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Enhancing Junior High School Students' Analytical Thinking and Science Learning Achievement Through Active Learning Based on the MACRO Model

*Sirimas Thipjaroom, Prasart Nuangchalerm**

Mahasarakham University, Thailand
*Correspondence: E-mail: prasart.n@msu.ac.th

ABSTRACT

This classroom action research aimed to enhance junior high school students' analytical thinking ability and science learning achievement through active learning based on the MACRO Model. The participants were 32 students from Nikomsangtoneng Rayong 8 School, Thailand. The intervention consisted of ten lesson plans on Motion and Force, implemented over two learning cycles. Data were collected using analytical thinking tests, science achievement tests, and a learning behavior observation form. The data were analyzed using mean, percentage, and standard deviation. The findings showed improvements in analytical thinking ability and science learning achievement across the two cycles. Students also demonstrated positive learning behaviors during the active learning process. The results suggest that the MACRO Model can support science learning among junior high school students.

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1. INTRODUCTION

The development of analytical thinking is an important goal of science education, particularly in preparing students to understand scientific concepts, interpret evidence, solve problems, and make reasoned decisions in daily life. In the context of twenty-first-century learning, students are expected not only to acquire knowledge but also to apply higher-order thinking skills, collaborate with others, communicate ideas, and respond effectively to complex situations. Therefore, science instruction should provide learning experiences that encourage students to actively engage in inquiry, analyze information, construct explanations, and reflect on their learning processes.

Science learning plays a crucial role in developing students' ability to understand natural phenomena and apply scientific knowledge to real-life situations [1, 2]. However, science instruction in many classrooms still tends to emphasize content delivery and memorization rather than active participation and thinking skill development. Such instructional practices may limit students' opportunities to ask questions, investigate problems, discuss ideas, and build conceptual understanding. To address these challenges, learning activities should be designed to promote student-centered learning, meaningful participation, and the development of analytical thinking skills.

Active learning is an instructional approach that can support these goals by engaging students directly in the learning process. Through active learning, students are encouraged to participate in discussions, conduct investigations, solve problems, present ideas, and construct knowledge through interaction with peers and teachers. Previous studies have shown that active learning can improve students' scientific problem-solving, conceptual understanding, and learning achievement in science classrooms [3, 4]. These findings indicate that active learning is relevant for promoting both cognitive and behavioral aspects of student learning.

One active learning approach that can be applied in science instruction is the MACRO Model. This model consists of five instructional stages: motivation, active learning, conclusion, reporting and presentation, and knowledge dissemination. These stages provide students with opportunities to become motivated learners, participate in meaningful learning activities, summarize knowledge, communicate findings, and share what they have learned with others. Through these processes, students are expected to develop analytical thinking, problem-solving ability, collaboration, and a deeper understanding of scientific concepts.

In some schools, students' analytical thinking ability was found to be below the expected standard. A preliminary assessment of junior high school students using a multiple-choice test based on everyday scientific phenomena showed that students had difficulty analyzing significance, identifying relationships, and applying principles. In addition, students' science learning achievement showed a declining trend in previous academic years. These conditions indicate the need for instructional improvement that can help students become more actively involved in learning and develop better analytical thinking skills.

Based on these considerations, this study applied active learning based on the MACRO Model to improve junior high school students' analytical thinking ability and science learning achievement in the topic of Motion and Force. The study was conducted through classroom action research consisting of two learning cycles. The findings are expected to provide evidence on how active learning based on the MACRO Model can support students' higher-order thinking and science learning achievement.

2. METHODS

This study employed classroom action research to enhance junior high school students' analytical thinking ability and science learning achievement through active learning based on the MACRO Model. The research was conducted during the second semester of the 2023 academic year in a science classroom at Nikomsangtoneng Rayong 8 School, Thailand. The instructional topic was Motion and Force.

The participants were 32 junior high school students from class 2/4 at Nikomsangtoneng Rayong 8 School, Thailand. They were selected through purposive sampling because they were students in the classroom and were directly involved in the implementation of the instructional intervention.

The intervention was implemented in two learning cycles. Each cycle consisted of planning, action, observation, and reflection. In the planning stage, we identified students' learning problems, prepared active learning activities, and developed research instruments. In the action stage, the learning activities were implemented using lesson plans based on the MACRO Model. In the observation stage, data were collected through tests, classroom observation, and video recordings. In the reflection stage, we analyzed the results of each cycle and used the findings to improve the next instructional cycle.

The instructional intervention consisted of ten active learning lesson plans on Motion and Force. Each lesson lasted two hours, resulting in a total of 20 instructional hours. Learning Cycle 1 covered Lesson Plans 1-5, while Learning Cycle 2 covered Lesson Plans 6-10.

Four types of research instruments were used in this study. The first instrument was a set of active learning lesson plans on Motion and Force based on the MACRO Model. The second instrument was an analytical thinking ability test consisting of open-ended items. The third instrument was a science learning achievement test consisting of multiple-choice items. The fourth instrument was a student learning behavior observation form used to record students' participation, task completion, collaboration, and thinking and problem-solving behaviors during the learning activities.

Data were collected from analytical thinking ability tests, science learning achievement tests, classroom observations, video recordings, and the student learning behavior observation form. At the end of each learning cycle, students completed the analytical thinking ability test and the science learning achievement test. Their learning behaviors were also observed and recorded during the implementation of the active learning activities.

The data were analyzed using descriptive statistics, including mean, percentage, and standard deviation. Analytical thinking ability was assessed in three dimensions: analysis of significance, analysis of relationships, and analysis of principles. The scoring criteria were classified into three levels: good, fair, and needs improvement. Students were required to achieve at least 70% of the total score to meet the criterion. Science learning achievement was also evaluated using a 70% criterion. Students' learning behaviors were analyzed using mean percentage and interpreted according to the quality levels in the observation form.

3. RESULTS AND DISCUSSION

This section presents the results of the classroom action research conducted in two learning cycles and discusses the effectiveness of active learning based on the MACRO Model in enhancing junior high school students' analytical thinking ability and science learning

achievement. The findings are organized according to the sequence of the learning cycles, beginning with the results of analytical thinking ability, learning achievement, and students' learning behaviors in the first cycle, followed by the results of the second cycle. The discussion also compares the progress between the two cycles and relates the findings to previous studies on active learning, analytical thinking, and science learning achievement.

The results of the first learning cycle showed that students' analytical thinking ability improved after the implementation of active learning based on the MACRO Model through Learning Management Plans 1-5. As shown in **Table 1**, the mean score for analysis of significance was 2.73, followed by analysis of principles at 2.59 and analysis of relationships at 2.53. The overall mean score was 2.62 out of 3, equivalent to 87.33%, which was classified as a good level. At the individual level, 29 students met the 70% criterion, while 3 students did not meet the criterion. These findings indicate that most students were able to analyze important information and apply scientific principles, although some still had difficulty identifying relationships among concepts, causes, and effects in scientific situations.

The learning achievement results in the first learning cycle are presented in **Table 2**. The findings showed that 29 students achieved the 70% criterion, while 3 students did not. The mean score was 16 out of 20, equivalent to 80.47%. This result indicates that active learning activities helped most students understand the topic of Motion and Force. However, the students who did not meet the criterion showed that further instructional support was still needed, particularly in helping students apply scientific concepts to problem-solving tasks and test items.

The observation results in **Table 3** showed that students' learning behaviors in the first learning cycle were at a good level in all assessed attributes. Students' behavior during learning activities reached 90.23%, behavior in completing assigned tasks reached 92.19%, and thinking and problem-solving ability reached 83.85%. These results suggest that students were generally engaged in learning activities, able to collaborate with peers, and able to complete assigned tasks. Nevertheless, participation in expressing opinions and the ability to analyze and synthesize were relatively lower than other indicators. This condition suggests that active learning requires continuous teacher facilitation, structured questioning, discussion, and reflection to encourage students to participate more actively and think more deeply [5, 6]. Therefore, instructional strategies should be designed to improve students' ability to analyze, interpret, explain, and construct knowledge [7-9].

Based on the reflection from the first cycle, improvements were made in the second cycle by providing clearer instructions, strengthening teacher guidance, encouraging more student participation, and using problem situations connected to real-life contexts. The results of the second learning cycle showed further improvement in students' analytical thinking ability. As presented in **Table 4**, the mean score for analysis of significance increased to 2.80, analysis of relationships increased to 2.63, and analysis of principles increased to 2.64. The overall mean score increased to 2.69 out of 3, equivalent to 89.53%, which was also classified at a good level. At the individual level, 30 students met the 70% criterion, while only 2 students did not. This improvement indicates that the instructional adjustments made after the first cycle helped students analyze scientific information more effectively.

The learning achievement results in the second learning cycle, based on Learning Management Plans 6-10, are presented in **Table 5**. The findings showed that all 32 students achieved the 70% criterion. The mean score was 17 out of 20, equivalent to 84.06%.

Compared with the first cycle, students' learning achievement improved, and no students failed to meet the criterion. This finding indicates that active learning based on the MACRO Model supported students' conceptual understanding of Motion and Force. The improvement may be attributed to learning activities that encouraged students to discuss ideas, investigate problems, apply concepts, and receive clearer guidance during the learning process. This result supports previous studies showing that active learning can improve science learning achievement, problem-solving ability, and students' engagement in classroom activities [3, 4, 10, 11].

Table 1. The first learning cycle: analytical thinking ability

NO	ASSESSMENT CRITERIA			TOTAL (9)	$\bar{x}$	SD	QUALITY LEVEL	%	≥ 70% CRITERION
	ANALYSIS OF SIGNIFICANCE (3)	ANALYSIS OF RELATIONSHIP (3)	ANALYSIS OF PRINCIPLES (3)						
1	2.50	2.00	2.00	6.50	2.17	0.29	Fair	72	Pass
2	3.00	2.00	3.00	8.00	2.67	0.58	Good	89	Pass
3	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
4	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
5	2.00	2.00	2.00	6.00	2.00	0.00	Fair	67	Fail
6	1.50	1.50	2.00	5.00	1.67	0.29	Fair	56	Fail
7	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
8	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
9	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
10	3.00	2.00	2.50	7.50	2.50	0.50	Good	83	Pass
11	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
12	2.00	1.50	2.00	5.50	1.83	0.29	Fair	61	Fail
13	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
14	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
15	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
16	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
17	3.00	2.00	2.00	7.00	2.33	0.58	Fair	78	Pass
18	2.50	2.50	2.50	7.50	2.50	0.00	Good	83	Pass
19	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
20	2.00	2.50	2.00	6.50	2.17	0.29	Fair	72	Pass
21	3.00	2.00	3.00	8.00	2.67	0.58	Good	89	Pass
22	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
23	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
24	2.50	2.50	2.50	7.50	2.50	0.00	Good	83	Pass
25	2.50	2.50	2.50	7.50	2.50	0.00	Good	83	Pass
26	3.00	3.00	2.50	8.50	2.83	0.29	Good	94	Pass
27	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
28	3.00	3.00	2.50	8.50	2.83	0.29	Good	94	Pass
29	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
30	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
31	3.00	3.00	2.50	8.50	2.83	0.29	Good	94	Pass
32	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
$\bar{x}$	2.73	2.53	2.59	7.86	2.62	0.24	-	-	-
SD	0.40	0.46	0.37	1.02	0.34	0.18	-	-	-
%	91.15	84.38	86.46	87.33	87.33	-	-	-	-
Level	Good	Good	Good	-	-	-	-	-	-

Table 2. The first learning cycle: learning achievement

NO	SCORE OBTAINED (20)	% OF FULL SCORE	CRITERION
1	14	70	Pass
2	15	75	Pass
3	16	80	Pass
4	16	80	Pass
5	12	60	Fail
6	13	65	Fail
7	15	75	Pass
8	15	75	Pass
9	14	70	Pass
10	16	80	Pass
11	18	90	Pass
12	14	70	Pass
13	17	85	Pass
14	17	85	Pass
15	18	90	Pass
16	16	80	Pass
17	15	75	Pass
18	16	80	Pass
19	18	90	Pass
20	13	65	Fail
21	17	85	Pass
22	17	85	Pass
23	16	80	Pass
24	18	90	Pass
25	18	90	Pass
26	16	80	Pass
27	19	95	Pass
28	17	85	Pass
29	17	85	Pass
30	16	80	Pass
31	18	90	Pass
32	18	90	Pass
Mean	**16**	**80.47**	-
SD	**1.73**	**8.65**	-

Table 3. First learning cycle - observation of students' learning behaviors

ATTRIBUTE	ASSESSMENT CRITERIA	MEAN (%)	QUALITY
Students' behavior during learning activities	1. Interest in learning activities	96.88	Good
	2. Participation in expressing opinions	76.56	Good
	3. Responding to questions	93.75	Good
	4. Accepting others' opinions	93.75	Good
	Overall	90.23	Good
Behavior in completing assigned tasks	1. Consulting and planning collaboratively before working	93.75	Good
	2. Performing tasks according to procedures	92.19	Good
	3. Work outcomes meet the specified objectives	90.63	Good
	Overall	92.19	Good
Thinking and problem-solving ability	1. Ability to analyze and synthesize	76.56	Good
	2. Ability to construct knowledge	87.50	Good
	3. Ability to make appropriate decisions to solve problems	87.50	Good
	Overall	83.85	Good

Table 4. Second learning cycle - analytical thinking ability

NO	ASSESSMENT CRITERIA			TOTAL (9)	$\bar{x}$	SD	QUALITY LEVEL	%	≥ 70% CRITERION
	ANALYSIS OF SIGNIFICANCE (3)	ANALYSIS OF RELATIONSHIPS (3)	ANALYSIS OF PRINCIPLES (3)						
1	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
2	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
3	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
4	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
5	2.50	2.00	2.00	6.50	2.17	0.29	Fair	72	Pass
6	2.00	2.00	2.00	6.00	2.00	0.00	Fair	67	Fail
7	3.00	3.00	2.50	8.50	2.83	0.29	Good	94	Pass
8	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
9	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
10	3.00	2.00	3.00	8.00	2.67	0.58	Good	89	Pass
11	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
12	2.00	2.00	2.00	6.00	2.00	0.00	Fair	67	Fail
13	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
14	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
15	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
16	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
17	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
18	2.50	2.50	2.50	7.50	2.50	0.00	Good	83	Pass
19	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
20	2.00	2.50	2.00	6.50	2.17	0.29	Fair	72	Pass
21	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
22	3.00	2.50	3.00	8.50	2.83	0.29	Good	94	Pass
23	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
24	2.50	2.50	2.50	7.50	2.50	0.00	Good	83	Pass
25	2.50	2.50	2.50	7.50	2.50	0.00	Good	83	Pass
26	3.00	3.00	2.50	8.50	2.83	0.29	Good	94	Pass
27	3.00	3.00	3.00	9.00	3.00	0.00	Good	100	Pass
28	3.00	3.00	2.50	8.50	2.83	0.29	Good	94	Pass
29	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
30	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
31	3.00	2.50	2.50	8.00	2.67	0.29	Good	89	Pass
32	2.50	3.00	2.50	8.00	2.67	0.29	Good	89	Pass
$\bar{x}$	2.80	2.63	2.64	8.06	2.69	0.24		-	-
SD	0.33	0.34	0.34	0.83	0.28	0.20		-	-
%	93.23	87.50	88.02	89.58	89.58	-		-	-
Level	Good	Good	Good	-	-	-		-	-

The observation results in **Table 6** also showed positive changes in students' learning behaviors during the second learning cycle. Students' behavior during learning activities increased to 93.36%, behavior in completing assigned tasks increased to 95.83%, and thinking and problem-solving ability increased to 91.67%. These results indicate that students became more actively involved in learning, worked more effectively in groups, and demonstrated better problem-solving behaviors. The increase in students' ability to analyze and synthesize also suggests that repeated engagement in active learning activities helped students develop higher-order thinking skills. This finding is consistent with studies emphasizing that active

learning can promote student participation, satisfaction, collaboration, and meaningful learning experiences [5, 6].

The findings indicate that active learning based on the MACRO Model was effective in enhancing junior high school students' analytical thinking ability and science learning achievement. The improvement from Cycle 1 to Cycle 2 demonstrates that classroom action research can support instructional improvement through continuous planning, action, observation, and reflection. The MACRO Model provided structured learning stages that enabled students to become motivated, participate actively in learning activities, construct knowledge, present ideas, and disseminate knowledge. These processes encouraged students to analyze information, identify relationships, apply principles, and solve problems in science learning.

Table 5. Second learning cycle - learning achievement

NO	SCORE OBTAINED (20)	% OF FULL SCORE	CRITERION
1	15	75	Pass
2	15	75	Pass
3	16	80	Pass
4	16	80	Pass
5	14	70	Pass
6	14	70	Pass
7	16	80	Pass
8	16	80	Pass
9	16	80	Pass
10	17	85	Pass
11	18	90	Pass
12	16	80	Pass
13	18	90	Pass
14	17	85	Pass
15	18	90	Pass
16	17	85	Pass
17	15	75	Pass
18	16	80	Pass
19	17	85	Pass
20	15	75	Pass
21	18	90	Pass
22	17	85	Pass
23	16	80	Pass
24	19	95	Pass
25	18	90	Pass
26	18	90	Pass
27	20	100	Pass
28	18	90	Pass
29	17	85	Pass
30	18	90	Pass
31	18	90	Pass
32	19	95	Pass
Mean	**17**	**84.06**	-
SD	**1.47**	**7.34**	-

Table 6. Second learning cycle - observation of students' learning behaviors

ATTRIBUTE	ASSESSMENT CRITERIA	MEAN (%)	QUALITY
Students' behavior during learning activities	1. Interest in learning activities	100	Good
	2. Participation in expressing opinions	78.13	Good
	3. Responding to questions	96.88	Good
	4. Accepting others' opinions	98.44	Good
	Overall	93.36	Good
Behavior in completing assigned tasks	1. Consulting and planning collaboratively before working	95.31	Good
	2. Performing tasks according to procedures	95.31	Good
	3. Work outcomes meet the specified objectives	96.88	Good
	Overall	95.83	Good
Thinking and problem-solving ability	1. Ability to analyze and synthesize	81.25	Good
	2. Ability to construct knowledge	96.88	Good
	3. Ability to make appropriate decisions to solve problems	96.88	Good
	Overall	91.67	Good

The improvement in analytical thinking ability found in this study is consistent with previous research showing that analytical thinking can be developed through learning models that require students to analyze, interpret, explain, and construct knowledge [7-9]. In science learning, analytical thinking is important because students need to connect scientific concepts with evidence, everyday phenomena, and problem-solving situations. Therefore, science instruction should not only emphasize content mastery but also provide opportunities for students to practice reasoning, decision-making, and evidence-based explanation.

Furthermore, the improvement in learning achievement supports previous findings that active learning and classroom action research can enhance students' academic performance, engagement, problem-solving ability, and higher-order thinking skills [3, 4, 7, 10, 11]. Through active participation, group discussion, investigation, presentation, and reflection, students were able to construct their own understanding rather than passively receive information from the teacher. These learning processes helped students become more engaged, confident, and responsible for their learning. Therefore, active learning based on the MACRO Model can be considered an appropriate instructional approach for junior high school science classrooms, particularly for topics requiring conceptual understanding and problem-solving, such as Motion and Force. Finally, this study adds new information regarding science learning, as reported elsewhere [1, 2, 12].

4. CONCLUSION

This study concluded that active learning based on the MACRO Model effectively enhanced junior high school students' analytical thinking ability and science learning achievement in the topic of Motion and Force. The results showed improvement from the first learning cycle to the second learning cycle in analytical thinking ability, learning achievement, and students' learning behaviors. Students became more actively involved in learning activities, showed better collaboration in completing assigned tasks, and demonstrated improved thinking and problem-solving abilities. The instructional process provided students with opportunities to participate actively, analyze scientific information, discuss ideas with peers, construct knowledge, present learning outcomes, and apply scientific concepts to problem-solving situations. The improvement across the two cycles also indicates that classroom action

research can support instructional refinement through continuous planning, action, observation, and reflection. Therefore, the MACRO Model can be used as an alternative instructional approach to promote analytical thinking and science learning achievement among junior high school students.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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