



ENHANCING SCIENTIFIC PROBLEM-SOLVING AND LEARNING ACHIEVEMENT OF LOWER SECONDARY STUDENTS THROUGH ACTIVE LEARNING

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ABSTRACT

Active learning is an essential part of good science education. It engages students in the learning process, allowing them to get a better comprehension of scientific subjects. This research aims to enhance scientific problem-solving and also learning achievement of eighth-grade students through active learning organization. This study employed a pre-experimental design. The target group was 30 eighth-grade students from one school in Thailand. Three-hour learning management plans provided 15 hours of active learning organization. The result indicated that active learning encourages students to solve scientific problems. Students actively engage in defining and improving the learning process based on their own interests. As a result, students' academic achievement and problem-solving in science were improved. Furthermore, when comparing the academic achievement and scientific problem-solving scores between after experiment and criterion. Additionally, students expressed a high level of satisfaction with the active science learning activities, as these activities contributed to their academic achievement and problem-solving in the field of science. It can be concluded that active learning is very useful and engage students to science classroom.

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Keywords: achievement; active learning; problem-solving; science teaching

INTRODUCTION

Human learning is not solely a result of responding to stimuli; it involves a thought process that encompasses the accumulation of information. This process includes creating meaning, establishing correlations among data, and extracting information to guide actions and solutions (Himanen et al., 2019). Thinking is a complex cognitive process used to seek answers, solve problems, and achieve desired objectives. It encompasses critical thinking skills, synthesis, creativity, and problem-solving abilities (Onsee & Nuangchalerm, 2019; Rahman, 2019; Polmart & Nuangchalerm, 2023). Student engagement in the lesson and participate in free at all level of education are learning processes that enable stu-

dents to acquire meaningful knowledge through collaboration with their peers (Xiaofeng et al., 2022).

According to the constructivist theory of learning, which is the foundation for active learning, learners generate their own knowledge via a process of interaction with their surroundings and the experiences they have (American Chemical Society, 2019; Kovarik et al., 2022). On the basis of this notion, active learning is established. The idea of constructivism places emphasis on the reality that students are not only passive recipients of information; rather, they are active participants in education. On the contrary, their comprehension of the universe is actively built by them through the experiences they have and the interactions they have with the suitable learning environment around them (Cooperstein & Kocevar-Weidinger, 2004; Van Manen, 2016). In ac-

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cordance with this theory, the most effective method for making use of information is to actively connect with it in a meaningful way, as opposed to passively absorbing it.

Active learning and the constructivist philosophy of education help students to achieving their learning goals via the use of hands-on and mind-on activities (Arik & Yilmaz, 2020; Rahman et al., 2022). It provides an explanation of how individuals acquire knowledge, constructivism serves as the philosophical basis for active learning (Mohammed & Kinyó, 2020). Active learning, on the other hand, offers instructional strategies that are in line with this instructional paradigm. They are actively constructing their own knowledge through experiences and interactions with the environment, and cultivate their own knowledge (Baepler et al., 2016).

Participating in conversations and working together with other people is an effective way to learn. Instead of only allowing students to passively acquire knowledge, activities are meant to actively include them in the process of learning (Hoidn & Reusser, 2020). Discussions, experiments, activities that require problem-solving, and group projects are all ways in which students engage. Students are encouraged to engage in activities that help them to create connections, examine material, and construct their own knowledge (Werder & Otis, 2023).

These approaches also emphasize the development of life skills for happiness living and fulfilling modern lives. Furthermore, the Core Curriculum of Basic Education B.E. 2008 (Revised B.E. 2017) defines students' competencies according to the curriculum, which include the following: communication ability in implementing the curriculum, higher-ordered thinking ability, problem-solving ability, life skills, and technology ability. Therefore, it is crucial for everyone to cultivate scientific literacy, enabling them to gain knowledge and understanding of the natural world and the technology created by humanity (McGowan & Bell 2020; Sharon & Baram-Tsabari, 2020). Scientific literacy empowers individuals to apply knowledge rationally, logically, creatively, and ethically (Costa et al., 2021; Janoušková et al., 2023).

The study of science holds great importance as it encourages students to think systematically when confronted with scientific problems. This competency is vital for students' development. Problem-solving as the ability to correctly and appropriately address problems and obstacles based on rational reasoning. It involves understanding the interrelationships and changes of events in

society, seeking knowledge, applying that knowledge to prevent and solve problems, and making effective decisions while considering their impact on oneself (Wongchantra & Nuangchalerm, 2011; Wolff et al., 2021).

Moreover, science subjects necessitate the application of knowledge and scientific process skills in education. Students are expected to research and systematically solve problems, enabling them to apply their knowledge in real-life situations or pursue further education in science-related professions. Problem-solving goes beyond being a cognitive exercise or a skill aimed solely at developing intelligence. It is a skill that fosters positive attitudes, diverse ways of thinking, values, and a deeper understanding of social situations. Therefore, within the education system, there should be a strong emphasis on developing and training young individuals, providing them with ample opportunities to practice problem-solving thinking (Dalal et al., 2022). This approach greatly contributes to students' ability to make informed and sensible decisions.

There are several obstacles that might be encountered while engaging in active learning in the science classroom. It is essential to overcome these hurdles in order to successfully adopt effective active learning methodologies (Dyamayanti et al., 2023). There is a possibility that traditional teaching techniques are strongly embedded in the learning environments, and there is also a possibility that both teachers and students will be resistant to adopting active learning. Additionally, when there are a lot of students in a science class, it might be difficult to integrate interactive activities and get all of the students fully involved. In order to facilitate active learning, it is possible that extra resources, such as technology, materials, or specific places, may be required. These resources may not be easily accessible (Sawatruk-sa & Rodpun, 2019; Wijayanti et al., 2019; Surakarn et al., 2020; Lufri et al., 2021).

Active learning has developed into a dynamic educational strategy and science classroom that goes beyond the traditional methods of instruction. Students are actively participated and engaged with science lesson through learning activities. They can cooperate with friends to think and do science lessons as well as hands-on experiences (Owens et al., 2020; Lombardi et al., 2021; Cascolan, 2023). This is due to the fact that it places an emphasis on student engagement, involvement, and critical thinking (Hodges, 2020; Ongon et al., 2021). Within the framework of scientific education teaching, the objective of this article is to study the several ways in which acti-

ve learning effects academic achievement and the capacity to find solutions to issues (Khammanee et al., 2023). This is to provide comprehensive knowledge of the transformative potential of active learning by incorporating several types of information, including scientific facts, educational ideas, and practical insights (Pruekpramool et al., 2023).

The aim of this research is to develop science activities through an active learning process and promote scientific problem-solving skills among eighth-grade students by utilizing an open approach to learning activities. To support this study, the researcher conducted a thorough review of relevant literature. The literature review provides a foundation of existing knowledge and research findings in the field of science education and active learning. By examining and analyzing previous studies, the researcher can identify gaps in the current literature and contribute to the development of effective science activities that enhance student engagement, critical thinking, and problem-solving abilities. The utilization of an open approach to learning activities allows for

flexibility, creativity, and student-centered learning experiences, fostering a deeper understanding and application of scientific concepts.

When organizing learning activities, it is important to follow the guidelines of active learning. Teachers should strive to create an engaging atmosphere that promotes student participation and interaction (Hadibarata & Rubiyatno, 2019). This can be achieved by reducing the traditional teaching roles and instead providing opportunities for learners to have actively participated in the meaningful learning process. Teachers should encourage students to seek knowledge and build their understanding through independent exploration, fostering a sense of discovery and achievement. Additionally, students should be encouraged to apply their knowledge and understanding to analyze, synthesize, evaluate, and create solutions that connect with their immediate environment and address problems of the community, society, or nation. By incorporating these principles into the learning activities, teachers can create a dynamic and student-centered learning (Table 1).

Table 1. The Role of Teacher and Student in Active Science Learning

Activity	Teacher role	Student role
1. Sensational interests' questionnaire	<ul style="list-style-type: none"> - Generate interest - Create curiosity - Ask questions, encourage students to think - Draw out answers that do not cover what students know or their thoughts about ideas or content 	<ul style="list-style-type: none"> - Ask questions such as why this happened, what did I learn about it? - Show interest
2. Making active learning	<ul style="list-style-type: none"> - Encourage students to collaborate on surveys - Encourage students to explain ideas or concepts, or define them in their own words - Have students provide evidence, reason and clarify - Have students explain, define, - Have students use their previous experiences as a basis to explain a collective idea or concept - Observe and listen to student-student interactions - Debriefing leads to student inspection surveys - Give students time to think about their doubts as well as their problems - Serves as a mentor to students 	<ul style="list-style-type: none"> Think independently but within the scope of the activity - Test predictions and hypotheses - Predict and make new assumptions - Try to find alternatives to solve it. problems and discuss those alternatives with others - Describe a possible solution or answer - Listen critically to other people's explanations - Ask questions about what others have explained - Use the data obtained from the recording. Observation in explanation - Record observations and provide feedback - Down conclusion

3. Lesson to learn	<ul style="list-style-type: none"> - Expect students to use the results of discussions and demonstrations resulting from the exchange of learning among themselves to formulate new ideas or create new knowledge on their own. Explain what you've learned - Encourage students to apply what they have learned or expand their knowledge and skills in new situations - Have students explain in a variety of ways - Have students reference the available information and provide evidence - Ask students what they have learned or what ideas they have learned 	<ul style="list-style-type: none"> - Take the information obtained from the definition - Explanations and skills apply in new situations similar to the old ones - Use the same information to ask questions, and determine the purpose of thinking about solving problems. Decision-making and experimental design - Draw reasonable conclusions based on the evidence presented - Record observations and explanations - Check to understand with friends
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The world is now rapidly changed and accelerated by technological advancements, scientific literacy holds immense importance for individuals. It is essential for people to possess knowledge and understanding about the biological and physical worlds, and the use of technology created by humans (Dirks, 2022). In this context, student engagement emerge as effective educational approaches that foster meaningful collaboration among students. The study aims to study scientific problem-solving and learning achievement of students through active learning management in science classroom. Based on the significance of this study, we have developed active science learning activities specifically tailored to enhance academic achievement and foster scientific problem-solving of lower secondary school students. These activities promote learner participation and insight-building by connecting students with factual knowledge, concepts, and skills through hands-on learning experiences.

METHODS

The research methodology used in this study should be written such as pre-experimental one-shot case study design. Data were collected from the target group, which consisted of eighth-grade students from one School, located in Ban Bung Salai, Wang Saphung District, Loei Province, Thailand. A total of 30 students participated in the study through cluster random sampling. The research included implementing 5 active science learning activities focused on force and motion specifically designed for eighth-grade students. Each learning management plan lasted for three hours, resulting in a total of 15 hours of instruction. The entire research process spanned

over 5 weeks. The procedure can be explained in following.

Introduction and clarification: The first step involved introducing and clarifying to the students how to engage in active science learning activities related to force and motion. This step aimed to ensure that students understood the learning objectives and expectations.

Active engagement: In the second step, students actively participated in the active science learning activities. They were encouraged to explore, experiment, and discover concepts related to force and motion through hands-on experiences.

Observations and documentation: During the implementation of the active science learning activities, the researcher observed and recorded the students' learning behaviors. This step allowed for the collection of valuable data on student engagement, interaction, and understanding of the concepts.

Activity completion and review: Students completed the planned activities and engaged in a review process to consolidate their understanding of force and motion concepts. This step aimed to reinforce learning outcomes and provide opportunities for reflection and discussion.

Posttest evaluation: The study employed post-test only design, so the mean score used and compared with the criterion. Following the completion of the activities, students underwent a posttest using a learning achievement test specifically designed to assess their understanding of force and motion. All 30 students participated in this evaluation.

Problem-solving assessment: In the final step, the students' problem-solving abilities related to force and motion were measured. This assessment aimed to gauge their critical thinking skills

and their application of learned concepts in solving scientific problems.

In this research, the collected data were analyzed using both quantitative and qualitative methods. Quantitative data analysis involved applying basic statistical measures such as percentages, averages, and standard deviations. The data were analyzed to compare the academic achievement and scientific problem-solving of eighth-grade students before and after participating in active science learning activities focused on force and motion.

The analysis aimed to determine whether the students' average scores, after engaging in the active learning activity plan, reached or exceeded the threshold of 75 percent. This study employed comparison which was conducted using the statistical method known as the One Sample t-test. This statistical test allows for the evaluation of whether the mean score of a sample significantly differs from a predetermined criterion. By utilizing these analytical techniques, the research aimed to provide insights into the impact of active science learning activities on the academic performance and problem-solving abilities of the eighth-grade students.

RESULTS AND DISCUSSION

The development process involved designing five learning management activities by integrating insights from studying real-world problems in science classes, research papers, concepts, and learning theories. Upon completion of each learning management plan, subtests were conducted to assess students' progress. The data collected from these subtests were analyzed to compare the average scores, standard deviation, the number of students meeting the criteria, and the percentage of students meeting the criteria.

Active science learning activities on force and motion to promote academic achievement and scientific problem-solving skills among eighth-grade students. The design of the active science learning activity was revised based on recommendations from 3 experts and the details of its feasibility can be described through syntax of active learning organization.

Step 1: Sensational interest questionnaire

Recommendations were made to adjust the context and enhance the connection between

the content and real-life events, as suggested by the questionnaire. The fourth expert recommended clarifying and improving the activities in Step 2 of the active science learning management plan. After conducting the learning activities, the researcher analyzed the collected data, which included the active science learning management plans, behavioral observations, post-activity reflections, quizzes, academic achievement assessments, scientific problem-solving assessments, and satisfaction questionnaires related to the active science learning management among eighth-grade students. The results indicated that the students demonstrated great enthusiasm for the activities. They engaged in independent learning, discovered new knowledge through everyday situations, and applied problem-solving techniques based on real-life experiences. The use of digital media further enhanced students' excitement and engagement in the learning process.

Step 2: Making active learning

The results of the learning activities indicated that students actively engaged in defining and enhancing the learning process to align with their individual preferences and interests. This approach facilitated learning that is relevant to real-world situations, fostering comprehension and long-term memory retention among students.

Step 3: Lesson to learn

The results of the learning activities demonstrated that students were able to apply their acquired knowledge and experiences to solve both scientific and everyday problems. Furthermore, students successfully summarized their newfound knowledge and effectively transferred this knowledge using online formats, such as graphic charts and educational games. Considering the evaluation of the suitability of organizing active science learning activities on force and motion to enhance academic achievement and scientific problem-solving skills for secondary school students, five professionals assessed the activities and determined the average overall score, concluding that they were highly appropriate.

After implementing the active science learning activities on force and motion to promote academic achievement and scientific problem-solving skills among eighth-grade students, the study examined the students' performance in relation to a 75 percent threshold.

Table 2. Academic Achievement After Experiment

test	n	mean	k	SD	df	t	Sig
Post test	30	23.60	23.00	1.99	29	1.25	0.000

Upon examining Table 2, it can be observed and explained that the p-value (1-tailed test) is 0.000, which is less than 0.05 level of statistical significance. Therefore, the null hypothesis $H_0: \mu \leq 23$ is rejected, and the alternative hypothesis $H_1: \mu > 23$ is accepted, indicating an improve-

ment in academic achievement. After students have participating in the active science learning activity on force and motion, the students achieved a score 23 points higher, with a statistical significance of 0.05. The problem-solving score can be shown in Table 3.

Table 3. The Results of the Comparison of Scientific Problem Solving After the Active Science Learning Activity

test	n	mean	k	SD	df	t	Sig
Post test	30	15.86	15.00	1.73	29	1.49	0.000

Upon examining Table 3, it can be observed that the p-value (1-tailed test) is 0.000, which is less than 0.05. Therefore, the null hypothesis $H_0: \mu \leq 15$ is rejected, and the alternative hypothesis $H_1: \mu > 15$ is accepted, indicating that the scientific problem-solving performance after participating in the active science learning activity on force and motion to promote their academic achievement and scientific problem-solving. It found that they had higher than 15 scores with a statistical significance level of 0.05.

In addition, student satisfaction with active science learning activities, the result indicated that the students expressed a high level of satisfaction with the active science learning activities on force and motion, which were designed to enhance academic achievement and scientific problem-solving skills among eighth-grade students. The mean satisfaction score was 4.67, with a standard deviation of 0.47. This suggests that the students found the activities engaging, enjoyable, and beneficial to their learning experience.

The preceding sentences cover a study that attempted to increase academic achievement and scientific problem-solving skills among students in eighth grade by having them participate in active science learning activities that focused on force and motion. In the course of the research, a plan for the administration of active science learning was put into action (Poonputta & Nuangchalerm, 2022).

The first step in the research was to collect information about the preferences and interests of the pupils by having them fill out a questionnaire regarding sensational interests. Adjustments were made to the setting of the learning activities based on the findings of the questionnaire. These adjustments were made to increase the connection between the content of the learning activities and actual life experiences. The purpose of using this method was to make the exercises more interesting to the students by making them more applicable to their day-to-day lives (Trini-

dad, 2020). After the newly redesigned learning activities were put into place, the students took an active role in defining and improving the learning process in order to bring it into alignment with their own unique preferences and areas of interest (Brito, 2019). The students' learning was enriched as a result of their more active participation, which in turn led to a more meaningful overall experience (Hoidn & Reusser, 2020). According to the findings of the study, this method of active learning improved both comprehension and scientific problem-solving.

The findings from the educational activities revealed that the students were not only excited about the activities but also capable of applying the knowledge and experiences they had recently gained to find solutions to problems that were both scientific and of a more everyday nature. In addition, the students did an excellent job of synthesizing their newly acquired information and transferring it using a variety of online media, including graphical charts and instructional games (Reardon & Derner, 2023). This lends credence to the idea that active learning techniques enable skills in practical application and information transfer (Hernández-de-Menéndez et al., 2019; Hassan et al., 2021). In order to determine whether or not the active science learning activities were helpful, five experts were tasked with evaluating them. After compiling their findings, the experts arrived at the conclusion that the activities were, on average, highly applicable. This evaluation demonstrates that the potential of active science learning activities on force and motion to promote academic achievement and scientific problem-solving skills among eighth-grade students is strengthened by the results of the evaluation (Khan et al., 2017).

Following the implementation of the active science learning activities, the students' overall performance was evaluated in comparison to a 75% cutoff point for the study. However, the specific outcomes of the performance evaluation

were not indicated in the phrases that were presented. In general, the discussion emphasizes the advantages of having eighth-grade students engage in active science learning activities that focus on force and motion. The activities were changed based on the advice of the experts, and they were adapted to the interests of the students; this resulted in improved involvement and excitement from the students. According to the findings of the study, the students successfully demonstrated effective academic performance and the development of problem-solving skills by actively participating in the learning process and being able to apply their knowledge to real-life scenarios (Situmorang et al., 2020). The utilization of digital media contributed significantly to the overall improvement of the learning experience. The results of the professional evaluation lend even more support to the effectiveness of these activities in raising students' academic performance and problem-solving skills.

The results of implementation an active science learning activity on force and motion on academic achievement and the ability to solve scientific problems. The first phrase states that the p-value for the one-tailed test is 0.000. The second sentence discusses the statistical significance of this finding. Based on the assumption of statistical analysis, it explored that the null hypothesis is correct by the p-value. This is an extreme or more extreme than the data that have been seen. In this scenario, a p-value of 0.000 indicates that there is an exceedingly small chance of detecting the results when the null hypothesis (that is, 23) is assumed. In addition to this, the significance level, which is often represented by the symbol, is stated to be 0.05 in the sentence. The significance level is the cutoff that the researcher uses to decide whether or not the p-value is sufficiently low to warrant rejecting the null hypothesis. This threshold is determined by the researcher. In the context of this discussion, the significance level of 0.05 indicates that the researcher has decided that a significance level of 5% meets the criteria for statistical significance.

The results of testing the hypothesis are discussed in the second sentence. This discussion is based on the p-value and significance level. It can be concluded that the null hypothesis cannot be supported because the p-value (0.000) is lower than the significance level (0.05). When the null hypothesis is rejected, it indicates that there is sufficient evidence to show that the intervention (active science learning activity) had an influence that was statistically significant on the result that was being measured. The alternate hypothesis, which states that 23 is more than 23, is accepted.

The alternative hypothesis is the argument that the intervention resulted in an improvement in academic attainment, or more precisely, the mean score. The statistical significance of the improvement is discussed in the sentence's final clause, where it is stated that 0.05 is the level of statistical significance associated with the improvement. According to the findings of the study, the active science learning activity on force and motion had a considerable favorable impact on both academic accomplishment and the ability to solve scientific problems. The evidence provides support for the adoption of the alternative hypothesis, which shows that the intervention led to an improvement in students' academic performance and suggests that this improvement was due to the improvement in students' academic performance (Alqasa & Afaneh, 2022).

The level of satisfaction experienced by students is an essential component in determining the efficiency and significance of educational initiatives. When students report being happy with the overall learning experience, it's usually a good sign that the activities were interesting and did a good job of meeting the goals they set out to accomplish. This was revealed to be the case by the satisfaction evaluation. This provides evidence that the students were satisfied with the hands-on scientific learning activities in which they participated. Having a high degree of satisfaction can lead to improved motivation, more active engagement, and a more positive attitude toward the learning process.

The interpretation of the mean and the standard deviation is as follows: If the students gave the active science learning activities a mean satisfaction score. The greater the proximity of the mean score to the maximum possible score, the greater the overall degree of satisfaction. In other words, there was not much variation in the degrees of satisfaction stated by students, which suggests that the majority of students expressed levels of satisfaction with the activities that were comparable to one another. The latter portion of the phrase highlights that the students found the activities to be interesting, enjoyable, and beneficial to their learning experience. This good response suggests that the active learning activities in science were successful in grabbing the interest of the students and creating a positive environment for learning (Olivares et al., 2020; Reardon & Derner, 2023). Students are more likely to be motivated to study and to retain the information that they have received if they find the activities that they are participating in interesting and entertaining.

The active learning allowed students to deal with a diversity of learning activity (Bean & Melzer, 2021). This is an exhaustive resource for teachers who want to improve their pedagogy. It is all about making learning more interesting and interactive for students by combining writing, critical thinking, and active learning. Writing is a powerful means of education and analysis, it should encourage teachers to utilize writing as a tool to help their students improve their analytical abilities and offers practical techniques for integrating writing assignments into different subjects. Furthermore, it delves into the significance of active learning in the classroom, advocating for methods that encourage student involvement via interaction and participation.

In a nutshell, the words offer really helpful insights into the accomplishment of the active learning science exercises pertaining to force and motion. The fact that the students reported a high level of satisfaction with the activities shows that they were well received and had a favorable impact on the students' overall learning experience. This is shown by the high mean satisfaction score as well as the low standard deviation. The fact that the exercises were interesting, fun, and helpful most likely played a role in the development of the eighth-graders' academic progress and their capacity to solve scientific problems. In addition, Darling-Hammond et al (2020) stated that there is a growing agreement about the scientific basis of learning and development. Active learning from various areas of educational research and the learning sciences to provide a picture of tried-and-true methods for fostering the connections and experiences that students need to thrive, grow, and learn. So that schools can pave the road for all students to succeed as adults. The study also examine learning strategies that may assist teachers in dealing with student diversity, overcoming challenges, and building resilience.

CONCLUSION

The academic accomplishments of students and their ability to solve problems in science improved. In addition, when comparing academic achievement score and scientific problem-solving after participation in active learning activities higher than those 75% criteria. This is likely due to the fact that the activities contributed to the students' academic achievement as well as their ability to solve problems related to the subject of science. In conclusion, the findings indicate that students who engaged in active learning activities had a considerable improvement in both

their academic accomplishments and their ability to solve problems in the course of their scientific studies. The improvements that were noticed exceeded the criteria that had been specified, which indicates that there was a significant beneficial effect. The association between active learning engagement and increased academic achievement (Al Yakin & Seraj, 2023; Qureshi et al., 2023).

Educators and educational institutions need to strongly explore incorporating more active learning strategies into their course offerings in order to build upon the great results that have been achieved. It is possible to further increase the interest of students by encouraging them to participate in hands-on and interactive activities, which may promote a deeper engagement with academic content (Korkmaz et al., 2023). In addition, continuous evaluation and adjustment of active learning strategies may assist in adapting these approaches to the specific learning styles of each person. A persistent positive influence on students' academic accomplishments and problem-solving abilities in science may be ensured by collaborative efforts among educators, administrators, and researchers. These efforts can contribute to the continuous improvement of active learning methodologies, which can ensure a sustained positive impact.

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