

The Effects of the 4MAT learning model on the Scientific Process Skills of Grade 4 Students

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Abstract

The purpose of this study was to compare the scientific process skills of Grade 4 students before and after learning through the 4MAT learning model. The study was conducted in a medium-sized school under the Nongbualamphu Primary Education Service Area Office 1 during the second semester of the 2022 academic year. The sample consisted of 30 students that selected by cluster random sampling. This study design was one-group pretest-posttest design. The instruments used in this study included 1) 5 lesson plans on materials and substances by using the 4MAT learning model, and, 2) scientific process skills test. The data were analyzed using mean, standard deviation, percentage, and hypothesis testing to compare scientific process skills between before and after learning by t-test for dependent sample. The results of this study showed students' scientific process skills after learning ($\bar{x}=13.57$ or 74.81%) was higher than before learning ($\bar{x}=5.97$ or 33.15%) in significance at the 0.01 level.

Keywords: The 4MAT learning model; Scientific process skills; Grade 4 students

Introduction

Scientific process skills refer to the abilities and techniques used to investigate natural phenomena, collect and analyze data, and draw conclusions based on evidence. These skills are fundamental to the practice of science and involve a systematic approach to understanding the world. Gagne (2020) defined scientific process skills as "mental and physical abilities that enable learners to understand and investigate the scientific world effectively." According to National Research Council. (2012), Scientific process skills serve as essential tools for learning science and understanding the nature of scientific inquiry. These skills empower learners to approach problems systematically, enhance critical thinking, and develop a comprehensive understanding of scientific concepts. Core skills such as observing, classifying, predicting, and analyzing enable students to think critically

and engage meaningfully with scientific practices. According to Bybee, R. W. (2014), these skills enable students to ask questions, gather evidence, and draw logical conclusions, fostering their ability to solve real-world problems. Children at this 7-11 age are naturally curious. Scientific skills encourage inquiry-based learning, where students explore and discover answers themselves. Sharp, J., Peacock, G., Johnsey, R., Simon, S., Smith, R., Cross, A., & Harris, D. (2021) highlight that engaging young learner in hands-on activities develops their curiosity and enthusiasm for learning. Teaching these skills equips students to approach everyday challenges methodically. According to Piaget's theory of cognitive development, children in the concrete operational stage (ages 7–11) are primed to understand logical processes, making this an ideal time to teach such skills. By incorporating scientific process skills into Class 4 curricula, educators empower students with essential tools for academic success and personal growth. These skills encourage a deeper understanding of the world and prepare students for future challenges in a rapidly changing society.

The 4MAT learning model, developed by Bernice McCarthy, is highly effective in science classrooms because it caters to diverse learning styles and enhances student engagement, understanding, and retention. This model integrates different teaching strategies to address the varied needs of learners by connecting content to real-life experiences, promoting active participation, and encouraging higher-order thinking. The 4MAT model is based on Kolb's experiential learning theory, which identifies four types of learners: Type 1 (Innovative Learners): Learn by feeling and reflecting, Type 2 (Analytic Learners): Learn by thinking and understanding, Type 3 (Common Sense Learners): Learn by doing and experimenting, Type 4 (Dynamic Learners): Learn by creating and integrating, In a science classroom, this ensures that lessons reach all students, regardless of their preferred learning style (Sabry, M., El-Baaly, T., & Abu-Risk, O. E. M., 2021) The model connects scientific concepts to real-world experiences, making lessons more meaningful. For example, it begins with a personal connection (Why phase) and then builds understanding, practice, and application (What, How, and If phases). Science requires hands-on experimentation and critical thinking. The "How" phase of the 4MAT model supports active participation through experiments, projects, and collaborative activities, essential for understanding scientific concepts. The "If" phase challenges students to extend their learning by solving real-world problems, designing experiments, or exploring new applications, fostering creativity and innovation. Studies have shown that implementing the 4MAT model improves student achievement and interest in science. For example, Alanazi, F. H. (2020) demonstrated that the 4MAT model enhances conceptual understanding and supports differentiated instruction in science classrooms. By using the 4MAT model, teachers can create a dynamic and inclusive science learning environment

that not only addresses diverse learning needs but also fosters critical thinking and lifelong curiosity in students.

Research Objective

This research aimed to compare the scientific process skills of Grade 4 students before and after learning through the 4MAT learning model.

Research Hypothesis:

Students who studied using the 4MAT learning model demonstrated higher scientific process skills after studying compared to before studying.

Conceptual Framework

The research conceptual framework based on the 4MAT learning model which means the 4MAT learning model is an instructional activity that emphasizes responding to the diversity of learners through a combination of learning styles and brain-based learning processes. The activities start with creating interest (Why?), moving on to learning the content (What?), doing it in practice (How?), and ending with applying and extending knowledge (If?). This process helps learners connect knowledge to real life, learn deeply, and develop important skills effectively. In this research, the researcher used the 8-step 4MAT learning model of McCarthy. The details are as follows.

1. Independent variables: 4MAT learning model

Part 1 Meaning: Give meaning

Step 1 R: Connect, encourages students to connect and exchange experiences with each other.

Step 2 L: Attend, encourages students to think outside the box. The teacher should encourage students to capture the points that are closest to each content.

Part 2 Concepts: Concepts:

Step 3 R: Image, try to draw a variety of data to make it clearer.

Step 4 L: Inform, tell what you need to learn, summarize from the suggested diagram concepts and experiences that have been suggested.

Part 3 Skills: Practice skills

Step 5 L: Practice, the teaching format is a workshop where students try practicing or doing real work.

Step 6 R: Extend knowledge, the teacher assigns a task or project for the students to use the knowledge from this practice to further develop.

Part 4 Adaptations: Application

Step 7 L: Refine, analyze the problem, the learning that occurred, and the solutions that may occur.

Step 8 R: Perform, summarize, evaluate what has been learned, and apply it.

2. Dependent variable: Scientific process skills is the ability to perform scientific study in a methodical manner, including investigating, analyzing, and solving problems rationally and scientifically. These abilities assist students in developing a knowledge of the nature of science and the process of working as scientists. In this research, 6 scientific process skills were promoted: 1) observation, 2) inferring, 3) organizing data and communication, 4) experimenting, 5) interpreting data and conclusion, and 6) modeling construction. The 6 scientific process skills were tested using open-ended, subjective questions.

Research Methodology

1. Population and Samples; Grade 4 students in medium size school under the Nongbualamphu Primary Education Service Area Office 1 during the second semester of the 2022 academic year. The sample consisted of 30 students that selected by cluster random sampling. The population comprised two classrooms with a total of 135 students in 10 classrooms.

2. Variables used in the research;

2.1 Independent variables: 4MAT learning model

2.2 Dependent variable: Scientific process skills

3. Duration of time used in the research;

The duration of time used in this research involved a teaching experiment 5 weeks, with each 3 hours of teaching. The total teaching hours amounted to 15 hours. This experiment was excluding the hours dedicated to pre-test and post-test assessments.

4. Research Design;

Research design used is one group pretest and posttest design.

Group	Pretest	Experimental	Posttest
E	O ₁	X	O ₂

E The sample group

O₁ Pretest

X Using 4MAT learning

O₂ Posttest

5. Research Instruments;

5.1 Instrument for teaching experiments by 8-step of 4MAT learning model of McCarthy, five lessons plan on contents materials and matter include the following

contents: 1) Elasticity. 2) Hardness of materials. 3) Thermal conductivity in materials 4) Electrical conductivity of materials. 5) Material-based toys and utensils to promote scientific process skills of Grade 4 students.

5.2 Instruments of Evaluation by the scientific process skills test, the test is using open-ended, subjective questions of 6 scientific process skills; 1) observation, 2) inferring, 3) organizing data and communication, 4) experimenting, 5) interpreting data and conclusion, and 6) modeling construction.

6. Data Collection; The researcher conducting experiments and collecting data of using 4MAT learning model to a sample group as follow the steps.

6.1 The sample group applied scale of pretest of the scientific process skills test.

6.2 The teacher was informed about the purpose of the study and using instruction based on the 4MAT learning model of McCarthy, five lessons plan on contents materials and matter in classroom research, during the process teacher was observed, the interaction between teacher-students and students-students. The study instruments 7 weeks, 5 weeks for the instruction, 2 weeks for the application of the pretest and the posttest

6.3 Applied scale of posttest scientific process skills that the test same pretest.

6.4 The pretest and posttest scores were used to analyze the statistical data to test the hypotheses further.

7. Data Analysis; mean (\bar{x}), percentage (%), and standard deviations (S.D) of measured quantities was determined and t-test for dependent samples to compare a greater learning scientific process skills after studying than before studying.

Research Finding

Scientific process skills: The comparison between pretest-posttest of scientific process skills of grad 4 students by using the 4MAT learning model this can be summarized in table 1 as below.

Table 1: Data analysis results of scientific process skills.

Scientific process skills	Score	Test	\bar{x}	S.D	%	t	\bar{x}
1. observation	3	Pretest	1.37	0.67	45.56	6.44	0.00**
		Posttest	2.43	0.73	81.11		
2. inferring	3	Pretest	1.10	0.66	36.67	7.10	0.00**
		Posttest	2.30	0.70	76.67		
3. organizing data and communication	3	Pretest	0.90	0.66	30.00	8.55	0.00**
		Posttest	2.07	0.78	68.89		
4. experimenting	3	Pretest	0.93	0.73	28.89	8.26	0.00**

Scientific process skills	Score	Test	\bar{x}	S.D	%	t	\bar{x}
		Posttest	2.07	0.74	73.33		
5. interpreting data and conclusion	3	Pretest	0.87	0.55	30.00	7.30	0.00**
		Posttest	2.20	0.58	68.89		
6. modeling construction	3	Pretest	1.07	0.61	36.67	9.14	0.00**
		Posttest	2.27	0.64	75.56		
overall	18	Pretest	5.50	0.65	30.56	33.59	0.00**
		Posttest	13.13	0.68	72.92		

Note. ** $p < .01$

According to table 1, the mean scientific process skills pretest score obtained by Grade 4 students for overall was 5.50 (30.56%). After learning, their mean posttest score is 13.13 (72.92%). This is a comparison to determine how there is improvement from pretest to posttest; the results reveal that the posttest mean score was higher than the pretest.

Research Conclusion:

The findings of this study demonstrate a significant improvement in the scientific process skills of Grade 4 students following the learning intervention. The mean pretest score of 5.50 (30.56%) increased to a mean posttest score of 13.13 (72.92%). This substantial growth indicates that the implemented learning activities effectively enhanced the students' understanding and application of scientific process skills. The results highlight the positive impact of the intervention in fostering students' abilities in this domain.

Results Discussions:

Learning activities in science classrooms using the 4MAT learning model resulted in Grade 4 students obtaining a higher level of scientific process skills for the following reasons; 1) the 4MAT model supports students' various learning styles by including activities geared toward visual, auditory, kinesthetic, and analytical learners. This ensures increased engagement and skill development as students interact with the subject in ways that communicate to them Alanazi, F. H. (2020), 2) the 4MAT model fosters the development of critical scientific process skills, such as observation, experimentation, and data collection that by emphasizing hands-on learning through inquiry-based activities Active learning has been shown to significantly enhance student outcomes in science education (National Research Council, 2012), 3) the four stages of 4MAT ("Why," "What," "How," and "If") closely align with the steps of the scientific process. This scaffolding approach helps students understand and internalize the methodology of scientific inquiry (Alsaleem, B. I. A. (2019), 4) the model's structure incorporates opportunities for critical analysis and creative exploration, especially during the "How" and "If" stages. These stages encourage students to

hypothesize, test, and apply their findings in novel situations, which are essential components of scientific skill-building (Walters-Williams, J., 2022), 5) the "Why" stage connects learning content to students' real-world experiences and interests, motivating them to explore further. Research suggests that contextualized learning improves students' engagement and retention, particularly in scientific disciplines (Teo, T. W., 2017), 6) collaborative activities embedded in the 4MAT framework enhance students' teamwork and communication skills. These are vital for scientific inquiry as students share observations, interpret data, and discuss results (Johnson, D. W., & Johnson, R. T., 2019), 7) the "If" stage encourages reflection and synthesis, allowing students to evaluate their findings and explore new possibilities. Reflective practices are strongly correlated with higher-order thinking and problem-solving skills in science education (Kolb, D. A., Boyatzis, R. E., & Mainemelis, C., 2017), 8) the 4MAT model supports cognitive development by guiding students through concrete and abstract learning experiences, which is critical for young learners in grade 4 (Lefa, B., 2014). Therefore, the 4MAT learning model's structured yet flexible approach engages students in meaningful, hands-on learning experiences. By addressing diverse learning needs, fostering critical thinking, and aligning with the scientific method, it enables grade 4 students to develop and enhance their scientific process skills effectively.

Suggestions

1. Suggestions for applying the research results

1.1 The 4MAT learning model of teaching focuses on four types of learning activities for students and promotes the interaction of the right brain (imaginative) with the left brain (logical). As a result, teachers should comprehend the learning management process, which focuses on the simultaneous development of the right and left brains and teachers must monitor all four sorts of students in order to educate them imagination and reasoning.

1.2 Teachers should closely supervise students during the learning/experimental activities in steps 4 and 5, as well as when producing diagrams and writing knowledge descriptions in step 6 of the 4MAT learning model. They should also advise students to gradually complete activities until they find the answers themselves. Teachers should not provide students with answers to the tasks. And should stress encouraging students to express their thoughts or respond to everyone because some students are terrified of answering questions incorrectly.

2. Suggestions for future research

2.1 The 4MAT learning model approach should be used to teach science subjects at various levels, with the material and learning activities tailored to the students' abilities.

2.2 To handle classroom challenges and develop student abilities in multiple areas, the 4MAT learning model should be complemented with other variables that influence student learning, such as problem-solving ability, creativity, and learning satisfaction, among others.

References

- Alanazi, F. H. (2020). The Effectiveness of the 4MAT Teaching Approach in Enhancing Conceptions of Electricity in Physics for Female Students in the Kingdom of Saudi Arabia. *Journal of Turkish Science Education*, 17(2), 271–288.
- Alsaleem, B. I. A. (2019). "The 4MAT Model in English Language Teaching." *Arab World English Journal*, 10(4), 112–120.
- Bybee, R. W. (2014). NGSS and the Next Generation of Science Teachers. *Journal of Science Teacher Education*, 25(2), 211–221.
- Gagné, R. M. (2020). *The Conditions of Learning and Theory of Instruction* (5th ed.). New York, NY: Holt, Rinehart & Winston.
- Lefa, B. (2014). The Contribution of Vygotsky's Theory to Education. *Procedia - Social and Behavioral Sciences*, 116, 477–484.
- Johnson, D. W., & Johnson, R. T. (2019). *Cooperation and the Use of Technology*. In *Handbook of Research on Learning and Instruction* (pp. 1–22). Routledge.
- Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2017). *The Handbook of Experiential Learning and Management Education*. Oxford University Press.
- National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press.
- Sabry, M., El-Baaly, T., & Abu-Risk, O. E. M. (2021). Using 4MAT Model to Develop First Primary Pupils Creative Thinking Skills in Science. *Journal of Research in Curriculum Instruction and Educational Technology*, 7(3), 15-35.
- Sharp, J., Peacock, G., Johnsey, R., Simon, S., Smith, R., Cross, A., & Harris, D. (2021). *Primary Science: Teaching Theory and Practice*. Primary Science.
- Teo, T. W. (2017). *Science Education Research and Practice in Asia-Pacific and Beyond*. Springer.
- Walters-Williams, J. (2022). H-CUP: Increasing Higher Order Thinking Skills Levels through a Framework Based on Cognitive Apprenticeship, Universal Design, and Project-Based Learning. *Creative Education*, 13(9), 1818–1832.