

Empowering Junior High School Students' Thinking Skills Through the Application of Problem-Based Learning Models

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Abstract: The reason for this review is to portray imaginative reasoning abilities and science-critical abilities to think in middle school understudies by using issue-based learning models. The study was directed at class VIII students at one of Palu City's junior high schools. The population of class VIII consists of five classes totaling 160 students. Purposive sampling was used to select two classes as samples. Data on problem-solving and creative thinking abilities were obtained through essay tests. The instruments used were teaching modules, LKPD, and tests. Information investigation utilized an autonomous t-test with the assistance of SPSS variant 25.0. The findings revealed that the creative thinking skills in conventional classes were significantly lower than problem-based learning classes $t(62)=13.56, p<0.001$, and problem-solving skills in conventional classes were considerably lower than problem-based learning classes $t(62)=14.63, p<0.001$. Thus, this study concludes that the creative thinking skills and problem-solving abilities of Class VIII SMP students in science subjects can be empowered by implementing a problem-based learning model.

Keywords: Creative thinking skills; Problem-based learning models; Problem-solving skills

Introduction

Some necessary for the 21st century include high-level thinking, innovation, communication, collaboration, computerized thinking, imaginative and critical thinking, and problem-solving (Abdullah & Osman, 2010; ŽivkoviL, 2016). Imaginative reasoning and critical thinking abilities are essential for thinking abilities (Dilekçi & Karatay, 2023; Laar et al., 2017; Tang et al., 2020) which involve mental processes (Grogono & Hart, 2018) to generate innovative ideas or actions (Patrício et al., 2018). Creative thinking begins with persistence and cognitive flexibility (Anderson & Graham, 2021), oriented towards original thinking traits that emphasize divergence and appropriateness (Dou et al., 2021), creative imagination, fluency, and flexibility (Groyecka et al., 2020). On the other hand, not only do problem-solving abilities influence cognitive abilities, but they also protect against poverty and other

challenges in life (Kunze et al., 2018) because the problem-solving process itself requires competent problem-solvers employ critical, dynamic, analytical, evaluative, and skilled interpretation to address a variety of challenges (ŽivkoviL, 2016).

Students who think creatively can identify multiple solutions, tolerate ambiguity, have a creative problem-solving approach, have higher self-efficacy, and are better prepared to face and overcome academic problems (Stolz et al., 2022). Creative male students show impulsive, independent, risk-taking, able to defend opinions, are confident, individualistic, spontaneous, responsive, and quick to give up to act, while creative female students are more diligent, meticulous, systematic, persistent, calm, act according to plan, consistent, well-behaved, obedient and conformist, avoid risks, and act according to instructions or plans (Gralewski, 2019). In addition, students who are good at solving problems show that they can understand

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problems, come up with a lot of ideas, prepare actions, and plan their strategies (Sophonhiranrak et al., 2015; van Hooijdonk et al., 2020), and collaborate on strategies for solving problems (Intaros et al., 2014). Additionally, they demonstrate a willingness to solve problems and the capacity to comprehend and define them, skill in identifying the position of the problem, the ability to describe the content of the problem, skill in managing the problem-solving process, skill in choosing the right problem-solving strategy and able to use previous knowledge to build problem-solving solutions (Dostál, 2015). Unfortunately, not all students have the characteristics of innovative reasoning skills and the ability to solve problems.

The characteristics of creative thinking skills have the potential to influence students' ability to think creatively. Empirical evidence through research conducted consistently finds that creative thinking skills are not yet maximized by students, as several research reports indicate that only a small percentage of students at Kazan Federal University show creative thinking, including at a high level (Borodina et al., 2019), the originality of thought ability of PGSD students at one of the universities in Malang City is classified as low and is included in the non-creative level in the field of science (Muslihasari et al., 2024), the very low category is 42.7% in grade IV students at one of the elementary schools (Astuti et al., 2020), is classified as low in grade XI students at one of the high schools (Purwati & Alberida, 2022), and is higher in male students than female students after being taught using different learning models (Zubaidah et al., 2017), and some students' creative thinking increases and some students' experience a decrease after going through training (Jończyk et al., 2024; Perry & Arpova, 2017).

Problem-solving abilities that are not optimal are found in Jambi City State Middle Schools in a good category and range in percentage from 54-60% (Syaiful et al., 2020), a high category for students at St. Catholic Senior High School Gabriel Maumere (Eldis et al., 2024), very low in students of SMP Negeri 1 Paloh (Saputra et al., 2022), low in grade IX understudies in one of the middle schools in Karawang (Putri & Hidayati, 2023), and is classified as adequate with significantly different levels of proficiency based on grade level, gender, average grade, and mathematics grades in students from 21 junior high schools in a large city in Turkey (Özpinar & Arslan, 2023), gifted students have better problem-solving skills than non-gifted students (Chen et al., 2016), female students are superior to male ones and students from urban schools are better than students from rural schools (Amalina & Vidákovich, 2023b).

Creative thinking skills are influenced by many things as several reports inform that creative thinking

skills are not only influenced by one factor but require a balanced environment (Lin, 2023), emotional intelligence (Durnali et al., 2023), extrinsic motivation (Avcı & Durak, 2023), positive mood (Greene & Noice, 2023), quality of learning experiences in the classroom (Daly et al., 2016), self-perception and self-actualization (Anas et al., 2023). Other factors are social environmental support (Hondzel & Gulliksen, 2015), physical environmental quality (Lee & Lee, 2023; Swarzy-Impraim et al., 2023; Yildiz & Guler Yildiz, 2021), individual qualities, family background, school elements, and community (Wu et al., 2014), instructors, instructions, institutions, coworkers (Elkilany & Yousef, 2021), emotional support from teachers and other professionals (Hernández et al., 2024), learning models used when teaching, teaching materials used, academic abilities, and non-cognitive factors such as students' attitudes towards learning and confidence in their abilities (Jaenudin, 2023).

The determining factor for problem-solving abilities is student interest (Elvira et al., 2015), psychological factors such as motivation, perception, and self-efficacy (Bhadargade et al., 2020), academic success, attitudes, beliefs and problem-solving achievements (Güven & Cabakcor, 2013), innovation behavior (Kim et al., 2018), cognitive factors and socioeconomic status (Amalina & Vidákovich, 2023a), prior knowledge, cognitive factors, teaching methods, attitudes and personal factors of students (Kour & Razaqi, 2024), teachers as instructors, students as learners, and the environment as a motivator (Rajkumar & Hema, 2019), problem complexity and understanding and describing the structure of the problem correctly (Molnár & Greiff, 2023).

Factors that influence the way students think creatively and solve problems have the potential to cause problems in improving students' abilities to think creatively and solve problems and this is a phenomenon that cannot be avoided. However, to address this dilemma, empirical evidence through research that has been carried out consistently and has been widely reported, namely that creative thinking skills can be trained (Chen, 2024) through innovative learning processes (Desmet & Sternberg, 2024; Mohanty, 2015) including experiential learning activities (Alt et al., 2023; Ayob et al., 2011) namely learning methods that allow learners to construct their knowledge (Sukontawaree et al., 2022), because teaching methods that increase creativity can make a positive difference in the development of children's creative problem solving (Maker et al., 2023). Other innovative learning that can train creative thinking skills are blended learning (Hikmah et al., 2023), a learning approach that integrates STEAM education and computational thinking

(Mariana & Kristanto, 2023), strengthening character education (Yani et al., 2019), the Think Pair Share model based on flipped learning (Dirsa et al., 2024), project learning models (Chen et al., 2019; Ekayana et al., 2024), and creative problem-solving learning (Fatmawati et al., 2022). On the other hand, problem-solving skills can be improved through innovative learning (Adeoye & Jimoh, 2023; Guo et al., 2015; Johan & Rohaeti, 2024; Widodo et al., 2023) based on STEAM (Astuti et al., 2021). Creative thinking and problem-solving skills can be improved together through innovative learning (Kwangmuang et al., 2021). The results of the studies that have been reported show how important it is to develop innovative education processes in the school to improve students' ability to think creatively and solve problems, particularly in secondary school science instruction.

Innovative learning in the form of interactive and effective learning practices (Bakör, 2011; Balakrishnan, 2022; Chang et al., 2022; Elsayed-Abdelhalim et al., 2020) can be created by putting problem-based learning models into practice. PBL, or problem-based learning, is an innovative portrayal that can foster various competencies because PBL excels in long-term knowledge retention (Yew & Goh, 2016), improving critical thinking skills (Seibert, 2021) creative thinking (Suciati et al., 2023), problem-solving and learning outcomes (Astuti et al., 2017; Promentilla et al., 2017), communication (Shamdas et al., 2023), self-efficacy (Shamdas, 2023c), conceptual understanding (Gorghiu et al., 2015), metacognitive knowledge and science learning outcomes (Shamdas et al., 2024) metacognitive awareness and critical thinking skills (Shamdas, 2023a), and metacognitive knowledge (Diekema et al., 2011; Gholami et al., 2016; Sutarto et al., 2022).

The impact of executing issue-based instruction models on the capacity for original thought and problem-solving has emerged as a significant issue in education. However, no data has been found regarding the influence of the problem-based learning model on creative thinking skills and problem-solving abilities in class VIII junior high school students in Palu City. Apart from that, no literature explicitly analyzes creative thinking skills and problem-solving abilities in class VIII junior high school students in Palu City. Information related to the issue of implementing problem-based learning models is very important because the process of problem-based instruction may help encourage students to be actively engaged in education which has the potential to trigger them to come up with new ideas and solve problems through real problems in their living environment.

Based on the literature review, students' creative thinking skills and problem-solving abilities should be

trained through the learning process. Ersoy et al. (2014) through their research recommends the importance of organizing the school environment and the teaching and learning process as well as appropriate teaching strategies, learning methods, and techniques that must be used so that students can increase their creativity. The role of the teacher is no longer simply to convey knowledge to students but as a facilitator who seeks to help students become good problem solvers using higher-order thinking skills. Therefore, the creative thinking skills and problem-solving abilities of junior high school students in Palu City need to be trained and familiarized. Apart from that, it is also important to identify students' creative thinking skills and problem-solving abilities after learning by applying the problem-based learning model. Thus, this research needs to be conducted because the research findings are not only scientific information about the job of issue-based learning models to stimulate students to think creatively and solve problems but can also provide important references for educational units or interested parties in making policies and strategies to help encourage enhancing students' capacity for creative thinking and problem-solving effectively. The findings obtained can also be used as a basis for designing learning on other science materials and as a reference for improvement research on science learning. Therefore, the reason for this review is to depict imaginative reasoning abilities and science-critical abilities to think in middle school understudies through the utilization of issue-based learning models.

Method

The kind of quantitative research with the survey method is employed in the Posttest-Only Control Design. Overview research is a methodology that depicts and investigates the factors and builds of revenue (Ponto, 2015) namely, providing a quantitative picture of a population's trends, attitudes, or opinions by studying samples from the population; the sample study's results are then used to generalize or draw conclusions about the population. This design, on the other hand, involves randomly dividing students into two groups and only giving the experimental group treatment; however, both groups are given a posttest (Creswell, 2014). The problem-based learning model is the independent variable, and the dependent variable is creative thinking skills and problem-solving abilities. The study was conducted in the odd-numbered semester of the 2024-2025 scholarly year on students in Class VIII at SMP Negeri 14 Palu, Central Sulawesi, particularly in science lessons. The entire population belonged to Class VIII SMP Negeri 14 Palu spread across

five classes totaling 160 students. The sample used two classes totaling 64 students, namely class VIII-Melati totaling 32 students given treatment with the problem-based learning model, and class VIII-Cambodia also totaling 32 students as a control class using the conventional learning model. Purposive sampling was used to choose the sample because the number of students in the two classes was the same and their academic abilities were similar (data source: Class VIII science teacher).

Learning using a problem-based learning model by applying five syntaxes adopted from Arends (2012), applied to food and digestive system materials, the topic of learning in the first meeting is nutritious and balanced food and the topic of learning in the second meeting is

food needs for the body. After the training series, the students were given a test of essays consisting of five inquiries to measure their ability to think critically and solve problems. Five indicators of creative thinking modified from Treffinger et al. (2002) are shown in Table 1 and four indicators of problem-solving abilities modified from Polya (1985) are shown in Table 2. The instruments used in this study were teaching modules, student worksheets, and tests. At Tadulako University in Indonesia's Biology Education Study Program, FKIP, two senior lecturers who are specialists in educational evaluation performed internal validation on each instrument. The outcomes of the analysis exhibited that all instruments were included in the valid criteria.

Table 1. Creative Thinking Indicators and Assessment Rubrics

Indicator	Criteria	Score
Fluency	Provides more than one different idea, and a clear and precise explanation of the solution.	4
	Providing one right idea and a clear and precise explanation of the solution	3
	Providing more than one idea and an inadequate explanation of the solution	2
	Providing one idea and explanation of a less-than-ideal solution	1
	No answer or the answer given is wrong	0
Flexibility	Provide more than one alternative answer that is correct and relevant to the problem given	4
	Provide one precise and relevant answer to the problem given	3
	Providing more than one alternative answer that is correct but less relevant to the problem given	2
	Providing one correct answer but less relevant to the problem given	1
	No answer or the answer given is wrong	0
Originality	Provide more than one unique idea that is precise, clear, and relevant to the problem given	4
	Providing a unique idea that is precise, clear, and relevant to the problem given	3
	Providing more than one unique idea that is appropriate but less relevant to the given problem	2
	Providing a unique idea that is right but less relevant to the problem given	1
	No answer or the answer given is wrong	0
Elaboration	Providing more than one logical detail based on an existing idea so that the meaning of the idea becomes very clear and can be used as a solution to the problem.	4
	Providing a logical detail based on an existing idea so that the meaning of the idea becomes very clear and can be used as a solution to the problem.	3
	Providing more than one logical detail based on an existing idea, but the meaning of the idea is not relevant to the problem so it cannot be used as a solution.	2
	Providing a logical detail based on an existing idea, but the meaning of the idea is not relevant to the problem so it cannot be used as a solution.	1
	No answer or the answer given is wrong	0
Metaphorical thinking	Combining more than one idea and relating it to everyday experiences that can be used as a solution to a problem	4
	Combining more than one idea and relating them to everyday experiences but not relevant to the problem	3
	Combining more than one idea but not relating it to everyday experiences and not relevant to the problem	2
	Less able to integrate ideas relevant to the problem	1
	No answer or the answer given is wrong	0

Table 2. Problem Solving Indicators and Assessment Rubric

Indicator	Criteria	Score
Understand the problem	Give different clear and right reactions to the main pressing concern	4
	Provide a single, precise response to the problem at hand	3
	Providing multiple correct responses without addressing the issue at hand	2
	Providing only one correct response without addressing the actual problem at hand	1

Indicator	Criteria	Score
Devise a plan	Neither a response nor the response is accurate.	0
	Provide an accurate and comprehensive concept map of the problem at hand.	4
	A precise but incomplete concept map of the problem at hand is provided.	3
	An inaccurate but comprehensive concept map in light of the issue at hand	2
	Giving an idea map that is neither exact nor sufficiently complete to resolve the main thing in need of attention	1
Carry out the plan	Neither a response nor the response is accurate.	0
	Provide answers that are correct and well-organized in accordance with the concept map.	4
	Correct responses that are well-organized, but they do not match the concept map	3
	Answers questions correctly, but it's not organized or in line with the concept map.	2
	Giving responses that are incorrect, unorganized, and do not correspond to the concept map	1
Looking back	Neither the given answer nor any answer is correct.	0
	Provide accurate and comprehensive responses to the problem at hand.	4
	Giving a right however deficient end as per the issue being referred to	3
	Delivering a conclusion that is both accurate and incomplete and does not address the issue at hand	2
	Giving ends that are wrong and deficient and don't compare to the issue being referred to	1
	No response or the response given is off-base	0

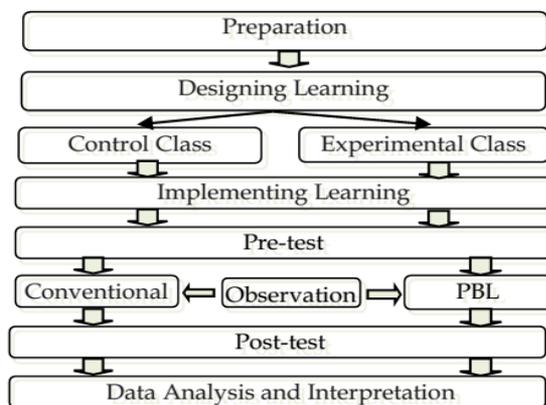


Figure 1. Research flow

The essay test's results provided information about the capacity to think inventively and take care of issues. Analyses of data used an independent t-test to examine how the problem-based learning model affects creativity skills and problem-solving abilities because this exam was used for samples with two different treatments (Sugiyono, 2013). An assumption test was first taken care of on the info to be tested through a normality test

Table 3. Descriptive Statistics and Normality Analysis of the Data

	Class	Kolmogorov-Smirnov				Group Statistics		
		Statistic	df	Sig.	N	Mean	Std. deviation	Std. error mean
Creative thinking skills	Experiment	.14	32	.09	32	81.28	5.11	.90
	Control	.10	32	.20*	32	65.21	4.33	.76

b. Lilliefors significance correction

The test of Kolmogorov-Smirnov findings in Table 3 notifies that the info on creative thinking talents in the laboratory class that implemented the problem-based learning model $[D(32)=0.143, p=0.097]$ and traditional education in the class of control $[D(32)=0.102, p=0.200]$ were regular distribution.

to determine normally distributed data and a homogeneity test of variance for data variance uniformity. All information investigation used version 25.0 of SPSS. The research process flow is shown in Figure 1.

Result and Discussion

The discussion and outcomes of the influence of problem-solving instruction models on the ability to think creatively and problem-solving abilities in science lessons are presented below.

The Impact of the Problem Created Learning Models for Creative Reasoning Skills

Table 3 displays the outcomes of data analysis (data normality analysis and descriptive statistics) and Table 4 (variance homogeneity analysis and independent t-test analysis results) demonstrate the effect of issue-based learning models on the creative thinking abilities of Palu City's Class VIII junior high school students.

The outcomes of the Levene check out Table 4 inform that it variance of the creative thinking skills data of both the control class and the trial class is uniform $[F(1,62) = 3.672, p = 0.060]$. Additionally, the outcomes of the results of the unpaired t-test analysis show that creative thinking skills in the class of control with conventional learning $(M = 65.22, SD=4.33)$ are

fundamentally lower than in the preliminary class that applies the model of problem-based learning ($M = 81.28$, $SD = 5.11$), $t(62) = 13.56$, $p < 0.001$.

Table 4. Analysis Findings of Homogeneity of Variance and Independent t-Test

		Levene's test for equality of variances		t-test for equality of mean						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
								Lower		Upper
Creative thinking skills	Equal variances assumed	3.67	.060	13.56	62	.000	16.06	1.18	13.69	18.43

The results of the independent t-test analysis obtained in this study are that aptitude for creative thinking in the control class with ordinary learning is considerably less than in the experimental class, meaning that the model of problem-based instruction affects the originality of thought abilities in grade VIII understudies in science subjects. This finding is in line with research reports by Ates et al. (2024), Sari et al. (2023), Sekarini et al. (2020), and Weng et al. (2022) that most students showed an increase in their creativity skills after being taught the PBL model. This is because the problem-based environment approach provides students with the opportunity to weave experiences by actively participating in creating innovations and discovering new knowledge used to solve problems (Birgili, 2015) and the flexibility of PBL which combines intellectual and emotional aspects can help strengthen information intake, motivation, encourage innovation and increase cognitive engagement and application of dynamic thinking (Yu, 2024).

Since syntax one, the student-centered learning model, or student orientation to problems, has been observed. It starts by exposing students to real problems. The topic of learning nutritious and balanced food is very close to students' daily lives and it is easy for understudies to grasp the idea of this learning subject with a video presentation about the variety of food menus that students usually find but contains the problem of choosing healthy, nutritious and balanced

foods for each age of human growth. The problems presented to these students stimulate them to think creatively and encourage effective reasoning to identify healthy and balanced food menus for different ages and plan healthy, nutritious, and balanced foods for breakfast, lunch, and dinner menus in one day. The problems presented in Syntax One provide students with the provision to explore and be creative in finding solutions to problems through group cooperation. This kind of learning process is supported by the reported findings that PBL successfully improves students' perspectives on each problem through a multidimensional approach and makes students become more active learners because this learning process facilitates students to express opinions and exchange ideas (Ernawati et al., 2023).

The Influence of Problem-based Learning Models on Problem-Solving Abilities

The results of the information examination, which are presented in Table 5 as the results of the information ordinariness examination and expressive measurements, and in Table 6 as the results of the fluctuation homogeneity examination and autonomous t-test examination, respectively, demonstrate the impact of the issue assembled learning models on the critical thinking skills of Class VIII middle school students in Palu City.

Table 5. Descriptive Statistics and Normality Analysis of the Data

	Class	Kolmogorov-Smirno			Group Statistics				
		Statistic	df	Sig.	N	Mean	Std. deviation	Std. error mean	
Problem-Solving Skills	Experiment	.15	32	.062	32	71.62	1.68	.29	
	Control	.11	32	.200*	32	65.37	1.73	.30	

*. This is a lower bound of the true significance

b. Lilliefors significance correction

The test of Kolmogorov-Smirnov findings are presented in Table 5 inform that it problem-solving ability of the data from the experimental class implemented the problem-based learning model

[$D(32) = 0.151$, $p = 0.062$] and traditional education in the class of control [$D(32) = 0.117$, $p = 0.200$] were regular distribution.

The results of Table 6's Levene test inform that the distinction of the critical ability to think both the trial class and the control class have identical data [$F(1,62) = 0.026, p = 0.874$]. Additionally, the findings of the analysis that was carried out using the unpaired t-test show that its ability to solve problems in the classroom

of control with conventional learning ($M = 65.3750, SD = 1.73670$) is fundamentally lower than the trial class that applies the model of problem-based learning ($M = 71.6250, SD = 1.68005, t(62) = 14.63, p < 0.001$).

Table 6. Analysis Findings of Homogeneity of Variance and Independent t-Test

		Levene's test for equality of variances			t-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
										Lower	Upper
Problem-solving skills	Equal variances assumed	.026	.87	14.63	62	.000	6.25	.42	5.39	7.10	

The aftereffects of the Independent t-test analysis that this study uncovered are that the capacity for problem-solving in the control course with traditional education is considerably less than in the experimental class, meaning that the model of problem-solving instruction affects the ability to solve problems of grade VIII understudies in science subjects. Students are better able to create a few arrangements that are relevant to the recognized issues when they have a better understanding of the topic that has been placed by the instructor in sentence structure one. Syntax three in this model provides the widest opportunity for the students to look for and find information about the planned solution by exploring material from various available sources that are used as discussion material with group members. In-depth discussions with group members can trigger students to collaborate to map out several solutions that have the potential to be implemented or used. This study's findings are consistent with those of studies that inform that the approach of problem-based learning can increase students' potential to solve problems (Asyhari & Sifa, 2021; Nanang & Parmin, 2022; Y. I. Sari et al., 2021; Shamdas, 2023b; Yanto et al., 2021) because this model can encourage students to participate in learning, practice individual problem-solving, and share ideas with group members (Phungsuk et al., 2017). Other research results report that PBL provides benefits in the form of better knowledge retention and memory, improved problem-solving skills, better decision-making skills, and development of lifelong learning abilities (Shalini, 2021) because the cycle in issue-based learning can help students identify problems, ask their questions, research answers, report results, and create interest in their learning (Barell, 2007).

Conclusion

The consequences of the review showed that the innovative reasoning abilities of conventional classes

were significantly lower than problem-based learning classes $t(62) = 13.56, p < 0.001$, and the problem-solving ability in conventional classes was considerably lower than problem-based learning classes $t(62) = 14.63, p < 0.001$. Thus, this study concludes that the creative thinking skills and problem-solving abilities of Class VIII SMP students in science subjects can be empowered by implementing a problem-based learning model.

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Author Contributions

From the proposal's preparation to the journal's publication, this research involved all authors directly. Conceptualization, G.S.; methodology, Is.; validation, L.A.; investigation, Z.D; writing—review and editing, G.S.; Is; L.A.; and Z.D. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare that there is no conflict.

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