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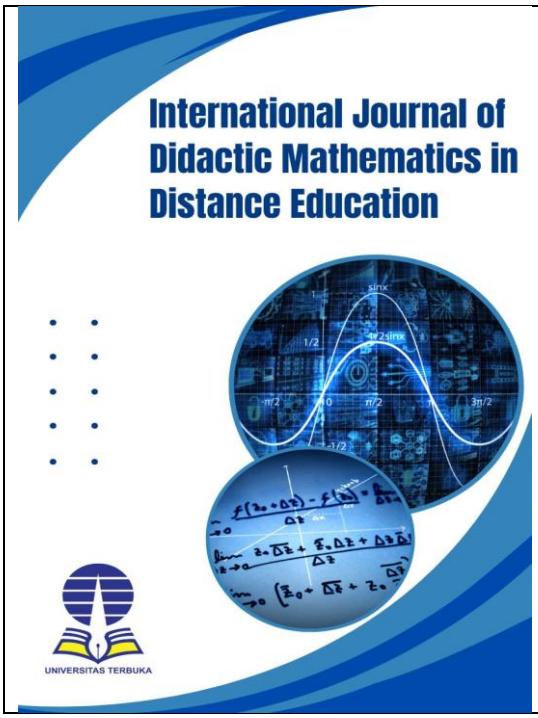

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Integration of character education in constructivism-based learning model: its impact on students' mathematics learning outcomes

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Abstract
This study investigates the effectiveness of a constructivist mathematics learning model that incorporates character education in improving students' understanding of mathematical concepts. This research uses a quantitative approach with a quasi experimental design. This study involved students from 3 schools, who participated in 5 integrated learning sessions and uses a paired sample t-test to evaluate the effect of the integrated learning model on students' understanding of mathematics concepts. Data analysis was conducted using inferential statistical techniques. Based on the results of the paired samples test on the pretest and postest scores, it shows that Sig value. (1-tailed) 0.000 < 0.05 and t_{count} = 58.539 > 1.673 means that significantly the average student learning outcomes after being taught with an integrated constructivism-based learning model of character education are better than before being taught with an integrated constructivism-based learning model of character education. The results of this study show that the integration of character education in the learning model creates a more interactive, reflective and value-based learning experience, which ultimately contributes to improved understanding of mathematical concepts. Furthermore, this study also offers practical recommendations for educators and policy makers in designing learning models that are more adaptive and oriented towards student character development.

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1. Introduction

Mathematics is a very important discipline to improve logical thinking, analytical, and problem solving skills (Fatihah et al., 2023; Sudirman et al., 2023). These abilities are very supportive for academic success and in everyday life, but in practice, learning mathematics still faces various challenges, especially in improving conceptual understanding and building students' positive attitudes towards mathematics (Cipora, 2022; Evans & Field, 2020). Many students memorize formulas without understanding abstract concepts which leads to low learning outcomes (Moliner & Alegre, 2022; Smedt, 2022). Constructivism-based learning is widely recommended as an alternative solution to improve students' understanding of what they are learning by emphasizing an active, explorative, and experiential learning process (Glaister et al., 2023). This learning model allows students to actively participate in solving problems independently and collaboratively and build their own knowledge (Korkor & Bonyah, 2024). However, this learning model relies not only on cognitive components, but also affective components, including students' attitude and character in learning (Efwan et al., 2024; Rahman et al., 2024; Suprihatin, 2024; Zheng et al., 2023). Therefore, the integration of character education in constructivism-based learning models is a potential innovative approach in creating more meaningful and effective learning experiences. In mathematics learning, character education aims to instill values such as perseverance, honesty, cooperation, and a

sense of responsibility during the learning process (Espinosa & Gonzales, 2023; Haider, 2022). By combining student- centered constructivist strategies and character education that emphasizes the development of positive attitudes, it is expected that student learning outcomes will improve significantly in both cognitive and affective aspects. However, until now there is still limited research that comprehensively explores the effectiveness of constructivism-based learning models integrated with character education in improving student learning outcomes in mathematics learning.

Although mathematics is one of the main subjects taught in schools, many students still have difficulty understanding the basic concepts taught. Conventional learning approaches that center on one-way transfer of knowledge from teacher to student, tend to encourage students to memorize formulas without understanding the concepts taught, which is the main cause of low learning outcomes of mathematics learning (Dwyer, 2023). As a result, many students struggle to use their knowledge in a broader context such as solving real-life problems. In addition, affective factors such as students' attitudes and perceptions towards mathematics also play an important role in determining how effective their learning is (Mammadov & Tozoglu, 2023; Geisler et al., 2023). Poor perceptions of mathematics such as academic anxiety, lack of self-confidence, and lack of instrinsic motivation, are often major barriers to improving student learning outcomes (Mammarella et al., 2023; Ningsih et al., 2023).

Most learning approaches in schools, however, focus more on academic achievement than on overall learning outcomes. In Sorong district, mathematics learning at the junior high school level faces a number of specific problems that affect student learning outcomes. One study revealed that many students perceive mathematics as a difficult and boring lesson (Lestari et al., 2023). Another study showed that the mathematics learning difficulties of junior high school students in Sorong Regency were not only related to academic ability but also influenced by environmental factors and students' attitudes during the lesson (Fenetiruma, 2024). The constructivism-based learning model is an effective strategy in improving students' conceptual understanding by placing students actively involved in the learning process (Romdhon et al., 2024, Jumadia et al., 2024). This learning model emphasizes students' active involvement in constructing knowledge through exploration, discussion, and reflection (Putri et al., 2024; Ering et al., 2024)). However, although this model has shown its effectiveness on learning outcomes, there is no research that explores the effectiveness of constructivism-based mathematics learning models integrated with character education on student learning outcomes.

To overcome the problem of learning mathematics in junior high school, a strategy is needed that not only improves student learning outcomes but also forms their positive character towards the subject. This study aims to examine the effectiveness of the constructivism-based mathematics learning model integrated with character education on student learning outcomes. This model is designed to overcome the obstacles faced by students in sorong district, especially in terms of understanding basic concepts, student attitudes, and the tendency to memorize without understanding the essence of the material. By placing students as active subjects in constructing their own knowledge, this model is expected to encourage better cognitive and affective engagement in the learning process (Ruchiyat et al., 2020). Specifically, this study looks at how the integration of character education in the constructivism learning model can help students' positive character towards mathematics. Values such as perseverance, intellectual honesty, curiosity, and cooperation are important aspects in creating a conducive and meaningful learning environment (Cahyadi & Muttaqin, 2025; Hidayati et al., 2024). By applying this learning model, it is expected that students will not only be able to improve their conceptual understanding but also develop a more positive attitude towards academic challenges, including in mathematics. In addition to making an empirical contribution to the effectiveness of the learning model, this study also aims to offer practical recommendations for educators and policy makers in designing learning models that are more adaptive and oriented towards student character development. Thus, the results of this study will not only provide new insights in the field of mathematics education but serve as a foundation for the development of more inclusive and sustainable learning policies.

Various studies have discussed how effective constructivism-based learning models are in improving students' mathematical understanding, however, most studies only concentrate on the cognitive component without considering how character education contributes to the learning process (Sitanggang,

2018). Approaches that only focus on academic outcomes have not been able to fully address the problems of mathematics learning in Sorong district. Therefore, there is an urgent need to explore learning models that not only improve student learning outcomes but also build student character. Previous studies have shown that constructivism-based learning can improve students' conceptual understanding by encouraging their active involvement in constructing knowledge (Deng et al., 2011), but research that explicitly examines the impact of integrating character education in constructivism-based learning models on learning outcomes is still very limited. Most studies focus on pedagogical aspects without exploring how character education values can influence student engagement in mathematics learning. In addition, there are not many studies that specifically examine the application of this model in the context of education in regions such as Sorong Regency, which has unique challenges in the learning process.

This research offers a new contribution by exploring how the combination of constructivism-based learning with character education can create a more effective and meaningful learning environment. Thus this research not only highlights the effectiveness of the learning model in improving students' conceptual understanding but also emphasizes the importance of forming their positive attitude towards mathematics. The uniqueness of this research lies in the holistic approach that combines cognitive and affective aspects in one learning model. In the context of Sorong District where students still face challenges in understanding basic math concepts as well as lack of motivation and confidence in learning, this learning offers a more comprehensive solution compared to more conventional learning. By integrating character education values in the learning process, this model is expected to change the paradigm of student learning from just memorizing formulas to a more effective and meaningful exploration process. By examining the impact of the integration of character education in constructivism-based mathematics learning on student learning outcomes, this study is expected to enrich the literature in the field of mathematics education and provide practical recommendations for educators and policy makers. The results of this study also have broad implications for curriculum development and teaching methods that are more adaptive to the needs of students in various educational contexts.

2. Method

2.1. Research Design

This research uses a quantitative approach with a quasi experimental design. The model applied is a non-equivalent control group design, where groups are not randomly selected but determined based on certain characteristics. This approach was chosen to test the effectiveness of the application of constructivism-based mathematics learning models integrated with character education on student learning outcomes.

2.2. Populations and samples

The population in this study were all junior high school students in Sorong Regency. The sample was selected using purposive sampling technique to ensure proportional representation based on school accreditation level. The sample consists of three junior high schools with different accreditation categories, namely one school with A accreditation, one school with B accreditation, and one school with C accreditation. The three schools selected were spread throughout Sorong district, both public and private schools, with a total number of respondents of 56 students.

2.3. Data Collection

Data in this study were collected through learning outcome tests developed based on indicators of competency achievement in the junior high school mathematics curriculum. This pre-test and post-test was used to measure students' concept understanding by applying the learning model. The tests were in the form of descriptions where the validity and reliability of the tests were tested before being used in the research to ensure the instrument had a high level of confidence. The learning outcome test that has been created, then tested for validity and reliability. The validity test uses construct validity while the reliability test uses Cronbach's Alpha.

2.4. Data Analysis

Data analysis was conducted using inferential statistical techniques to measure the effectiveness of the applied learning model. Inferential statistical analysis to analyze data by making generalizations on sample

data so that the results can be applied to the population. But before that, the normality test was carried out first as a prerequisite test.

Pre-requisite Test

The prerequisite test was conducted before the hypothesis test (t-test). The prerequisite test is the normality test. For this test, the Kolmogorov-Smirnov test formula is used because the test can be used on large samples and small samples. According to Lestari and Yudhanegara (2015) the Kolmogorov-Smirnov formula is as follows:

$$D_{count} = maks\ \{|p_k - z_{table}|\}$$

Description: pk = cumulative proportion.

The data normality test is intended with the hypothesis:

H_0 : Data comes from a normally distributed population,

H_a : Data does not come from a normally distributed population

the basis for decision making Accept H_0 if the value of the value $D_{count} \leq D_{table}$ and Reject H_0 If $D_{count} > D_{table}$.

Hypothesis Testing

Hypothesis testing is used to determine the answer to the temporary conjecture formulated in the research hypothesis.

a. Paired Sample Test

The paired sample test is used to test the effectiveness of the learning model seen from the improvement of students' abilities before and after learning. The test formula is:

$$t = \frac{\overline{D}}{\frac{SD}{\sqrt{n}}} = \frac{\overline{D}}{\sqrt{\frac{\Sigma x^2 d}{n(n-1)}}}$$

Description:

t = Values,

$\overline{D}$ = mean difference between pre-test and post-test,

SD = standard deviation of difference between pretest and post-test,

n = number of samples,

$\Sigma x^2 d$ = sum of squares of standard deviation of pretest and post-test.

Research hypotheses

Two-party test:

H_{01}: The average learning outcomes of students before being taught using the Constructivism- based learning model integrated with character education learning model compared to being taught with the Constructivism- based learning model integrated with character education learning model have no significant difference

H_{a1}: The average learning outcomes of students before being taught using the Constructivism- based learning model integrated with character education learning model compared to being taught with the Constructivism- based learning model integrated with character education learning model have a significant difference

Right Party Test:

H_{02} : Significantly the average student learning outcomes after being taught with the Constructivism-based learning model integrated with character education learning model is not better than before being taught with the Constructivism- based learning model integrated with character education model.

H_{a2} : Significantly the average student learning outcomes after being taught with the Constructivism-based learning model integrated with character education learning model is better than before being taught with the Constructivism- based learning model integrated with character education model.

Statistical hypothesis:

Hypothesized two-party test statistics are $H_0: \mu_0 = 0$ and $H_a: \mu_0 \neq 0$.

Statistical hypothesis Right party test is $H_0: \mu_0 \leq 0$ and $H_a: \mu_0 > 0$

The hypothesis testing criteria If $t_{count} \leq t_{tab}$ or significant level $\geq \alpha$ (p-value > 0.05) then H_0 is accepted and H_1 is rejected, and If $t_{count} > t_{tab}$ or significant level < α (p-value < 0.05) then H_0 is rejected and H_1 is accepted. According to Lestari and Yudhanegara (2015), the hypothesis testing formula above can be done if the prerequisite analysis test is met, otherwise a non-parametric test is used using the Wilcoxon signed rank test.

b. Gain Value (N-Gain)

Gain is the difference between the initial test and the final test, the gain shows the increase in the achievement of mastery of student learning material after learning is carried out. Normalized gain is used to avoid conclusions that will cause bias in research. the normalized gain formula according to Meltzer (2012) is as follows

$$< g >= \frac{\% < G >}{\% < G >_{max}} = \frac{(\% < S_f >) - (\% < S_i >)}{100 - (\% < S_i >)}$$

Where, $< g >$ = normalized gain score, $< S_f >$ = Final test score, and $< S_i >$ = Initial test score.

To relate the quality of the increase in students' learning achievement can be seen based on the normalized gain score with the classification according to Meltzer (2012) in the following table.

Table 1

Classification of Normalized Gain Value Interpretation

Normalized Gain Value	Interpretation
0.7 < $< G >$	High
0.3 < $< G >$ < 0.7	Medium
$< G >$ < 0.3	Low

c. One Sample t-Test

The one sample t-test was conducted to see the overall effectiveness of the learning model on mastery of subject matter and student attitudes. The testing formula is:

$$t = \frac{\bar{X} - \mu_0}{\frac{S}{\sqrt{n}}}$$

Description:

$\bar{X}$ = sample mean value,

μ_0 = hypothesized value,

S = sample standard deviation,

n = sample size.

Research Hypotheses

H_{01}:Students' learning outcomes after being taught with the Constructivism-based learning model integrated with character education learning model are less than or equal to 75.

H_{a1}:: Students' learning outcomes after being taught with the Constructivism- based learning model integrated with character education learning model are more than 75.

H_{02}:: Average Normalized Gain of learning outcomes of students taught with the Constructivism- based learning model integrated with character education learning model is less than or equal to 0.3.

H_{a2}: The average normalized gain of students' learning outcomes taught with the Constructivism-based learning model integrated with character education learning model is more than 0.3.

Statistical Hypotheses are

$H_{01}: \mu_1 \leq 75$ and $H_{a1}: \mu_1 > 75$, then

$H_{02}: \mu_2 \leq 0.3$ and $H_{a2}: \mu_2 > 0.3$.

The decision criteria are H_0 rejected if the significance value is smaller than 0.05 or the value $t_{hitung} > t_{(0,05;(n-1)}$.

3. Results and Discussion

3.1 Results

The results of descriptive statistical calculations of the acquisition of student learning outcomes can be seen as follows (Tabel 2).

Table 2

Statistical Description of Results

Description	Pretest	Posttest
Sum	1570	4637
Mean	28.04	82.80
Median	30	81
Mode	30	78
St. Deviation	8.26	6.60
Maximum	42	97
Minimum	5	72

The results of descriptive statistical analysis show that students can generally achieve the minimum completeness criteria set after participating in learning by using the Constructivism- based learning model integrated with character education. The results of this analysis also show that there are students who reach the maximum score of 97 although there are also students who have not reached completeness which can be seen from the minimum score which is still below 75. In general, the pretest scores of students have not reached completeness and the post- test scores have reached completeness where this can be seen from the mode value.

Table 3

Frequency Distribution of Learners' Earned Value

Description	SMP Negeri 1		SMP Muhammadiyah		Small Scale	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Completed	0%	97%	0%	91%	0%	95%
Not Completed	100%	3%	100%	9%	100%	5%

From the frequency distribution Table 3, it is known that 3 out of 56 students have not reached the minimum completeness criteria on the post-test score. For pretest scores, all students were declared incomplete.The normality test output of the subject matter mastery test data can be seen in the following Table 4.

Table 4

Normality Test of Limited Trial Data

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Pre-test	.171	56	.131	.927	56	.072
Post-test	.161	56	.110	.937	56	.060
Gain Score	.199	56	.142	.926	56	.102

From the results of the normality test, the data obtained that the significance value or p-value is greater thanα = 0,05 so it can be concluded that the data on student learning outcomes come from a normally distributed population. After the normality test is carried out as a prerequisite test before conducting hypothesis testing, the paired t-test will then be carried out through the paired samples test whose results are presented in the following Table 5.

Table 5

Paired Sample Test

	t	df	Sig. (2-tailed)	Sig. (1-tailed)
Pair	58.539	55	.000	.000

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Based on the results of the paired samples test on the pretest and postest scores, it shows that the Sig value. (2-tailed) 0.000 at a significant level of 0.05, because 0.000< 0.05 and t count 58.539> 2.004, the hypothesis H 0 is rejected, meaning that the average learning outcomes of students before being taught with the Constructivism-based learning model integrated character education compared to after being taught with the Constructivism-based learning model integrated character education has a significant difference. Sig value. (1-tailed) 0.000< 0.05 and t_{count} = 58.539 > 1.673 means that significantly the average student learning outcomes after being taught with an integrated constructivism-based learning model of character education are better than before being taught with an integrated constructivism-based learning model of character education.

Testing the average student learning outcomes on the posttest against the completeness criteria was carried out with the one sample t test. The test results output is presented in the following Table 6.

Table 6

One samples test

	t	df	Sig. (2-tailed)
Post-test	8.854	55	.000

Based on the results of the analysis conducted, the Sig. 0.000 with a value of α = 0.05 so that the p-value < α and the calculated t value of 8.854 is greater than the t tab 2.036 thus H 0 is rejected, which means that student learning outcomes after being taught with the Constructivism-Based learning model integrated Character education is greater than 75. which is the learning objective completion criteria set by the school.

Testing the average increase in student learning outcomes is done with the one sample t test. The test results output is presented in the following Table 7.

Table 7

One samples test score for improving learning outcomes

	t	df	Sig. (2-tailed)
Gain Score	41.704	55	.000

Based on the results of the analysis carried out, the value of Sig. 0.000 at the 0.05 significance level so that the p-value of 0.000 <0.05 and the calculated t value of 41.704 is greater than the t tab value of 2.004, the H_0 test decision is rejected which means that the average normalized gain of students taught with the Constructivism-based learning model integrated with character education is greater than 0.3. Based on these results, it can be stated that the constructivism- based learning model integrated with character education developed along with the learning tools supporting the model is effective for improving students' mastery of learning materials.

The results showed that the application of constructivism-based learning model integrated with character education significantly improved the learning outcomes of junior high school students in Sorong Regency. However, what is more important than these quantitative results is the pedagogical intervention carried out through the integration of character education values in learning activities. In the implementation of the constructivism learning model integrated with character education, character education is integrated into each stage of constructivist learning. For example, in the concept exploration phase, students are invited to work together in small groups to solve contextual problems that emphasize the values of responsibility, cooperation, and tolerance. In the construction phase, teachers facilitate reflective discussions that encourage the values of honesty and curiosity, while in the confirmation and reflection stages, students are given the opportunity to reflect on their learning process individually and in groups, thus forming the values of discipline and independence.

Learning activities are also directed to build students' awareness of the importance of critical thinking and respect for different opinions, as part of instilling democratic values and mutual respect. The teacher acts as a facilitator who not only directs conceptual understanding, but also provides an example in behavior, including in giving constructive feedback.

In addition to the paired sample t-test results, the one sample t-test analysis of the normalized gain value shows that the Sig. 0.000 < 0.05 with t_{count} 41.704 > t_{table} 2.004. This indicates that the average increase in student learning outcomes is in the moderate to high category. This finding shows that the

constructivism learning model integrated with character education not only cognitively impacts on mathematics understanding, but also affectively through the internalization of character values that support positive learning behavior. Thus, the success of this model is not only determined by the constructivism approach in developing mathematical concepts, but also by the cultivation of character in the learning process that encourages the formation of students' personalities as active, reflective, and responsible learners. The character education intervention inherent in the integrated constructivism model of character education makes it a comprehensive and contextual learning approach, especially in responding to the challenges of learning mathematics at the junior high school level in Sorong Regency.

3.2 Discussion

The results of this study indicate that the constructivism-based mathematics learning model integrated with character education significantly improves student learning outcomes in mathematics subjects. This finding is in line with constructivism theory which emphasizes that effective learning occurs when students actively construct their understanding through interaction with challenging and meaningful learning environments (Sitanggang, 2018; Kaya, 2015). In the context of this study, the constructivism-based learning approach combined with character education creates a more interactive, reflective and value-based learning experience, which ultimately contributes to improved understanding of mathematics concepts Statistically, the results of the paired sample t-test showed a significant increase in the average learning outcomes after the application of the constructivism-based mathematics learning model integrated with character education, with a t value of 58.539 which exceeded the t_{table} of 1.673 ($p < 0.05$). These results indicate that the learning model developed not only has a positive impact on students' concept understanding but is also able to overcome the limitations that often arise in conventional learning methods. Students who previously had difficulty in understanding mathematics material now show significant improvement after being given constructivism-based learning interventions and character education.

Furthermore, one sample t-test results confirmed that the average normalized gain was greater than 0.3, indicating the effectiveness of this model in improving learning outcomes. With a calculated t value of 41.704 greater than the t_{table} value of 2.004, this result confirms that the constructivism-based learning approach with the integration of character education has a substantial impact on students' academic achievement. This finding supports previous research showing that constructivism-based learning models not only improve learning outcomes but also help students develop critical thinking skills and problem-solving abilities (Hsbollah & Hassan, 2022; Yusmarni et al., 2019).

Constructivism-based mathematics learning integrated with Character Education has helped students' understanding in Sorong Regency related to mathematics learning. The diverse backgrounds of students in Sorong Regency are a challenge in teaching mathematics learning, so that by integrating character education into constructivism-based mathematics learning, students' mathematics learning outcomes can be maximized. It has been explained previously that constructivism-based mathematics learning integrated with character education can be applied well to students in Sorong Regency who have diverse backgrounds. This can be a reference for implementing mathematics learning with a similar model in other regions in Indonesia which of course also have diverse student backgrounds.

4. Conclusion

The results of this study show that the constructivism-based learning model integrated with character education is significantly effective on the mathematics learning outcomes of junior high school students in Sorong Regency. The paired sample t-test confirmed that there was a significant difference between the pre-test and post-test scores, showing the effectiveness of this model in improving the understanding of mathematical concepts. In addition, the one sample t-test showed that the average normalized gain was above 0.3, indicating that the improvement in learning outcomes was in the moderate to high category. Thus, it can be concluded that the constructivism-based learning model integrated with character education can be an effective alternative in improving the quality of mathematics learning, especially in the context of junior secondary education. These findings have several important implications: for teachers, the model offers a practical strategy to enhance students' conceptual understanding while simultaneously

fostering positive character traits such as responsibility, cooperation, and integrity; for curriculum developers and policymakers, it supports the integration of character education within academic subjects to improve both cognitive and affective learning outcomes; and theoretically, it reinforces the relevance of constructivist approaches in mathematics education. However, this study also has limitations. It was conducted within a specific regional context (Sorong Regency) with a relatively limited sample, which may affect the generalizability of the findings. In addition, the study focused primarily on cognitive outcomes and did not comprehensively measure long-term retention or affective changes. Future research should consider broader and more diverse settings, as well as incorporate longitudinal designs to explore the sustained impact of this integrated learning model.

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Author Contribution
Author 1: Conceptualization, Writing – Original Draft; Editing and Visualization; Formal analysis, and Methodology.
Author 2: Writing – Corresponding, Review & Editing
Author 3: Writing – Review & Editing

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Conflict of Interest
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