advancements in energy, space exploration, and synthetic biology may lead to more intricate human-technology interactions. Systematic thinking skills will become an essential skill in connecting various factors to develop policies, strategies, and innovations that effectively respond to the evolving global landscape

Contemporary schools face complex challenges, including poor management, educational inequality, and limited stakeholder collaboration. These issues often arise from fragmented perspectives, leading to short-term solutions. Systematic thinking helps address these challenges by recognizing interconnections between administration, instruction, parental involvement, and social contexts. Developing this skill enables students to approach problems holistically and create sustainable solutions (Meadows, 2008, pp. 12–25). According to Piaget's theory, knowledge is constructed through active engagement, so instructional models promoting systematic thinking must align with students' cognitive development. Cooperative learning fosters peer interaction and collective problem-solving, enhancing cognitive skills and systems thinking. Methodologies such as Problem-Based Learning (PBL), Inquiry-Based Learning (IBL), and the application of the Four Noble Truths support critical analysis and knowledge integration (Senge, 2006, pp. 89–104; Sterman, 2000, pp. 233–250).

In response to these needs, this study proposes the development of a structured and systematic teaching model aimed at enhancing students' systematic thinking skills at Waritchaphum Secondary School. The model is grounded in the theoretical principles of system construction (Joyce & Weil, 2004) and is designed to align with students' cognitive development

as outlined by Piaget. This approach is supported by previous research emphasizing the importance of aligning instructional strategies with students' developmental stages to foster meaningful learning (Lourenco & Machado, 2015), as well as studies demonstrating that system-based instruction can significantly enhance students' ability to manage complex real-world issues (Assaraf & Orion, 2011; Corvers & Wiek, 2022). Furthermore, the initiative aligns with Thailand's Basic Education Core Curriculum B.E. 2551 (Revised Edition B.E. 2560), which reflects the Ministry of Education's strategic emphasis on educational reform and lifelong human capital development. This national policy aspires to cultivate citizens who are intellectually competent, morally grounded, and capable of contributing meaningfully to the nation's stability, prosperity, and sustainable development (Ministry of Education, 2022).

Objectives

This study aims to achieve the following objectives

1. To develop an instructional model aimed at enhancing students' systematic thinking skills.

2. To evaluate the effectiveness of the instructional model in promoting systematic thinking skills among students.

3. To compare students' systematic thinking skills before and after the implementation of the instructional model.

Scope of the Study

1. Population and Sample Group

1.1 Population: Mathayom 2 students at Waritchaphum Secondary School, Sakon Nakhon Secondary Educational Service Area Office, Semester 1, Academic Year 2021, consisting of 3 classrooms with a total of 94 students.

1.2 **Sample Group:** Selected through Cluster Sampling by categorizing students into high-achieving, average, and those needing improvement, followed by random selection within each group, resulting in a total of 33 students.

2. Study Variables

2.1 Independent Variable: Instruction using a teaching model aimed at developing systematic thinking.

2.2 Dependent Variables: Systematic thinking skills and the effectiveness of the instructional model.

3. Content

The study focuses on systematic thinking skills based on the Basic Education Core Curriculum (Revised 2017) in the Social Studies, Religion, and Culture subject group. Includes 8 lesson plans covering the topic of The Four Noble Truths.

4. Experiment Duration

Conducted in Semester 1, Academic Year 2021, spanning 22 hours over 7 weeks. Each week consists of 3 hours per week, except the first week which had 4 hours.

concept framework

The researcher has explored relevant concepts and theories to develop an instructional model aimed at enhancing systematic thinking skills among Mathayom 2 students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office. The study incorporates principles, theories, and pedagogical frameworks to establish a research framework, including Instructional Model for Developing Systematic thinking skills (Tisna Kammanee, 2008, p. 221; Joyce & Weil, 2004) Piaget's Theory of Cognitive Development (Tisna Kammanee, 2012, pp. 64-66) Bruner's Theory of Cognitive Development (Tisna Kammanee, 2012, pp. 66-68) Cooperative Learning Approach (Johnson & Johnson, 1994, pp. 31-32) Concept of Systematic thinking skills . (Piaget, 1969, p. 58)

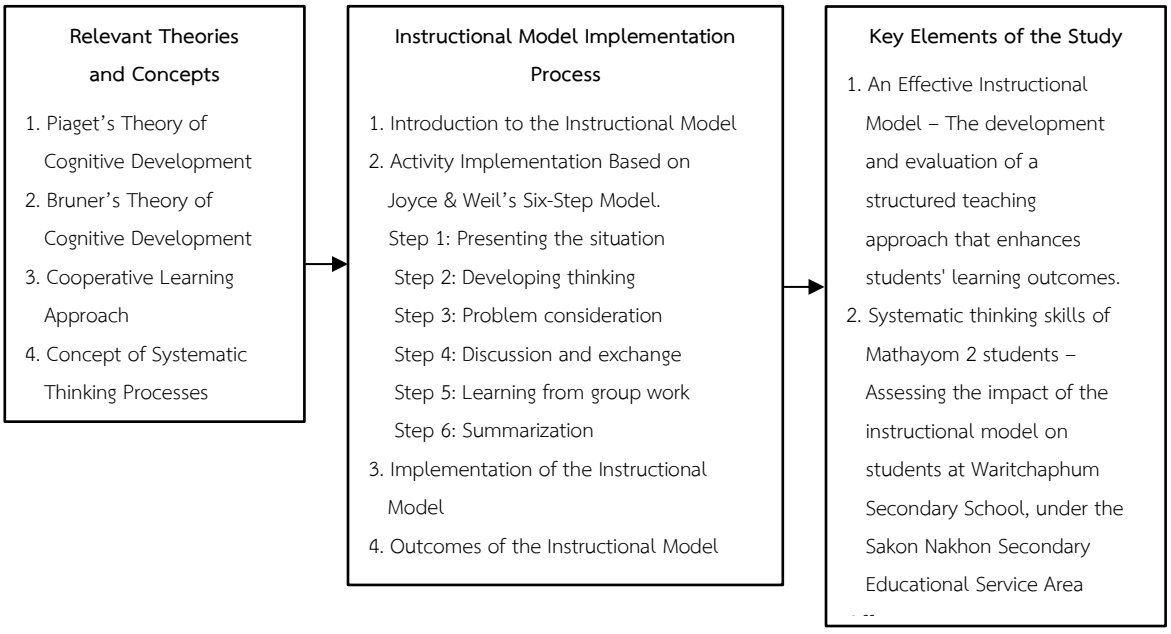

Figure 1 Conceptual Framework of the Study

Research methodology or research methodology

The research methodology for the study on developing an instructional model to enhance systematic thinking skills among Mathayom 2 students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office, is divided into three phases as follows:

Phase 1 Development of the Instructional Model

The process of developing the instructional model consists of the following steps:

Step 1 Preliminary Study

This step involves reviewing fundamental concepts, principles of instructional models, instructional model development, and the enhancement of systematic thinking skills based on the framework of Joyce and Weil (2004). The study also examines relevant research, particularly the work of Makrapan Chutarrasak (2006), who developed an integrated instructional module on systematic thinking skills in daily life. This module was designed as an interdisciplinary approach, combining knowledge from various disciplines to create a new paradigm. The aim is to apply systematic thinking skills knowledge effectively in analyzing and synthesizing real-world social issues.

Step 2 Development of the Instructional Model

The development of the instructional model consists of the following process:

Sub-step 1 Defining the Conceptual Framework and Constructing the Instructional Model

This stage involves analyzing and synthesizing the information gathered in Step 1 to develop an instructional model with the primary goal of enhancing systematic thinking skills among Mathayom 2 students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office. The researcher structured the instructional model into four main components:

1. Introduction to the Instructional Model

The introduction phase of the instructional model is grounded in Piaget's Theory of Cognitive Development, Bruner's Theory of Cognitive Development, and the cooperative learning theory proposed by Slavin, David Johnson, and Roger Johnson. These theories serve as fundamental principles guiding the introduction of the instructional model.
In this phase, instructors must consider the learners' developmental stages, cognitive differences, and individual abilities. The approach encourages students to build upon prior

experiences while acquiring new knowledge and experiences. The process is driven by motivation and cooperative learning, fostering both conceptual understanding and essential life skills.

2. Implementation of the Instructional Model

The instructional activities follow the six-step model proposed by Joyce and Weil, as outlined below:

2.1 Presenting the Situation

This step involves presenting a problem-based scenario that creates cognitive conflict. The aim is to stimulate students' thinking processes and encourage them to identify and define key issues.

2.2 Develop Thinking Approaches

This step encourages students to research and find information to resolve the cognitive conflict, leading them to answers that are rational. Students then organize and represent their findings through concept maps.

2.3 Problem Analysis

This phase promotes students' independent thinking and learning. They analyze problems by identifying the root causes, establishing relationships between factors, and designing and writing cause-and-effect problem cycles.

2.4 Discussion and Exchange

Students are encouraged to engage in discussion and share insights with their peers in small groups. Each group consists of 4-5 students. Each participant presents their own ideas, while others provide feedback to help reach a group consensus.

2.5 Learning from Group Work

In this step, students present the outcomes of their group's thoughts to the entire class. A representative from each group reports the conclusions to give all students an opportmoduley to learn from each other's work, thereby gaining new perspectives.

2.6 Summarize Together

This is the phase where discussions are held to summarize the content and ideas derived from the group work. The outcomes and lessons learned help students gain confidence in what they've learned, enabling them to continue learning independently in the future.

3) Outcomes of Implementing the Teaching Model

After applying this teaching model, both direct and indirect outcomes.

Table 1 Direct and Indirect Outcomes from the Implementation of the Teaching Model

Direct Outcomes	*Indirect Outcomes*
1. Enhancement of students' *systematic thinking skills process***.**	1. Encouragement of *self-directed learning***,** fostering students' confidence in independent thinking.
2. Improvement in students' *problem-solving abilities* based on logical reasoning.	2. Strengthening of students' *critical and creative thinking skills* for real-life application.
3. Increased engagement and *active participation* in the learning process.	3. Development of *communication and teamwork skills* through group activities.
4. Development of students' ability to *analyze and synthesize information* from various sources.	4. Cultivation of *lifelong learning habits*, preparing students for future academic and career challenges.
5. Promotion of *collaborative learning* through discussion and knowledge exchange.	Positive impact on the overall *learning environment***,** making it more engaging and student-centered

Sub-step 2 *Developing the Learning Management Plan* In this step, the researcher determines the *content* and *sequence of activities* for developing *systematic thinking skills process*. This is done by analyzing the *standards from the Basic Education Core Curriculum B.E. 2551 (Revised Edition B.E. 2560)* under the *Social Studies, Religion, and Culture* learning area. The learning management plan is designed to ensure *coherence and alignment* between curriculum standards *and* systematic thinking skills development activities**,** *enabling students to engage in* critical analysis, synthesis, and application of knowledge effectively.

Sub-step 3 Developing a Teaching Model Manual. This step involves creating a teaching model manual, which includes Background Concepts and theories underlying the model Objectives of the teaching model Content and principles used in the model Components of the teaching model Direct and indirect effects resulting from the application of the model.

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Sub-step 4 Developing Data Collection Instruments**.** The researcher developed the following tools for data collection.

1. Literature Review and Related Studies. The researcher studied documents and previous research on teaching models that enhance systematic thinking skills for Mathayom 2 students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Education Service Area Office. The instructional activities were structured into six steps:1) Presenting the situation 2) Developing thinking strategies 3) Problem analysis 4) Discussion and exchange 5) Group work reflection and 6) Joint conclusion

2. Lesson Plans. The lesson plans were developed based on the principles of the teaching model and consisted of the following components: Core content, learning objectives, learning materials, learning activities, Learning resources, Assessment and evaluation.

3. Systematic thinking skills Assessment Tool. The tool assessed four key aspects of systematic thinking: Identifying the problem, analyzing sub-factors, establishing relationships between factors, synthesizing a problem cycle, the test contained 20 multiple-choice questions (4 options each). Correct answers were given 1 point, and incorrect answers received 0 points. The content focused on environmental issues and was designed using test construction techniques.

4. Questionnaire for Content Validity Assessment. Experts (5 people) reviewed the content, language, activity sequence, and lesson plan alignment using an Item-Objective Congruence (IOC) index with a three-level rating scale: +1 = Consistent 0 = Uncertain
-1 = Inconsistent IOC values of 0.50 or higher were considered acceptable. The final IOC scores were: Lesson plan and activity design: 0.94 Systematic thinking skills assessment tool: 0.97 (indicating high validity)

5. Pilot Testing the Systematic thinking skills Assessment Tool. The revised assessment tool was tested on 30 Mathayom 2 students at Waritchaphum Secondary School. Difficulty index (p): 0.40 - 0.73 Discrimination index (r)**:** 0.30 - 0.55 (items with $r \geq 0.20$ were selected) Reliability was calculated using Kuder-Richardson Formula 20 (KR-20), resulting in 0.68, indicating an acceptable level of reliability.

Phase 2 Quality Validation of the Teaching Model

This phase focuses on *evaluating the quality* of the developed teaching model through the following steps:

Step 1 Checking Consistency and Appropriateness

The researcher presented the developed teaching model to *experts* for *feedback, suggestions, and revisions* regarding *Background* of the model *Concepts and underlying theories Principles and objectives Content and instructional steps Direct and indirect effects* of implementing the model *Evaluation methods***.**

Step 2 First Revision

After presenting the teaching model to experts for review, the researcher gathered feedback, suggestions, and necessary revisions. These included restructuring the model's principles from an essay-style format to a point-based format that explicitly outlines the underlying concepts and beliefs of the model's developer, as well as its general characteristics, key focuses, and instructional guidelines. The researcher carefully considered all expert recommendations and integrated them to enhance the coherence and appropriateness of the model's components. To ensure the revised model's validity and alignment, a questionnaire was developed to assess its consistency and suitability. Three experts were invited to evaluate four key aspects: (1) the introduction to the teaching model, (2) the alignment of the six instructional steps, (3) the implementation of the model, and (4) the outcomes of its application. The questionnaire was based on a five-point Likert scale, following the interpretation guidelines of Boonchom Srisaard (2010, pp. 99-100), to systematically measure the model's appropriateness and consistency.

4.51–5.00 Highly consistent and appropriate

3.51–4.50 Consistent and appropriate

2.51–3.50 Moderately consistent and appropriate

1.51–2.50 Slightly consistent and appropriate

1.00–1.50 Not consistent or appropriate

The findings show that the alignment and appropriateness of the learning activities are rated at the *highest level*. The average score for alignment is *4.70*, with a standard deviation of *0.07***,** indicating that the learning activities developed have been highly accepted by the experts for their consistency. Meanwhile, the appropriateness is rated at the highest level, with an average score of *4.81* and a standard deviation of *0.16*, demonstrating that the components of the learning activities are highly suitable and fitting for the teaching context.

Step 3 Quality Evaluation of the Teaching Model

This phase focused on assessing the completeness and quality of the teaching model by examining the appropriateness of language usage and the sequencing of instructional activities. A pilot study was conducted with 30 students who were not part of the main sample to evaluate the model's effectiveness. The efficiency of the model was measured against the predetermined 80/80 standard. Additionally, a comparison of students' pre-test and post-test scores was conducted using a t-test to determine the model's impact before its implementation with the target sample group.

Step 4 Second Revision

The researcher utilized the results from the pilot test conducted with students who were not part of the main sample to further refine and enhance the teaching model. This revision aimed to ensure the model's completeness and effectiveness before its actual implementation. The finalized version was then tested with a sample group consisting of 33 Mathayom 2 students from Waritchaphum Secondary School under the Sakon Nakhon Secondary Educational Service Area Office.

Phase 3 Implementation of the Teaching Model

Step 1 Experimental Grouping

To conduct the experiment, the researcher selected the sample group using *Cluster Sampling***.** The students were categorized into three groups based on their academic performance: high-achieving, average, and those needing improvement. A random draw was then conducted within each group to determine the final sample. As a result, the experimental group consisted of *33 Mathayom 2 students* from *Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office*.

Step 2 Preparation of Experimental Tools

The researcher prepared the necessary tools for the experiment, including the *teaching model* designed to enhance *systematic thinking skills for Mathayom 2 students***,** a *user manual* for implementing the teaching model, *lesson plans*, and *two versions of a systematic thinking skills assessment***.** The study employed a *quasi-experimental design***,** specifically the *One-Group Pretest-Posttest Design*, to evaluate the effectiveness of the teaching model. The experimental process followed this design, as illustrated in Figure 2

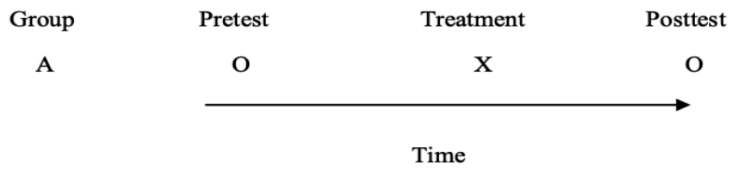

Figure 2 illustrates the research design adopted in this study, based on McMillan (2001, p. 331).

Step 3 Implementation of the Instructional Model

The researcher implemented the instructional model as follows:

1. Pretest*:* The researcher administered a pretest on systematic thinking skills to 33 students from Mathayom 2 students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office, using the 20-item systematic thinking skills assessment tool.

2. Intervention*:* The researcher implemented the instructional model designed to develop systematic thinking skills over 22 hours, spread over 7 weeks. Each week included 3 hours of instruction, except for the first week, which was allocated 4 hours. The total intervention lasted for 7 weeks with 33 students.

3. Posttest*:* After the intervention, the researcher administered the same 20-item systematic thinking skills assessment tool to the same group of 33 students to measure changes in their systematic thinking skills. The posttest was identical to the pretest and was designed to assess the effectiveness of the instructional model in developing systematic thinking.

Step 4 Data Analysis

The researcher performed data analysis as follows:

1. Calculating the effectiveness of the instructional model*:* The effectiveness of the instructional model for developing systematic thinking skills was calculated using the formula E1/E2 (Chaiyong Phromwong, 1990).

2. Comparing differences between pretest and posttest scores*:* The researcher compared the differences between pretest and posttest results using a t-test statistic (Boonchom Srisaat, 2000, p. 109).

Step 5 Conclusion of the Trial

In this step, the researcher will summarize the results of the trial use of

the instructional model to develop systematic thinking skills for Mathayom 2 students at Waritchaphum Secondary School, under the Sakon Nakhon Secondary Educational Service Area Office. The conclusion will serve as a feedback mechanism to help the researcher refine and improve the developed instructional model for further application.

Statistics Used in the Research

In this research, the researcher selected the following statistical methods

1. Calculating the effectiveness *of the instructional model***.** The effectiveness of the instructional model for developing systematic thinking skills was calculated using the performance criterion E1/E2 (McMillan, 2001, p. 331).

2. Comparing differences between pretest and posttest scores**.** The researcher compared the differences between the pretest and posttest results using the t-test for independent samples.

3. Percentage, Mean, and Standard Deviation**.** These descriptive statistics were used to summarize the data and provide insights into the distribution and variability of the results.

results

In this research, the researcher analyzed the data and summarized the findings as follows

1. The researcher developed an instructional model for enhancing systematic thinking skills for Mathayom 2 students secondary school students at Waritchaphum School, under the Secondary Education Service Area Office, Sakon Nakhon. The model's components were found to be consistent and highly appropriate, with a high rating overall. The four main components of the model are as follows

1.1 *Concept of the Instructional Model*

1.2 The Instructional Model for Developing Systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon

1.3 *Implementation of the Instructional Model*

1.4 *Outcomes of Using the Instructional Model*

An evaluation of the alignment and appropriateness of the instructional model for developing systematic thinking skills for Mathayom 2 students at Waritchaphum School, under the Secondary Education Service Area Office, Sakon Nakhon, is presented in Table 3.

Table 2 Results of Evaluation of the Consistency and Appropriateness of the Instructional Model for Developing Systematic thinking skills.

Evaluation issues	N=5		Consistency	N=5		Suitability
	$\overline{x}$	S.D.		$\overline{x}$	S.D.	
1. Importing into the format	4.60	0.27	maximum	4.73	0.27	maximum
2. Consistency of the 6 steps of learning management procedures	4.66	0.33	maximum	4.93	0.14	maximum
3. Implementation of the model	4.66	0.23	maximum	4.80	0.44	maximum
4. Results from using teaching models	4.86	0.18	maximum	4.80	0.18	maximum
Overview	4.70	0.07	maximum	4.81	0.16	maximum

From Table 2, it can be seen that the instructional model for developing systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon Secondary Education Service Area Office, which was developed by the researcher, demonstrated the highest level of consistency with an average score of 4.70 and a standard deviation of 0.07. The model also demonstrated a statistically significant improvement of appropriateness with an average score of 4.81 and a standard deviation of 0.16.

2. The evaluation results of the instructional model for developing systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon Secondary Education Service Area Office, showed an efficiency of 94.16/95.15, which exceeds the set criteria of 80/80, as shown in Table 3.

Table 3 Results of the Efficiency Analysis of the Instructional Model for Developing Systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon Secondary Education Service Area Office.

Measurement period	Full score	n	$\overline{x}$	S.D.	Percentage	Efficiency E_1/E_2
1st time	20	33	18.93	1.19	94.65	94.16/95.15
2nd time	20	33	18.54	1.32	92.70	
3rd time	20	33	19.09	1.07	95.45	
4th time	20	33	18.75	1.17	93.75	

Measurement period	Full score	n	$\overline{x}$	S.D.	Percentage	Efficiency E_1/E_2
Before studying	20	33	10.81	4.26	54.05	
During study	**80**	**33**	**75.33**	**2.30**	**94.16**	
After Study	**20**	**33**	**19.03**	**0.76**	**95.15**	

From Table 3, it can be seen that the instructional model for developing systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon Secondary Education Service Area Office, developed by the researcher, has an efficiency of 94.16/95.15. This is higher than the predetermined criterion of 80/80.

3. The results of comparing systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon Secondary Education Service Area Office, before and after using the instructional model, revealed that the students' systematic thinking skills after using the instructional model were significantly higher than before its use, with a statistical significance at the .05 level, as shown in Table 4

Table 4 Comparison of Systematic thinking skills Scores Before and After Using the Instructional Model to Develop Systematic thinking skills for Mathayom 2 students at Waritchaphum School, Sakon Nakhon Secondary Education Service Area Office.

Sample group	Full score	n	$\overline{x}$	S.D.	t	p
Before using the format	20	33	10.81	4.26	10.79	.001
After using the format	20	33	19.03	0.76		

Significantly different at the .05 level.

From Table 4, it can be seen that before using the teaching model to develop systematic thinking, the average score was 10.81 with a standard deviation of 4.26. After using the teaching model to develop systematic thinking, the average score was 19.03 with a standard deviation of 0.76. This indicates that students' systematic thinking skills after using the teaching model was significantly higher than before, with a statistically significant difference at the .05 level.

Suggestions

In this study, the researcher discusses the findings as follows

1. The developed instructional model proved effective in enhancing secondary students' systematic thinking skills when implemented through its structured stages. Although students initially struggled with problem identification, guided activities encouraged them to connect prior knowledge and develop deeper insights. The model's success can be attributed to its alignment with established frameworks by Joyce & Weil (2004) and Tisana Kammanee (2008), emphasizing systematic development processes including data collection, model design, validation, and evaluation. Collaborative learning, as supported by Johnson & Johnson (1994), further contributed to the development of higher-order thinking by fostering the exchange of diverse perspectives. This aligns with findings by Abu Al-Yazeed (2020), who highlighted the effectiveness of curricula designed around systematic thinking principles. Overall, the study affirms that structured instructional models grounded in systematic thinking can significantly enhance students' cognitive skills and prepare them for real-world complexities.

2. The evaluation of the instructional model for Grade 8 students at Waritchaphum Secondary School yielded an effectiveness score of 94.16/95.15, surpassing the established 80/80 benchmark. This outcome reflects the model's strong theoretical foundation, integrating cognitive development theories from Piaget and Bruner, and considering students' maturity, interests, and contextual factors. The learning environment fostered active participation and collaboration, key elements in promoting systematic thinking, as supported by Johnson & Johnson (1994). Integrated and interdisciplinary approaches, as emphasized by Senge (2006), and the use of simulations, as noted by Sterman (2000), further enhanced students' ability to perceive systemic relationships and test problem-solving strategies. These findings affirm that a well-designed, context-sensitive, and collaborative instructional model can significantly develop students' systematic thinking skills.

3. The implementation of the instructional model significantly enhanced Grade 8 students' systematic thinking skills, with a statistically significant improvement at the .05 level. Developed using Joyce and Weil's framework and validated by experts, the model emphasized cooperative learning, experiential strategies, and a supportive environment—factors that contributed to student engagement and improved outcomes. The model's contextual adaptation for rural learners, along with its integration of the Four Noble Truths as a culturally grounded framework, supported students in identifying root causes and sustainable solutions.

These results are consistent with previous studies (Brauer et al., 1997; Yamkasikon, 2003; Tumthong, 2010; Suksiriserekul, 2020) affirming the effectiveness of student-centered and critical thinking approaches in fostering systematic thinking. This study also aligns with Abu Al-Yazeed (2020), highlighting the role of systems-based instructional design in promoting higher-order cognitive skills. Cooperative learning principles (Johnson & Johnson, 1994) and interdisciplinary connections (Senge, 2006) further reinforce the pedagogical value of this approach. Although simulation tools (Sterman, 2000) were not utilized, future studies may incorporate them to enhance students' experiential understanding of systems thinking.

Furthermore, the study by Brauer, Grady, Matthew, and Wilhite (1997) corroborates the present findings by emphasizing the effectiveness of problem-based learning in promoting systems thinking. Their research demonstrates that engaging students in analytical, problem-centered tasks can significantly enhance their capacity to understand and navigate complex systems—a core strategy employed in this study's instructional design. In summary, the present research is consistent with a wide range of international studies that support the integration of systems thinking into educational practice. However, its distinguishing contribution lies in its contextual adaptation to the socio-cultural and developmental characteristics of rural Thai students. This underscores the importance of cultural and environmental sensitivity in designing and implementing instructional models that aim to foster complex cognitive skills such as systems thinking.

Suggestions for the Use of Research Findings

1. Application of the Teaching Model. The model effectively enhances students' systematic thinking skills. Schools should adopt it for secondary education.

2. Effectiveness of the Teaching Model. Evaluation shows the model's effectiveness exceeds the80/80 threshold. Schools are urged to implement it to improve systematic thinking.

3. Alignment and Appropriateness of the Teaching Model. The model meets high alignment criteria. Comprehensive implementation is essential for optimal outcomes in systems thinking development.

4. Role of the Teacher. Teachers should prioritize developing students' systematic thinking skills, fostering their application in daily life to enhance learning experiences.

Suggestions for Future Research

1. *Development of the Teaching Model at Other Educational Levels*. Future research should focus on developing a systematic thinking skills teaching model for lower and higher levels of education, such as elementary and upper secondary education, as well as testing the model in various educational regions across the country to broaden its application.

2. *Exploring Causal Relationships*. Research should explore the causal relationships between systematic thinking skills and various factors, such as family background, life experiences, environment, and learning potential, to better understand the elements that influence the development of systems thinking.

3. *Development of the Teaching Model in Other Subjects*. Further research should develop and apply the systematic thinking skills teaching model in other academic subjects, such as science, social studies, or mathematics, to promote systematic thinking skills along side academic learning in these disciplines.

References

Abu Al-Yazeed, S. (2020). *The effects of a digital curriculum in philosophy designed using systems thinking on enhancing secondary school students' systems thinking skills*. International Journal Instructional Technology and Educational Studies https://ijites.journals.ekb.eg/article_86085.html

Anderson, L. W., & Johnson, D. W. (2007). *Cooperative learning: Theory, research, and practice.* In R. Chidmongkol & S. Chidmongkol (Eds.). Abstract of educational development research.

Assaraf, O. B.-Z., & Orion, N. (2011). System thinking skills at the elementary school level. *Journal of Research in Science Teaching, 48*(5), 496–523. https://doi.org/10.1002/tea.20411

Borg, W. R., & Meredith, R. (1983). *Educational research: An introduction.* Harper & Row.

Brauer, C., Grady, F., Matthew, K., & Wilhite, S. (1997). *The effect of problem-solving on academic achievement in elementary education.* Master's action research project, Saint Xavier University and IRI/Skying Field-Base Master's Program.

Corvers, R., & Wiek, A. (2022). Teaching systems thinking for sustainable development in business schools. *Decision Sciences Journal of Innovative Education, 20*(4),225-240. https://doi.org/10.1111/dsji.12324

Chutharosak, M. (2008). *Systematic Thinking Application in Teaching (Revised Edition).* (1nd ed.). Bangkok: Academic Welfare Project, Phramongkutklao College.

Driscoll, M. P. (1994). *Psychology of learning for instruction.* Allyn & Bacon.

Gay, L. R. (1996). *Educational research: Competencies for analysis and application (5th ed.).*

Gunter, M. A., Merry, S. B., & colleagues. (2003). *Curriculum development: A guide to practice*. Pearson.

Johnson, D. W., & Johnson, R. T. (1994). *Learning together and alone: Cooperative, competitive, and individualistic learning.* Allyn & Bacon.

Joyce, B., Weil, M., & Calhoun, E. (2004). *Models of teaching (7th ed.).* Pearson Education.

Kammanee, T. (2008). *Teaching science.* Knowledge for organizing effective learning processes. Bangkok: Chulalongkorn University.

_____. (2012). *Teaching science.* Knowledge for organizing effective learning processes (15th ed.). Bangkok: Chulalongkorn University.

Lourenco, O., & Machado, A. (2015). *In defense of Piaget's theory: A reply to 10 common criticisms*. *Psychological Review, 122*(4), 691–707. https://doi.org/10.1037/a0038462

Malisee, K. (2019). *System thinking: A key tool for holistic problem-solving.* Bangkok: Chulalongkorn University.

Ministry of Education. (2008). *Social Studies, Religion, and Culture Curriculum in Basic Education Core Curriculum B.E.2551.* Ministry of Education.

_____. (2022). *Announcement of the Ministry of Education.* Regarding the policy and focus of the Ministry of Education for the fiscal year 2022. https://moe360.blog/2022/01/19/policy-and-focus-moe/

Manirat, P. (1988). *Research methods in behavioral and social sciences.* (2nd ed.). Bangkok: Charoenphol.

McMillan, J. H. (2001). *Essential assessment concepts for teachers and administrators*. Thousand Oaks, CA: Corwin Publishing Company.

Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.

Phromwong, C., & Thaweekulthap, W. (2010). *Common perceptions of technology and educational communication.* In Teaching materials on technology and educational communication, Unit1. Bangkok: Sukhothai Thammathirat University.

Phiboon, S. (2009). *Education for life and development.* Bangkok: Chulalongkorn University.

Rattanathongkham, S. (2002). *Research methodology for education.* Bangkok: Thammasat University.

Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. Irwin/McGraw-Hill.

Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization* (Rev. ed.). Doubleday.

Srisat, B. (2010). *Preliminary research.* (8nd ed.). Bangkok: Suwiriyasat.

Suksiriserekul, S. (2020). Critical thinking skill development: Analysis of a new learning management model for Thai high schools. *Journal of International Studies, 13*(2), 45–60. https://www.researchgate.net

Tumthong, B. (2010). *Curriculum development.* Bangkok: Chulalongkorn University.

Yamkasikon, M. (2003). *Development of a teaching model for enhancing system thinking in undergraduate students in technology programs*. Bangkok: Srinakharinwirot University.

_____. (2003). Developing critical thinking skills in Thai secondary education. *Journal of Educational Research, 15*(3), 150–162.