Development of Critical Thinking Skills in Grade7 Students at Sarawittaya School by Using the GPAS Five-Step Process in the Mathematics Curriculum

การพัฒนาทักษะการคิดอย่างมีวิจารณญาณของนักเรียนชั้นมัธยมศึกษาปีที่ 1 โรงเรียนสารวิทยา โดยใช้กระบวนการ GPAS 5 ขั้นตอนในหลักสูตรคณิตศาสตร์

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Abstract

This study aimed are 1) to determine the effectiveness index for analytical thinking skills among grade 7 students exposed to GPAS-5 learning for the topic of ratios and percentages 2) to compare learning outcomes on the topic of ratios and percentages for grade 7 students before and after teaching using the GPAS-5 approach and 3) to assess the satisfaction of grade 7 students with the learning process using the GPAS-5 approach, specifically on the topic of ratios and percentages. The sample group consisted of 40 grade 7 students in their second semester (academic year 2024) at Sarawittaya School in Bangkok, Thailand, selected through cluster random sampling. The research instruments included lesson plans, a critical thinking skills test, and a learning outcome record. Data were analyzed to study critical thinking skills development using the GPAS five-step process through means, standard deviations, percentages, and dependent *t-tests. The development of critical thinking skills using this process showed significant improvement among the students. Students' critical thinking skills increased by 69.23% from pre-test to post-test (effectiveness index = 0.6923), indicating that post-test critical thinking skills were significantly higher than pre-test skills (p < .05).* And the overall satisfaction of the students was at the highest level, with an average score of ($\overline{x}$=4.71,S.D.=0.04)

Keywords: Critical Thinking Skills, GPAS 5 Steps, Mathematics Curriculum

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บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์ 1) เพื่อกำหนดดัชนีประสิทธิผลด้านทักษะการคิดอย่างมีวิจารณญาณของนักเรียนชั้นมัธยมศึกษาปีที่1 โดยใช้กระบวนการ GPAS 5 ขั้นตอนในหัวข้ออัตราส่วนและร้อยละ 2) เพื่อเปรียบเทียบผลการเรียนรู้หัวข้ออัตราส่วนและร้อยละของนักเรียนชั้นมัธยมศึกษาปีที่1 ก่อนและหลังเรียนโดยใช้แนวทาง GPAS 5 ขั้นตอน และ 3) เพื่อประเมินความพึงพอใจของนักเรียนชั้นมัธยมศึกษาปีที่1 ต่อกระบวนการเรียนรู้โดยใช้แนวทาง GPAS 5 ขั้นตอน เรื่องอัตราส่วนและร้อยละ กลุ่มตัวอย่าง คือนักเรียนชั้นมัธยมศึกษาปีที่ 1 ในภาคเรียนที่ 2 ปีการศึกษา 2567 โรงเรียนสารวิทยา กรุงเทพมหานคร ประเทศไทย จำนวน 40 คน คัดเลือกโดยการสุ่มแบบกลุ่ม เครื่องมือวิจัยประกอบด้วย แผนการสอน แบบทดสอบทักษะการคิดอย่างมีวิจารณญาณ และแบบสำรวจความพึงพอใจ วิเคราะห์ข้อมูลเพื่อศึกษาการพัฒนาทักษะการคิดอย่างมีวิจารณญาณโดยใช้กระบวนการ GPAS 5 ขั้นตอน สถิติที่ใช้วิเคราะห์ข้อมูล ได้แก่ ค่าเฉลี่ย , ส่วนเบี่ยงเบนมาตรฐาน, ร้อยละ, ค่าดัชนีประสิทธิผล, และการทดสอบสถิติที (Dependent for t-test) กับการพัฒนาทักษะการคิดอย่างมีวิจารณญาณ ผลการวิจัยพบว่าการใช้กระบวนการ GPAS 5 ขั้นตอน แสดงให้เห็นถึงการพัฒนาของนักเรียนกลุ่มตัวอย่างที่เกิดทักษะการคิดอย่างมีวิจารณญาณของนักเรียนเพิ่มขึ้น 69.23% จากแบบทดสอบทักษะการคิดอย่างมีวิจารณญาณก่อนเรียนและหลังเรียนมีค่าดัชนีประสิทธิผลเท่ากับ 0.6923 และคะแนนแบบทดสอบทักษะการคิดอย่างมีวิจารณญาณหลังเรียนสูงกว่าก่อนเรียนอย่างมีนัยสำคัญทางสถิติที่ระดับ.05 และความพึงพอใจของนักเรียนโดยภาพรวมอยู่ในระดับ มากที่สุดมีค่าเฉลี่ย ($\overline{X}$=4.71,S.D.=0.04)

คำสำคัญ: ทักษะการคิดอย่างมีวิจารณญาณ, กระบวนการ GPAS 5 ขั้นตอน, หลักสูตรคณิตศาสตร์

Introduction

Mathematics plays a crucial role in achieving success in learning in the 21st century, helping individuals develop creative thinking, reasoning, systematic thinking, and planning skills. It allows people to analyze problems or situations thoroughly and accurately, enabling them to predict, plan, make decisions, and solve problems effectively. It can also be widely applied in real life. Moreover, mathematics is an essential tool for studying science, technology, and other fields, forming the foundation for human resource development, enhancing a country's competitiveness, and improving its economy. Therefore, mathematics education must continuously evolve to keep pace with the rapidly advancing global economy, society, and knowledge in science and technology. As a result, mathematics education needs to be modernized to align with these changes in the context of globalization (Ministry of Education, 2008).

Mathematics plays an important role as both a "tool" and a "thinking process" that helps learning become systematic, logical, and can be applied to solving problems in real situations. Mathematics plays an important role as both a "tool" and a "thinking process" that helps learning become systematic, logical, and can be applied to solving problems in real situations. And Mathematics as a science consists of interrelated elements, namely: Concepts, Principles and Theorems, Skills and Processes, Reasoning, Mathematical Communication, Connections and Applications (National Council of Teachers of Mathematics, 2000)

GPAS 5 Steps (Paw, 2018) has the following teaching process: 1) Goal Setting, Teachers and learners jointly define goals/competencies/desired characteristics. And clarify objectives, state their importance, and relate them to real life. 2) Process Planning, Design a learning plan, identify learning methods and resources. and Develop learning guidelines or procedures. 3) Conduct learning activities (Activities), Learners engage in hands-on practice, research, experimentation, discussion, project work, etc. Teachers act as facilitators. 4) Self-Reflection & Scoring, Students evaluate their own and peers' performance. And teachers evaluate based on competency and character traits. 5) Summary & Application, Learners summarize their knowledge and skills. And apply them to solve real-life problems or develop them into innovations/projects.

Definition of Critical Thinking (Facione,1990): Critical thinking is the active and skillful process of conceptualizing, analyzing, evaluating, and synthesizing information gathered from observation, experience, reflection, reasoning, or communication. It involves applying logic and evidence to make informed judgments, solve problems, and make decisions rather than relying on assumptions, biases, or emotions. Which components of critical thinking (Ennis, 2011) Interpretation, Ability to understand and express the meaning of information, experiences, or data. And involves clarifying concepts, identifying problems, and making sense of statements or graphs. 2) Analysis, Breaking down complex ideas or arguments into parts. And Identifying relationships, causes, assumptions, and supporting evidence. 3) Evaluation, Assessing the credibility of sources and the strength of evidence/arguments. And involves judging the reliability, relevance, and logical consistency. 4) Inference, Drawing reasonable conclusions from available information. And Predicting consequences, identifying possible explanations, and making informed guesses. 5) Explanation, Clearly and logically presenting reasoning behind

decisions or conclusions. And involves justifying arguments and communicating effectively with evidence. 6) Self-Regulation, Monitoring one's own thinking process. And Recognizing biases, questioning assumptions, and adjusting reasoning strategies when needed.

It is evident that mathematics is essential to human life, as it helps individuals develop problem-solving abilities, reasoning skills, communication, and creativity. It also equips people to face real-life problems and make informed decisions in various contexts, particularly in the face of rapid technological advancements. This highlights the need for a careful analysis of data and accurate decision-making in diverse situations. Mathematics is thus indispensable for daily life.

In educational institutions, mathematics serves as a key element in the learning process, providing a foundation for problem-solving skills that can be effectively applied to everyday life (Ministry of Education, 2008). One approach to enhance mathematical linkages is the GPAS five-step learning process (hereafter GPAS-5), which is a proactive learning method based on the higher-order thinking process (GPAS) and the three-story intellect framework. This framework consists of gathering information (G), processing the data (P), and applying the acquired knowledge (A). It also incorporates the concept of self-regulation (S), helping individuals develop higher-level skills and become lifelong learners. This approach is structured into five interconnected steps designed to foster innovation in students.

GPAS-5 is a core method that enhances students' sustained learning abilities at a high level. It fosters comprehensive learning, including thinking, problem-solving, communication, life, and teamwork skills. These abilities align with the goals of curricula and personal competency development for Thailand in the 21st century, contributing to the nation's progress toward Thailand 4.0 (Institute for the Development of Academic Quality, 2021). Recent research has shown that GPAS-5 has been highly successful in improving learning outcomes.

Therefore, when organizing learning activities, teachers should change their role and design activities with a student-centered approach that takes into account individual differences. A student-centered learning process develops students' physical, mental, intellectual, and moral qualities, fostering their growth. This is achieved by encouraging students to participate, collaborate, think together, and act collectively. Teachers play a key role in planning suitable activities that stimulate social interaction, encourage critical thinking, and facilitate students' self-development (Bureau of Academic Affairs and Educational Standards, 2008). To achieve learning objectives and ensure high academic performance, teachers must consider individual differences to fully develop students' potential (Koatrakul, 2008). In teaching mathematics, one effective method for helping students succeed is allowing them to engage in self-directed learning and practice. The integration of innovation and educational technology into the teaching process enhances its effectiveness. Therefore, teachers should choose appropriate learning media to support the teaching process and help students achieve the intended goals (Thepjinthana, 2008). Learning activities should also be enjoyable and engaging, with students as active participants in the learning process and challenged to learn effectively in the classroom (Panit, 2012). To ensure that students reach their full potential, learning media should be diverse and include natural media, printed materials, and technological tools. These resources enhance

learning, making it valuable, interesting, thought-provoking, easy to understand, and quick to grasp. They also encourage students to explore knowledge independently, fostering broad, deep, and continuous learning (Ministry of Education, 2008). Because each type of media provides different knowledge and learning experiences, combining various media systematically and coherently will lead to a richer learning experience.

GPAS-5 aligns with the development of 21st-century skills by promoting a motivating and enjoyable learning process, encouraging students to learn and work with others. By focusing on students and making them active participants in the learning process, this approach challenges students and fosters engagement (Panit, 2012). As a result, the GPAS-5 teaching method has become increasingly popular in education. This approach allows students to collaborate in groups, research answers independently, and communicate their findings to others, thereby fostering interest in learning and helping students solve problems by engaging in observation and inquiry.

An observation of the learning behaviors of grade 7 students at Sarawittaya School during the second semester of the 2024 academic year revealed issues in mathematics instruction. Students were disengaged from the learning process, often isolating themselves from their peers. They spent time using mobile phones to chat on social media, play games, or watch videos. Further observation of students' assignment submissions and individual interviews indicated these challenges in the learning process. However, when students' teamwork abilities were compared with their individual work capabilities, it was found that students performed better in teams than when working alone.

These findings prompted the researcher to conduct a study to develop students' mathematical linkage skills and innovative thinking using GPAS-5. This study aims to not only enhance students' mathematical connection skills but also promote their appreciation of mathematics, foster innovative thinking skills, and nurture them to become future innovators. It has the following objectives:

1. To determine the effectiveness index for analytical thinking skills among grade 7 students exposed to GPAS-5 learning for the topic of ratios and percentages.

2. To compare learning outcomes on the topic of ratios and percentages for grade 7 students before and after teaching using the GPAS-5 approach.

3. To assess the satisfaction of grade 7 students with the learning process using the GPAS-5 approach, specifically on the topic of ratios and percentages.

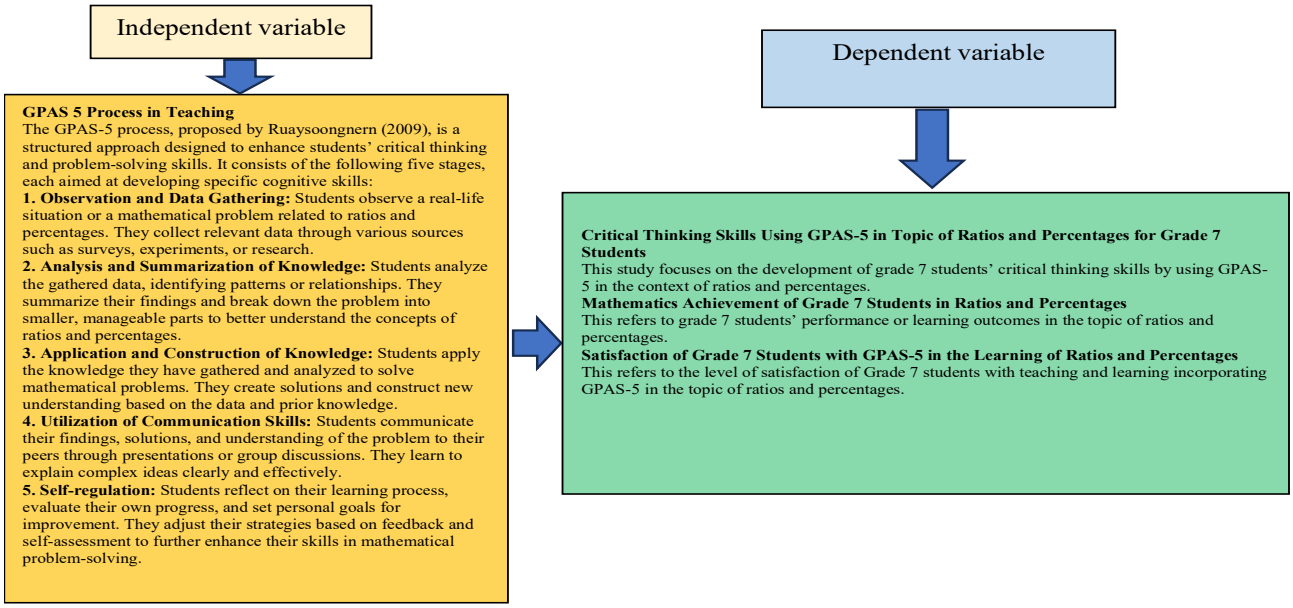

Figure 1: Please Add a Caption to This Figure

Definitions of Key Terms

GPAS-5 refers to teaching and learning using the GPAS approach proposed by Ruaysoongnern (2009), which consists of five steps:

Step 1: Gathering: Involves defining the topic by gathering information through sensory observation, recording data, and retrieving and summarizing previous information.

Step 2: Processing: Includes classifying, comparing, grouping, organizing, summarizing, reasoning, critiquing, and reviewing.

Step 3: Applying: Involves using knowledge creatively, analyzing, synthesizing, making decisions, applying knowledge to solve problems, and engaging in critical and creative thinking.

Step 4: Applying (Repeated): This step emphasizes applying knowledge creatively, analyzing, synthesizing, making decisions, and solving problems.

Step 5: Self-Regulating: Involves monitoring and controlling thinking, creating values, and developing habitual thinking patterns.

Learning Achievement refers to the scores obtained by grade 7 students on an achievement test designed by the researcher that covers the topic of ratios and percentages. The test is a four-choice multiple-choice questionnaire with 20 questions that assess knowledge, memory, calculation skills, understanding, application, and analysis.

Student Satisfaction refers to how grade 7 students think and feel about learning mathematics, specifically ratios and percentages, using the GPAS-5 approach. It is measured through a 10-item questionnaire based on a five-point Likert scale.

Research Methodology

In this study, both quantitative and qualitative research methods are employed in an experimental classroom setting. The study population consists of grade 7 students from Sarawittaya School, under the jurisdiction of the Office of the Basic Education Commission, Bangkok Metropolitan Area 2. The school has a total of 600 students enrolled in mathematics courses that follow the 2008 Basic Education Curriculum (revised 2017). The study was conducted in the first semester of the 2024 academic year. The sample comprised 40 grade 7 students from class 1/10 of Sarawittaya School, selected through cluster random sampling.

Research Instruments

The researcher examined the learning standards, student competencies, and assessment indicators for grade 7 students studying ratios and percentages through the GPAS-5 approach. The following instruments were created:

Lesson Plans: Four lesson plans for teaching ratios and percentages using the GPAS-5 approach were developed and submitted to the subject teacher for feedback. After subsequent revisions, they were presented to three experts in mathematics education, curriculum and instruction, and assessment and evaluation. These experts provided feedback, and the lesson plans were adjusted based on their suggestions. The revised lesson plans were then pilot-tested with students who were not part of the sample group.

Achievement Test: An achievement test on ratios and percentages for grade 7 students was created. This test consisted of 20 multiple-choice questions. It was presented to three experts in mathematics education, curriculum and instruction, and assessment for validation. The experts assessed its suitability and alignment with the learning objectives and content. The index of item-objective congruence (IOC) was calculated for the test items, with values ranging from 0.67 to 1.00. The final achievement test was pilot-tested with 40 students who were not part of the research sample but had already studied ratios and percentages. The test results were analyzed for difficulty level (p-value) and discrimination power for each question, and appropriate questions were selected for the final instrument.

Satisfaction Questionnaire: A satisfaction questionnaire was created, based on textbooks on questionnaire design and related research literature. The questionnaire aimed to measure student satisfaction with the learning activities using the GPAS-5 approach. It consisted of 10 items and used a five-level rating scale: very low, low, medium, high, and very high. The draft questionnaire was reviewed by three experts for suitability and alignment with the learning activities and revised on the basis of their feedback. After the revision, the IOC was calculated, yielding values of 0.67–1.00, and the reliability coefficient was 0.876. The finalized questionnaire was then presented to the research advisor and administered to the sample group.

Data Collection and Experimentation Process

The researcher implemented learning activities on the topic of ratios and percentages using the GPAS-5 approach with the sample group. After the implementation, the achievement test was administered, along with the satisfaction questionnaire to measure the students' satisfaction with the activities.

Data Analysis

The experimental data were analyzed by calculating the mean ($\bar{X}$) *and standard deviation (SD) and by performing a paired-sample t-test to compare pre- and post-test student achievement in ratios and percentages. The data from the satisfaction questionnaire were analyzed using grouped achievement results, with* $\bar{X}$ *and SD calculated for each group.*

Research Findings

The results of the research on developing analytical thinking skills among grade 7 students by using the GPAS-5 approach, specifically in the topic of ratios and percentages, are summarized as follows:

Development of Analytical Thinking Skills: The sample students showed significant improvement in their ability to analyze mathematical problems related to ratios and percentages and to apply their knowledge effectively. The learning process fostered their critical thinking and problem-solving skills.

Achievement Test Results: The post-test results of students indicated a marked increase in achievement compared to the pre-test results. Statistical analysis using the t-test revealed significant differences in student performance, demonstrating that GPAS-5 effectively enhanced students' understanding and problem-solving capabilities in mathematics.

Satisfaction with Learning Activities: The questionnaire showed that the students were highly satisfied with the learning activities. The majority stated that the GPAS-5 approach made the learning process more engaging and enhanced their understanding of ratios and percentages. Students felt more involved in the learning process, which contributed to their motivation and enthusiasm.

These findings suggest that GPAS-5 is an effective strategy for enhancing both analytical thinking skills and achievement in mathematics, as well as improving students' satisfaction with their learning experience. The approach also promotes active participation and engagement, making mathematics learning more enjoyable and meaningful for grade 7 students.

1. Development of Analytical Thinking Skills: The effectiveness index (EI) was used to measure the difference in analytical thinking skills before and after the learning process. This index was calculated using the following formula. Students' analytical thinking skills were found to improve significantly after the learning process using the GPAS-5 approach, as shown in Table 1.

Table 1: Effectiveness Index of Analytical Thinking Skills Scores Before and After Learning Using the GPAS-5 Approach

	n	Full score	Total score (maximum 800)	Mean score	EI	Percentage (%)
Pre-test	40	20	372.56	9.37	0.6923	69.23
Post-test	40	20	668.48	16.71		

As shown in Table 1, the EI for students' critical thinking scores, calculated from the pre- and post-instruction results using the GPAS-5 approach, was 0.6923, indicating a 69.23% gain in critical thinking skills.

2. Achievement Test Results: The post-test results of students indicated a marked increase in achievement compared to the pre-test results. The t-test revealed a significant difference in student performance, demonstrating that the GPAS-5 approach effectively enhanced students' understanding and problem-solving capabilities in mathematics.

2.1 As a result of the instruction using the GPAS-5 approach, students showed significant improvement in their ability to analyze mathematical problems related to ratios and percentages and apply their knowledge effectively. The learning process fostered their critical thinking and problem-solving skills.

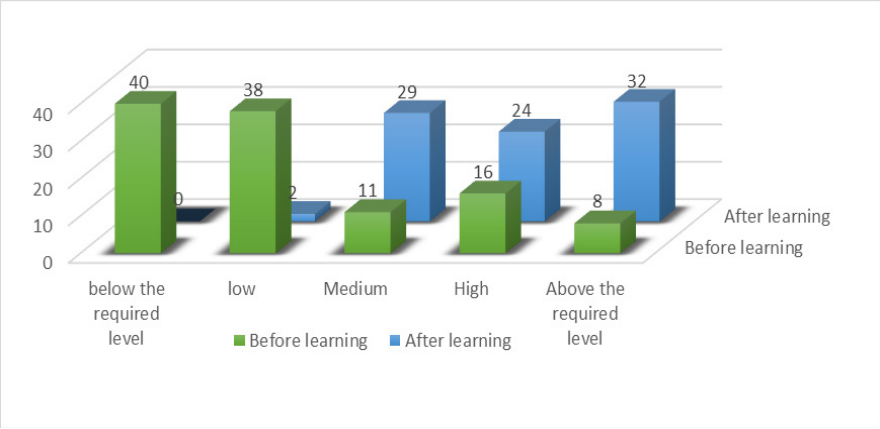

Figure 2: Please Add a Caption to This Figure

Figure 2 compares students' analytical thinking skills before and after the learning with the GPAS-5 approach, based on the results from the learning assessment through a learning record form. It is evident that the analytical thinking skills of the students significantly improved after undergoing the GPAS-5 learning process, enabling them to solve mathematical problems more effectively.

The taller the bar, the higher the analytical thinking skills score, indicating an improvement after applying the GPAS-5 approach. This type of bar chart clearly visualizes the comparison between pre- and post-learning analytical thinking skills and helps assess the effectiveness of the GPAS-5 teaching method. The teaching and learning process before the use of the GPAS-5 method and assessment for learning through a learning record form showed that most students (64.87%) had analytical thinking skills below the defined standard (0–49%). Moreover, only 2.7% of students had analytical thinking skills in the "moderately high" range (70–79%), and no students had scores in the "high" range (80–100%). After the teaching and learning process using the GPAS-5 method and assessment for learning through a learning record form, no students had analytical thinking scores below the defined threshold. Almost half of students (45.95%) had analytical thinking skills in the "moderate" range (60–69%), 32.43% of students had analytical thinking skills in the "moderately high" range (70–79%), and 10.81% had scores in the "high" range (80–100%). Thus, it can be concluded that the GPAS-5 process and assessment for learning through a learning record form successfully developed the analytical thinking skills of the students.

2.2 Table 2 compares the critical thinking skills in ratios and percentages before and after learning using the GPAS-5 approach.

Table 2: Comparison of Critical Thinking Skills in Ratios and Percentages Before and After Learning Using the GPAS-5 Approach

Sampling group	n	$\bar{X}$	S.D.	t	df	sig
Pre-test	40	9.37	0.59	16.76	39	0.00
Post-test	40	16.71	0.35			

$p < .05$

As shown in Table 2, the scores of the assessment evaluating critical thinking skills associated with ratios and percentages increased from 44.85% before learning using the GPAS-5 approach to 71.75% after the intervention ($p < .05$).

3. Satisfaction with Learning Activities: The overall satisfaction level of Grade 7 students with the learning process using the GPAS-5 approach for the topic of ratios and percentages had a high mean score of 4.71 (SD = 0.04), as shown in Table 3.

Table 3: Satisfaction of Students with Learning Activities Using the GPAS-5 Approach

n = 40

Item	$\bar{X}$	S.D.	Mean	Rank
Organization of learning activities	4.72	0.02	Very high	1
Learning materials and technology	4.69	0.01	Very high	4
Teacher	4.70	0.05	Very high	3
Measurement and evaluation	4.71	0.03	Very high	2
Total	4.71	0.04	Very high	-

Among the different aspects, the highest satisfaction was reported for the organization of learning activities ($\overline{X}$ =4.72, S.D.=0.02), followed by measurement and evaluation ($\overline{X}$ =4.71, S.D.= 0.03). The least satisfaction was reported for the learning materials and technology ($\overline{X}$ =4.69, S.D.=0.01).

Discussion

Guidelines for Developing Proactive Learning Using the GPAS 5 Steps Concept
Topic: Statistics to Promote Statistical Problem-Solving Processes for Grade 7 Students

Step 1: Gathering (G) – Observation and Data Collection

This step emphasizes using questions to stimulate students' interest. The teacher poses questions and hypotheses to trigger prior experiences and promote active learning. Students observe and collect data from diverse learning resources, select relevant information, and analyze real-life problems to understand causes, evaluate situations, and choose appropriate solutions. The teacher presents a situation (e.g., running a small shop) or allows students to choose one. Students formulate questions that require statistical data to answer. Each group identifies what data are needed, collects data through group members, and evaluates whether the questions are statistical in nature. Students present and justify their group's questions, encouraging full participation and engagement. This stage highlights learning through sensory pathways (sight, hearing, touch, smell, taste), which enhances brain development. Diverse environments promote curiosity and effective learning (Institute for the Promotion of Teaching Quality, 2021).

Step 2: Processing (P) – Analysis and Knowledge Construction

Students process data by analyzing, categorizing, comparing, and finding relationships. Using graphic organizers, they summarize essential ideas, synthesize key concepts, generate alternatives, and decide on the best approach for problem-solving. The teacher guides students to organize statistical data systematically. Students link statistical concepts to problem-solving processes. Groups discuss their findings, summarize key points, and compare them to the questions posed in Step 1. Teachers provide additional input on types of data, methods of data collection, and reliable sources. This step strengthens logical connections and systematic thinking, encouraging students to build conceptual understanding (Institute for the Promotion of Teaching Quality, 2021).

Step 3: Applying and Constructing the Knowledge (A1)

Students create and implement real work plans, evaluate their effectiveness, and refine their processes. They use insights gained to construct knowledge and principles. Groups decide how to present collected data (e.g., tables, charts, graphs). Students justify their choices (e.g., why a bar graph was used, how accuracy was verified). Activities develop creative thinking, problem-solving, and critical thinking. This aligns with the principle that active engagement and hands-on practice expand knowledge, foster deep understanding, and develop 21st-century competencies such as innovation, critical thinking, and lifelong learning (Institute for the Promotion of Teaching Quality, 2021).

Step 4: Applying Communication and Presentation Skills (A2)

Students present their work and problem-solving processes, including statistical questioning, data collection, interpretation, and data presentation. They use various formats such as reports, discussions, or project boards. Students demonstrate communication, creativity, and confidence. Teachers and peers provide feedback and ask clarifying questions to deepen understanding. This step reinforces the role of mathematics in daily life and society. It also supports students' confidence, participation, and ability to justify their reasoning.

Step 5: Self-Regulating (S)

Students evaluate both individual and group work, identifying strengths and weaknesses, and propose improvements. They reflect on the learning process and connect it to real-world applications, including innovation and social contributions. Activities may involve surveys (e.g., opinions about new technology). Students reflect on problem-solving, collaboration, and innovation skills. The focus is on fostering responsibility, self-regulation, and social value creation. This stage promotes metacognitive skills, reflective thinking, and lifelong learning competencies, helping learners align with global citizenship goals and 21st-century educational visions (Institute for the Promotion of Teaching Quality, 2021).

It was found that teaching methods using the GPAS-5 approach helped improve students' critical thinking skills. This improvement can be attributed to the GPAS-5 approach, in which the teacher acts as a facilitator by creating a suitable environment, presenting a problem, and providing all necessary support to students. The teacher guides and encourages students to think critically, with students performing tasks independently. This approach consists of four stages: gathering and selecting data, organizing data, applying knowledge, and self-regulating. During learning, various assessment tools, including worksheets, learning outcome records, and portfolio evaluations, provide feedback that helps students understand their strengths and weaknesses, allowing them to make adjustments in their learning. The portfolio serves as a tool for both students and their parents to evaluate progress and critical thinking skills. Teachers should train students to confidently express themselves through thinking, asking and answering questions, and engaging in discussions to develop critical thinking. Samrang (2002) similarly suggests that teachers should train students to ask questions, provide opportunities for self-questioning, and use prompting questions to encourage critical thinking development.

The research showed that the feedback from various assessment tools provided students with valuable information and significantly enhanced their critical thinking skills. These tools enabled students to record learning outcomes that reflected their thinking and displayed their critical thinking skills. It also allowed them to self-assess and review what they understood or did not understand, providing teachers with immediate insight into their progress. This process also promoted interaction and communication between students and teachers. Furthermore, through tasks such as completing mathematics worksheets and compiling portfolios, students were able to reflect on their learning and

make improvements based on feedback from self-assessments, peers, teachers, and parents, leading to continuous self-development. Waedlom (2010) and Stiggins et al. (2004) also emphasized the importance of assessment feedback in helping students improve their performance and engage in self-reflection.

The research findings also revealed that the EI for students' critical thinking skills, calculated from the pre- and post-instruction results, was 0.6923, indicating a 69.23% gain in critical thinking skills after the learning intervention using the GPAS-5 approach. Furthermore, the post-intervention critical thinking skills were statistically significantly higher than the pre-intervention scores ($p < .05$). This result can be attributed to the effectiveness of learning using the GPAS-5 approach, where the teacher stimulates students' thinking while allowing them to question and answer independently. This finding aligns with Ruaysungnoen (2009), who described the GPAS-5 process as a way of developing thinking skills, with the teacher creating an engaging environment while guiding students to think critically. It also reflects Marzano's (2001) categorization of critical thinking into five processes: classification, categorization, summarizing, applying, and predicting. Mathematics, as a subject that fosters logical and systematic thinking, supports students in analyzing problems and making informed decisions, which is consistent with the aims of the GPAS-5 approach.

From the study of student learning outcomes, it was found that students' achievement in mathematics, particularly in the topic of factoring quadratic expressions, improved significantly after learning with the GPAS-5 approach. Out of 40 students, 29 students (75%) passed the learning criteria, with a mean score of 80%, significantly higher than the 75% criterion ($p < 0.05$). This improvement was attributed to the use of the CPA method, which progresses from concrete to abstract learning stages. Students began with hands-on, concrete experiences and then progressed to abstract concepts, which deepened their understanding of the content. This approach aligns with the research of Ruaysoongnern (2009), who found that students' achievement in solving linear equations was improved by the GPAS-5 approach.

It was also found that students were highly satisfied with the learning activities, with the top three areas of satisfaction being activities that helped students develop their proficiency through self-directed learning (mean=4.77, S.D.=0.43), teaching materials that increased students' interest in learning (mean=4.69, S.D.=0.47), and activities that aligned with the content and followed a logical sequence from simple to complex, following the GPAS-5 approach (mean=4.63, S.D.=0.49). However, students were less satisfied with the fact that they were unable to immediately know the results of quizzes due to the time needed for grading. Additionally, some students felt that the GPAS-5 approach provided them with limited challenge, since they already understood the abstract concepts. Overall, the mean student satisfaction with the learning activities was 4.58, indicating a very high level of satisfaction. Khatbanjong and Painparadorn (2023) similarly reported high student satisfaction in mathematics learning using the GPAS-5 approach.

Based on the discussion of the research findings, the development of the learning activities for the topic of factorizing quadratic polynomials for grade 2 secondary students using the GPAS-5 approach met the desired criteria of 75/75. The results showed that students' learning achievements significantly improved, and their overall satisfaction with the learning activities was very high, with a mean score of 4.58. This success was due to the well-designed learning activities that considered differences among individual students and focused on real-life applications, allowing students to understand the relevance of mathematics in everyday life. The GPAS-5 approach helped ensure that students developed a deeper understanding of mathematical concepts, resulting in positive learning outcomes.

Recommendations

Various assessment tools, including worksheets, learning outcome records, and portfolio evaluations, should be used to develop students' critical thinking skills. By using diverse tools, teachers can monitor students' progress and help them recognize their strengths and weaknesses. It is also essential to provide continuous feedback to students through these assessment tools, so that they receive information on their strengths and weaknesses, allowing improvement and self-development.

In future research, the GPAS-5 approach could be applied to develop other thinking skills, such as creative thinking, problem-solving, and evaluative thinking. Further studies could investigate the long-term effects of using the GPAS-5 approach in enhancing students' critical thinking skills. Other variables that may impact the development of students' critical thinking skills, such as family background, students' attitudes, and academic performance, could also be explored.

References

Bureau of Academic Affairs and Educational Standards. (2008). *The Basic Education Core Curriculum B.E. 2551 (A.D. 2008).* Ministry of Education. (in Thai)

Ennis, R. H. (2011). *The nature of critical thinking: An outline of critical thinking dispositions and abilities.* University of Illinois.

Facione, P. A. (1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. *The Delphi Report.* American Philosophical Association.

Institute for the Promotion of Teaching Quality. (2021). *Learning environment and brain-based learning for quality development.* Institute for the Promotion of Teaching Quality.

Khatbanjong, S., & Painparadorn, T. (2023). The development of the mathematics learning outcome on equality of Mathayom 2 students by using STAD technique. *An Online Journal of Education, 18*(2), 1–18. https://doi.org/10.14456/ojed.2023.15 (in Thai)

Koatakul, S. (2008). *Educational psychology* (7th ed.). Chulalongkorn University Press. (in Thai)

Marzano, R. J. (2001). *Designing a new taxonomy of educational objectives*. Corwin Press.

Ministry of Education. (2008). *Guidelines for student development activities according to the curriculum of Basic Education B.E. 2544*. Kurusapa Printing. (in Thai)

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston.

Panit, W. (2012). *21st century learning path for disciples*. SodsriSaritwong Foundation. (in Thai)

Paw. (2018). *Guidelines for GPAS 5 steps learning management.* Schools under the Institute for the Promotion of Teaching Science and Technology.

Ruaysungnoen, T. (2007). *Guidelines for managing teaching and learning concepts. In Practice manual: Taking teachers to follow the project to move thinking into the classroom*. Area Office Sisaket Education Area 2. (in Thai)

Ruaysoongnern, T. (2009). *A document of developing thinking skills in the research and development project of learning models for developing basic education students' thinking* (2nd ed.). Institute of Learning Development Bangkok. (in Thai)

Samrang, C. (2002). *Why we teach and how to teach: How to design learning activity for children to learn to think.* Sodsri-Saridwongso Foundation. (in Thai)

Skinner, B. F. (1989). *The origins of cognitive thought: Recent issues in the analysis of behavior.* Merrill Publishing.

Stiggins, R. J., Arter, J. A., Chappuis, J., & Chappuis, S. (2004). *Classroom assessment for student learning.* Assessment Training Institute.

The Institute for the Promotion of Teaching Science and Technology. (2012). *Mathematics curriculum and teaching guidelines.* IPST.

Thepjinda, J. (2008). *The study of academic achievement in mathematics on the Pythagorean theorem using multimedia for 2nd-year secondary school students at Wat Khao Siwichai School, Surat Thani Province.* [Unpublished master's thesis] Kasetsart University. (in Thai)

Waedlom, N. (2010). *Development of analytical thinking ability on mathematical substances of grade 6 students, Kamkehatharsai School, under Bangkok Metropolitan administration by formative alternative assessment.* [Unpublished master's thesis] Kasetsart University. (in Thai)