Enhancing Grade 10 Students' Critical Thinking Using Board Games

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ABSTRACT

This action research focused on improving Labo National High School's Grade 10 students' critical thinking skills in Statistics and Probability using board games during the 2024–2025 school year. Engaging students in more active and critical thinking in mathematics is needed for data interpretation and decision making. However, many traditional methods of teaching fail to capture students' active participation and critical thinking. This investigation utilized a quasi-experimental framework and comprised two sets of participants: one set practiced critical thinking using board games, while the other received traditional instruction. Each set of participants underwent assessments before and after the intervention. Outcomes indicated that, while students in all groups made improvements to their critical thinking skills, the group that instruction included board games made more significant gains and participated more actively. The use of board games was observed to enhance student motivation, teamwork, and problem-solving skills. In light of these findings, it can be concluded that board games can promote students' analytical thinking and understanding of more complex statistical concepts. Engaging students using board games into the mathematics curriculum is recommended to promote critical thinking. Learning through games is less monotonous and more meaningful. The provision of resources and materials needed for this effort should come from the school administration.

Keywords: critical thinking, board games, Statistics and Probability, mathematics instruction, game-based learning

INTRODUCTION

Mathematics education, especially Statistics and Probability, includes essential skills like interpreting data and making decisions about probability. These skills lead to sound reasoning. Students can assess different viewpoints as they reach logical conclusions from examined problems. However, many students find it hard to develop strong critical thinking in these areas (Basri et al., 2019). They usually depend on memorizing facts and following formulas, which can be hard to use in real life (Rahman, 2019). This gap shows the need for teaching methods that connect theory with practice. Such methods should promote deeper engagement and critical reasoning.

Students who struggle to relate abstract ideas to everyday life activities in statistics, data interpretation, and probability distributions will find these topics difficult (Kwangmuang et al., 2021). These difficulties often come from traditional teaching methods that are inactive and uninteresting. This can cause students to lose motivation and struggle to understand the subject's real-world relevance (Filgona et al., 2020). The lack of critical thinking in these areas not only leads to low academic performance but also prevents students from developing and using essential problem-solving skills in real-life situations.

Innovative teaching strategies will bridge these gaps (Sharoff, 2019). Games on the blackboard and the whiteboard provide structured interactive opportunities for students to practice problem-solving, strategic thinking, and teamwork. These skills are essential for developing higher-order thinking skills (Noda et al., 2019). These classroom games simulate real-life situations in statistics and probability. Students must assess information, calculate probabilities, and make rational decisions. Research shows that promoting active, hands-on learning through these games increases student engagement, strengthens understanding of concepts, and develops critical thinking skills (Chen et al., 2021).

This action research aims to assess how effective blackboard and whiteboard games are in improving Grade 10 students' critical thinking skills in Statistics and Probability at Labo National High School. The study focuses on

adding fun, game-based activities to classroom instruction. This gives students chances to take part in interactive learning tasks that promote problem-solving, reflection, and analytical reasoning (Machuquiero & Piedade, 2024). By including elements like strategic decision-making, discussion, and teamwork, this approach seeks to create an active learning environment that supports both understanding of concepts and the growth of critical thinking skills (Laine & Lindberg, 2020).

Through blackboard and whiteboard games, teachers can help students explore real-world statistical problems, learn from each other, and discuss complex topics more deeply (Hartt, 2022). This method aims to make the classroom experience more engaging and practical. It not only improves students' math skills but also boosts their ability to think critically, work together, and solve problems confidently (Bayeck, 2020).

Despite the growing research on game-based learning, there is still a clear gap in studies that specifically look at the role of blackboard and whiteboard games in developing critical thinking in Statistics and Probability. Previous research has explored different aspects of educational gaming, such as its impact on student engagement (Liu et al., 2020), its use in mathematics teaching (Lin & Cheng, 2022), and its effect on problem-solving skills (Tsai et al., 2021). However, few studies have examined how these games can improve critical thinking related to statistical concepts like probability distributions and data analysis (Miles, 2017).

While studies have shown that video games can improve computational thinking, their effectiveness depends on meaningful instructional integration (Tsarava et al., 2019). There are also mixed results about how board games affect critical thinking when used with traditional teaching methods (Gentry et al., 2019). Board games promote engagement and collaboration, but there is little research on their role in developing critical thinking skills in Statistics and Probability. This action research aims to evaluate how blackboard and whiteboard games can enhance students' critical thinking abilities in these math areas.

The study will focus on creating and carrying out blackboard and whiteboard game activities. These will help Grade 10 students understand key statistical concepts, such as probability distributions, data interpretation, and statistical measures. However, the research is limited to one school, which might affect how widely the findings apply. The short length of the intervention could also mean that long-term effects may not be seen fully. Additionally, differences in how effective teachers are when using the games could impact the results. Although the main aim is to improve critical thinking, other skills like computational fluency and creativity will not be measured.

Despite these limitations, the research is valuable. It aims to fill gaps in the current literature by offering evidence on how blackboard and whiteboard games help improve critical thinking in Statistics and Probability. These are areas where students often struggle to connect theory with practice (Seibert, 2021). This study supports new teaching methods by introducing classroom games as teaching tools. It shows how game-based learning can change traditional lessons into interactive and engaging experiences. Additionally, it highlights the importance of critical thinking as a key 21st-century skill that is essential for both academic success and real-world problem-solving (Thornhill-Miller, 2023). The findings are expected to give practical insights for educators and curriculum developers who want to include interactive strategies in math instruction. The ultimate goal is to improve students' math literacy and critical thinking skills.

METHODOLOGY

A. Research Design

This action research study will use a quasi-experimental research design. This design is suitable for educational research because it lets us examine causal relationships between an intervention and learning outcomes, even if we cannot randomly assign participants (Maciejewski, 2020). This approach is fitting since it allows us to measure how effective blackboard and whiteboard games are at improving critical thinking skills in Statistics and Probability.

B. Research Setting

The upcoming 2024-2025 academic school year will entail conducting the study among Grade 10 students at a junior high school within the region. The school is one of the first to implement the K to 12 basic education

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program which includes junior and senior high school levels as per the resolution from the Department of Education (DepEd). DepEd also requires the school to maintain the Junior High School curriculum from grade 7 to grade 10, which further demonstrates the school's commitment to modern education during DepEd's transition within the sector.

C. Respondents of the Study

This study involves 60 Grade 10 learners who will participate in the study. The participants will be selected through a purposive sampling technique following the administration of a pretest to all students from four Grade 10 sections during the 2024–2025 school year. The pretest results will be used to rank the learners according to their performance levels. From these results, two groups will be purposively identified: thirty (30) students with the lowest and thirty (30) with the highest scores. The selection will be based on the following criteria: (1) students officially enrolled as Grade 10 learners for the 2024–2025 school year, (2) students classified as either low- or high-performing based on their pretest results, and (3) students who are willing to participate fully in the study. Only four sections will be considered for selection, and the researcher will ensure that all inclusion criteria are met before conducting the study.

D. Instruments

This study utilized the following instruments:

A. Statistics Test. The instrument is a 30-item questionnaire created by researchers that covers topics from the 4th grading period of Mathematics 10, with a focus on Statistics and Probability. The goal of these topics is to help them get better at looking at data, understanding statistical measures, and using probability ideas in everyday life. The researcher will have experts, such as the research adviser, school head, principal, and cooperating teacher, look over the test to make sure it is valid. The researcher will perform a pilot test with a distinct group of participants excluded from the study and will verify that the instrument attains a Cronbach's Alpha ranging from 0.7 to 1.0. The instrument will be utilized for both the pre-test and post-test.

In determining the test performance, the following scale will be used.

Score	Grade Equivalent	Interpretation
26-30	90-100	Outstanding
23-25	85-89	Very Satisfactory
21-22	80-84	Satisfactory
18-20	75-79	Fairly Satisfactory
1-17	74 below	Did not meet expectations

Lesson Plan. The researchers will develop a lesson plan centered on teaching Statistics and Probability in mathematics subject. Before its implementation, the cooperating teacher will thoroughly review the lesson plan and subsequently revise by the researcher. The lesson will then be carried out with Grade 10 students at a public high school in Misamis Occidental during the 2024-2025 school year.

E. Data Collection

Pre-Implementation Phase. Prior to conducting the study, the researcher will obtain consent from the principal, the participating teacher, the parents of the student, the Schools Division Superintendent, and the dean of the College of Education. Following approval, the parents of the students will receive consent forms, and the students themselves will be asked to sign them. A pre-test will be given to determine the students' baseline understanding of the Filipino vocabulary and concepts that are the focus of the study after all required permissions and forms have been obtained. Along with creating lesson plans and pertinent resources, the researcher will incorporate board-based learning into the teaching methodology. At this stage, assessments and activities will also be created using the lesson plans and PowerPoint presentations created by the teachers.

Implementation Phase. In the classroom, the researchers would use board games to present and discuss the lessons. Students will also receive comprehensive instructions on how to use the board learning for activities

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and assessments. To find out how much the students' critical thinking skills have improved, an assessment will be given a month after the intervention has been in place. A class record will be created in order to document the data and monitor the students' progress during the implementation period.

Post-Implementation Phase. The post-implementation stage involves tallying the data, analyzing it, interpreting the findings, and reporting the results to conclude the project. Giving recommendations, proofreading, editing, and finalizing the research study will also be conducted after. It also involves the proper dissemination of the research results to a specific audience.

F. Ethical Considerations

In compliance with the ethical guidelines of the study, the subjects gave their informed consent. The researchers gave participants a thorough briefing on the Data Privacy Act of 2012 as part of their ethical practice. This was carried out to show the dedication to safeguarding private data and guaranteeing responsibility when handling sensitive information.

Participants received comprehensive information about the study's goals, possible advantages, and the significance of their involvement at every stage of the process. Additionally, the researchers reassured participants that their anonymity would be maintained throughout the study and stressed the confidentiality of the data collected.

G. Data Analysis

The researcher will calculate descriptive statistics, specifically the mean and standard deviations, to assess the level of performance both before and after implementing the intervention.

Mean and Standard Deviation. They will be used to identify the level of students' critical thinking before and after the use of board games.

T-Test. This tool will be used to compare students' critical thinking before and after the use of board games.

Frequency and Percentage. This will be used in identifying the level of performance of students before and after the use of board-games learning.

Paired T-Test. This tool will be used to explore the significant difference in students' performance before and after the use of board-games learning.

RESULTS AND DISCUSSION

Level Of Students' Critical Thinking Skills Before The Implementation Of Board Games

Performance	Frequency	Percentage
Did not Meet the Expectation	30	100.00
Overall Performance	8.77 – Did not meet the Expectation	

Note: Performance Scale: 26-30(Outstanding); 23-25 (Very Satisfactory); 21-22(Satisfactory); 18-20 (Fairly Satisfactory); 1-17 (Did not Meet Expectation)

Level of students' critical thinking skills before the implementation of Board Games Intervention Group

Performance	Frequency	Percentage
Did not Meet the Expectation	30	100.00
Overall Performance	8.67 – Did not meet the Expectation	

Note: Performance Scale: 26-30(Outstanding); 23-25 (Very Satisfactory); 21-22(Satisfactory); 18-20 (Fairly Satisfactory); 1-17 (Did not Meet Expectation)

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Table 1, the critical thinking proficiency levels of Grade 10 students before board games were introduced. With a mean score of 8.667 for the intervention group (n = 30) and a similar mean score of 8.767 for the control group (n = 30), both groups demonstrated relatively poor performance. The expected level of critical thinking ability in statistics and probability is significantly below these results.

The low pre-test scores in both groups show the challenges students face when trying to use critical thinking with mathematical concepts. This problem may come from the lack of engaging, inquiry-based learning methods in traditional classrooms. Previous research shows that students often struggle with statistical reasoning because standard methods focus on memorizing calculations instead of logical thinking and problem-solving (Ramli et al., 2022). These findings point to the need for more interactive teaching strategies. For example, using board games can help students understand better and improve their critical thinking skills.

B. Level Of Students' Critical Thinking Skills After the Implementation of Board Games

Table 2: Level of students' critical thinking skills after the implementation of Board Games Control Group

Performance	Frequency	Percentage
Outstanding	3	10
Very Satisfactory	19	63.33
Satisfactory	6	20
Fairly Satisfactory	2	6.67
Did not Meet the Expectation	-	-
Overall Performance	19.53 - Outstanding	

Note: Performance Scale: 26-30(Outstanding); 23-25 (Very Satisfactory); 21-22(Satisfactory); 18-20 (Fairly Satisfactory); 1-17 (Did not Meet Expectation)

Level of students' critical thinking skills after the implementation of Board Games Intervention Group

Performance	Frequency	Percentage
Outstanding	9	30
Very Satisfactory	12	40
Satisfactory	7	23.33
Fairly Satisfactory	2	6.67
Did not Meet the Expectation	-	-
Overall Performance	21.87 - Outstanding	

Note: Performance Scale: 26-30(Outstanding); 23-25 (Very Satisfactory); 21-22(Satisfactory); 18-20 (Fairly Satisfactory); 1-17 (Did not Meet Expectation)

Table 2 presents the students' post-test scores after the intervention. The intervention group achieved a mean score of 21.867, representing a substantial improvement of +13.2 points from their pre-test mean. The control group also showed progress, reaching a mean score of 19.533, which reflects a +10.77 point gain. Although both groups improved, the larger increase in the intervention group suggests a more substantial effect attributable to the use of board games.

These results show that board games significantly improved students' ability to think critically about statistical problems. This finding matches previous research, which points out that educational games encourage cognitive engagement, informed decision-making, and problem-solving skills (Maryana et al., 2024). The interactive nature of board games also led to increased student motivation and collaboration, both of which are important for developing higher-order thinking.

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C. Significant Difference In Students' Critical Thinking Skills Before and After the Implementation of Board Games

Table 3: Significant difference in students' critical thinking skills before and after the implementation of board games Control Group

Variables	M	SD	*T* value	*P* value
Critical thinking skills before traditional instruction	8.77	1.78	-22.84***	0.000
Critical thinking skills after traditional instruction	19.53	1.99		

Note: *** p < .001 (Highly Significant);**p≤0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not significant)

Significant difference in students' critical thinking skills before and after the implementation of board games Intervention Group

Variables	M	SD	*T* value	*P* value
Critical thinking skills before traditional instruction	8.67	2.29	-23.66***	0.000
Critical thinking skills after traditional instruction	21.87	2.14		

Note: *** p < .001 (Highly Significant);**p≤0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not significant)

Table 3 presents the results of the paired t-tests comparing the pre- and post-test scores. The intervention group showed a highly significant difference in performance (t = -23.66, p = 0.000), confirming that the use of board games had a statistically significant impact on students' critical thinking skills. The control group also showed significant improvement (t = -22.84, p = 0.000), though the gain was smaller compared to the intervention group.

The notable increase in the intervention group highlights how effective board games are in promoting a deeper understanding. Karakoç et al. (2022) support this by showing that game-based learning environments engage students in active exploration and decision-making, which improves cognitive processes such as analysis and evaluation. The data indicates that the board games not only boosted test performance but also developed meaningful critical thinking in Statistics and Probability.

D. Observed Improvements In Engagement And Understanding Of Statistics And Probability

Although the primary focus of this study was on test scores, the substantial gains in the intervention group imply improvements in engagement and conceptual understanding. The interactive and enjoyable nature of board games likely contributed to a classroom environment where students were more focused, collaborative, and reflective. These behavioral changes, often observed alongside cognitive gains, support the notion that game-based learning leads to more holistic development of mathematical thinking.

These results show that using board games in math teaching can turn passive learning into an active experience focused on students. This not only improves achievement but also helps students build vital 21st-century skills like problem-solving, communication, and reasoning.

Although the primary focus of this study was on test scores, the substantial gains in the intervention group imply improvements in engagement and conceptual understanding. The interactive and enjoyable nature of board games likely contributed to a classroom environment where students were more focused, collaborative, and reflective. These behavioral changes, often observed alongside cognitive gains, support the notion that game-based learning leads to more holistic development of mathematical thinking.

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CONCLUSION

Based on the findings, Students initially faced challenges in applying critical thinking to Statistics and Probability, highlighting the need for innovative teaching strategies that go beyond traditional lecture-based methods.

The use of board games significantly enhanced students' critical thinking skills by fostering an interactive and cooperative learning environment. This approach encouraged students to engage in analytical thinking, problem-solving, and clearer communication of their ideas.

Board games proved to be an effective instructional tool, improving both cognitive and behavioral engagement in the mathematics classroom. The study confirms that game-based learning can effectively bridge the gap between theoretical statistical concepts and practical application, creating a more dynamic and engaging learning experience.

Appendix

Directions: Read the questions properly and choose the letter of the correct answer.

_____1. What does the 1st quartile (Q_1) represent in a dataset?
A. The value that separates the top 75% from the bottom 25% of the data
B. The value that separates the top 25% from the bottom 75% of the data
C. The average of the entire dataset
D. The most common value in the dataset

_____2. A class of 40 students took a Math test. What is the correct formula to find the position of the 3rd quartile (Q_3) using the Mendenhall and Sincich method?
A. $Q_3 = 3(n + 1) \div 4$
B. $Q_3 = 3(n - 1) \div 4$
C. $Q_3 = n \div 4$
D. $Q_3 = (n \times 3) \div 10$

_____3. If the 2nd quartile (Q_2) of a dataset is 72, what does this mean?
A. 25% of the data are below 72
B. 72 is the most frequent value
C. 50% of the data are below or equal to 72
D. 72 is the highest value in the dataset

_____4. In a class, the scores of 12 students in a quiz arranged in ascending order are:
52, 55, 58, 60, 63, 65, 68, 70, 72, 74, 77, 80.
What is the value of the 1st quartile (Q_1)?
A. 55 C. 60
B. 58 D. 63

_____5. At Labo National High School, the heights (in cm) of 16 Grade 10 students are:
145, 148, 150, 152, 154, 157, 159, 160, 162, 165, 168, 170, 172, 175, 177, 180.
What is the value of the 3rd quartile (Q_3)?
A. 170 C. 168
B. 172 D. 165

_____6. What does the 7th decile (D_7) represent in a dataset?
A. The value that separates the top 70% from the bottom 30% of the data
B. The value that separates the top 30% from the bottom 70% of the data
C. The average value of the dataset
D. The value that occurs most frequently in the dataset

_____7. A class of 50 students took a Math test. To find the position of the 6th decile (D_6), which formula should you use?
A. $D_6 = 6(50 + 1) \div 10$
B. $D_6 = 6(50 - 1) \div 10$
C. $D_6 = 6(50 + 1) \div 4$
D. $D_6 = 6(50 \times 1) \div 10$

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_____8. The monthly salaries of 100 employees in a company were analyzed. If the 9th decile (D_9) is $80,000, what does this mean?
A. 90% of employees earn less than or equal to $80,000
B. 10% of employees earn less than or equal to $80,000
C. 90% of employees earn more than $80,000
D. 10% of employees earn exactly $80,000

_____9. A school measured the heights (in cm) of 60 students and organized the data in ascending order. If the 4th decile (D_4) is 155 cm and the 7th decile (D_7) is 165 cm, what does $D_4 = 155$ cm mean?
A. 40% of students are taller than 155 cm
B. 40% of students are shorter than or equal to 155 cm
C. 70% of students are shorter than 165 cm
D. 30% of students are shorter than 165 cm

_____10. At Labo National High School, the heights (in cm) of 20 Grade 10 students are recorded in ascending order:
142, 145, 148, 150, 152, 155, 157, 160, 162, 165, 167, 170, 172, 174, 175, 177, 179, 180, 182, 185
What is the value of the 3rd decile (D_3)?
A. 145 C. 150
B. 148 D. 152

_____11. Which of the following best describes a percentile?
A. A measure that divides data into 10 equal parts
B. A measure that identifies the middle value in a data set
C. A measure that shows the percentage of values below a specific point
D. A measure that finds the most frequently occurring value

_____12. What is the correct formula for finding the percentile position using the Mendenhall and Sincich method?
A. $P_k = k(n - 1) \div 100$
B. $P_k = k(n + 1) \div 10$
C. $P_k = k(n + 1) \div 100$
D. $P_k = k(n - 1) \div 10$

_____13. A class has 40 students. Using the formula $P_k = k(n + 1) \div 100$, what is the position of the 75th percentile (P_{75})?
A. 30.5th position
B. 31st position
C. 25th position
D. 20.5th position

_____14. If a student's score is at the 80th percentile, what does it mean?
A. The student scored below 80% of the class
B. The student scored equal to the class average
C. The student scored higher than 80% of the class
D. The student had the highest score in the class

_____15. The Math scores of 20 students at Labo National High School are listed in order:
42, 45, 48, 50, 53, 55, 57, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 85
John scored 68. Using the formula $P_k = k(n + 1) \div 100$, what is the percentile position of his score in the data?
A. 12.88th position
B. 13.2th position
C. 14th position
D. 11.34th position

Consider the set of scores in a quiz in Math 10 of Section Cerium: 11, 13, 14, 15, 15, 16, 19, 19.

_____16. What is the median of the given quiz scores?
A. 14 C. 15.5
B. 15 D. 16

_____17. Which of the following is the correct formula for finding a quartile position in an ordered data set?

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A. $Q = \frac{4(n)th}{4}$
B. $Q_k = \frac{4(n)th}{4}$
C. $Q_k = \frac{4(n+1)th}{4}$
D. $Q_k = \frac{k(n+1)th}{4}$

_____18. What is the data set's first quartile (Q1)?
A. 13 C. 15
B. 14 D. 11

_____19. What does the first quartile (Q1) represent in this context?
A. The score below which 25% of the students scored
B. The score that occurs most frequently in the data
C. The average score of all students in the class
D. The highest score achieved by any student

_____20. Calculate the 3rd quartile.
A. 16 C. 17.5
B. 17 D. 19

_____21. How many score points does each decile represent in a data set?
A. 10% of the data
B. 25% of the data
C. 50% of the data
D. 75% of the data

_____22. Which of the following is the correct formula for finding the position of a decile in an ordered data set?
A. $D_k = \frac{k(n+1)th}{4}$ C. $D_k = \frac{k(n+1)th}{10}$
B. $D_k = \frac{k(n-1)th}{4}$ D. $D_k = \frac{10(n+1)th}{k}$

_____23. What is the 3rd decile (D3) of the given quiz scores?
A. 13 C. 15
B. 14 D. 16

_____24. What does the 3rd decile (D3) represent in this context?
A. The score that occurs most frequently in the data
B. The average score of all students in the class
C. The score below which 30% of the students scored
D. The highest score achieved by any student

_____25. Which of the following is the correct formula for finding the position of a percentile in an ordered data set?
A. $D_k = \frac{k(n+1)th}{10}$ C. $P_k = \frac{k(n+1)th}{10}$
B. $Q_k = \frac{k(n+1)th}{4}$ D. $P_k = \frac{k(n+1)th}{100}$

_____26. What is the 90th percentile (P90) of the given quiz scores?
A. 15 C. 16.5
B. 16 D. 19

_____27. What does the 90th percentile (P90) represent in this context?
A. The score that occurs most frequently in the data
B. The average score of all students in the class
C. The score below which 90% of the students scored
D. The highest score achieved by any student

_____28. A teacher analyzed the quiz scores of Section Cerium and found that the first quartile (Q1) is 14.
Which of the following is the best interpretation of this result?
A. 25% of the students scored below 14.
B. 25% of the students scored above 14.
C. 50% of the students scored exactly 14.
D. 75% of the students scored below 14.

_____29. A school awards students who scored in the top 30% of the class. Based on the given scores, the third decile (D3) is 14.
Who are the eligible students for the award?
A. Students who scored above 14.
B. Students who scored below 14.
C. Students who scored exactly 14.
D. Students who scored below 19.
_____30. A scholarship program is offered to students who belong to the top 10% of the class.
Which percentiles should the school consider when selecting students for the scholarship?
A. 10th percentile
B. 50th percentile
C. 90th percentile
D. 25th percentile

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