The I² Strategy: Effects on Grade 7 Challenged Learners Achievement & Writing Skills in Statistics

Beverly D. Sarno-Perez[1], Douglas A. Salazar, PhD[2]

[1]Kiwalan National High School, Department of Education (DepEd), Iligan City, Philippines

[2]Department of Science and Mathematics Education, College of Education, MSU – Iligan Institute of Technology, Iligan City, Philippines

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ABSTRACT

Challenged learners often face significant barriers in mathematics, particularly in data analysis, where numerical reasoning intersects with reading comprehension. This study investigates the effectiveness of the I² (Identify and Interpret) strategy as an intervention tool to enhance the statistical literacy and holistic writing skills of challenged learners. The study utilized a mixed-method research design involving students identified with frustration-level reading proficiency. Quantitative analysis using the Wilcoxon Signed-Ranks Test revealed a statistically significant improvement in achievement test scores ($Z = -2.341$, $p = .033$) between the pretest and posttest, with a normalized gain (g) of 0.23. This indicates that the strategy successfully helped learners' bridge a measurable portion of the gap between prior knowledge and mastery. Furthermore, the learners' holistic writing skills demonstrated significant growth ($Z = -2.706$, $p = 0.007$), with the majority of participants advancing from "Emerging" to "Expanding" levels of proficiency. Qualitative data indicated that the I² strategy reduced cognitive load by systematizing the analytical process, allowing students to better concentrate and organize their thoughts. Learners perceived the intervention as not only "enjoyable" but instrumental in improving their English grammar and vocabulary alongside their mathematical skills. The study concludes that the I² strategy is an effective dual-purpose scaffold that fosters both data literacy and linguistic competence, transforming the learning experience for struggling students.

Keywords: I² Strategy, Challenged Learners, Statistical Literacy, Data Analysis, Scaffolding, and Mathematics Intervention.

INTRODUCTION

Cultivating critical thinking, embedding higher-order thinking skills (HOTS) in assessment, and designing STEM-integrated lessons are not optional add-ons but core levers for improving mathematics learning. Meta-analyses show that explicit critical-thinking instruction yields small-to-moderate gains in CT skills, formative assessment produces small positive effects overall on achievement with larger impacts when it includes student self-assessment and formal feedback, and integrated STEM approaches deliver additional gains in mathematics achievement (Abrami et al. 2015; Rosli et al. 2019).

Yet despite K-to-12 reforms, Philippine outcomes in mathematics remain among the weakest globally: in PISA 2018 the Philippines ranked last in reading and second-to-last in mathematics and science among 79 systems, with average mathematics 353 (below Level 1) and 81% of students below the minimum proficiency Level 2. TIMSS 2019 on Grade 4 corroborated this, placing the country last of 64 in mathematics (mean 297) with 81% below the low benchmark of 400 (Orbeta & Paqueo, 2022b; Bernardo et al., 2022). More recent evidence indicates the problem persists, as PISA 2022 still finds Filipino students among the lowest performers with no significant improvement from 2018, while foundational mathematics skills have declined across cohorts from 2003 to 2019—clear signs of a systemic learning crisis (Acido & Caballes, 2024; Igarashi & Suryadarma, 2023). Compounding this, there is a need for instruction and assessment solutions that systematically build reasoning for all learners (Orbeta & Paqueo, 2022b).

Addressing the gap in learning requires classroom-level adoption of CT-rich pedagogy, HOTS-based formative assessment, and integrated STEM design tasks, coupled with stronger teacher preparation aligned to international mathematics literacy demands but explicitly closing gaps in 21st-century contexts and skills identified in national teacher-education curricula (Abrami et al. 2015; Rosli et al. 2019; Orbeta & Paqueo 2022).

This gap is particularly acute in the domain of data literacy. Local assessments consistently identify the interpretation of statistical graphs and drawing conclusions from data as one of the least learned competencies in Grade 7 Mathematics (Buquing, 2024; Alcantara & Bacsa, 2017). To address this specific deficit, the Teacher Advancement Program (TAP) for Science and Mathematics—a strategic initiative under the Center for Integrated STEM Education (CISTEM) and powered by the Unilab Foundation—advocates for targeted interventions that strengthen content mastery and pedagogical innovation. Central to the TAP framework in teaching statistics is the "Identify and Interpret" (I^2) strategy, also referred to as "What I See, What It Means" (WIS-WIM) (*CISTEM | My Site*, n.d.).

The Biological Sciences Curriculum Study (2012) promotes this strategy to explicitly scaffold the complex process of reading and summarizing graphs, tables, and figures. The strategy addresses the cognitive bottleneck in graph comprehension by breaking it into two distinct phases: the first part, "What I See," challenges students to break down a graph into individual, objective observations; the second part, "What It Means," guides students to create meaning from those observations and then fuse those meanings to produce a logical explanation of what the graph depicts. By decoupling observation from inference, this strategy enables students to take given data, build a visual in their minds, and effectively translate that visual into words.

To address these gaps within the specific context of a school in Iligan City the researchers utilized a mixed-method, exploratory design and adopted the I^2 strategy among Grade 7 challenged learners. Given that the I2 strategy explicitly relies on reading, writing, and numeracy skills to interpret data and draw conclusions, it serves as a vital, dual-purpose intervention for this demographic—strengthening their statistical reasoning while simultaneously scaffolding the writing skills required to express it. Consequently, this paper seeks to demonstrate the I^2 strategy's effectiveness as an intervention tool to enhance both the statistical achievement and holistic writing skills of this specific demographic.

METHODOLOGY

Research Design

This study employed a one-group pretest-posttest design with qualitative support. Qualitative data were gathered through learner reflections using open-ended survey questionnaires and analyzed thematically.

Participants and Sampling Technique

This study utilized a purposive sampling technique to select participants from the Grade 7 learners. The selection process was governed by specific inclusion criteria designed to identify "challenged learners" who would benefit from the intervention. To be included in the study, learners were required to meet two primary conditions:

- Academic Performance: Learners were classified as having grades of "Did Not Meet Expectations" (below 75%) or "Fairly Satisfactory" (75–79%) in both Mathematics and English.
- Reading Proficiency: Learners were identified as reading at the "instructional" or "frustration" level based on pre-reading assessments.

Out of the entire Grade 7 learners at the school, a total of 12 learners met these stringent criteria. Consequently, all 12 identified learners were selected to participate in the study, serving as the complete sample for the research.

Research Instrument

The researchers-developed achievement test, consisting of 20 validated items on statistical graphs, was used for both the pretest and posttest. Its validity and reliability were established through a try-out and item analysis, yielding a Cronbach's alpha reliability coefficient of 0.74 following the revision of eight questions. Activity sheets used to assess the writing skills of challenged learners were adapted from the Teacher Advancement Program (TAP) for Science and Mathematics. Learner experiences were captured via a researchers-developed self-reflection questionnaire.

The line graphs, bar graphs, pie charts, and stem-and-leaf plots used in the activity sheets were adapted from F. Lim et al. (2024). Guide questions were included to assess whether learners truly understood the graphs they analyzed were scaffolded from lower-order to higher-order thinking skills.

To assess the effectiveness of the I^2 strategy on writing skills, holistic evaluation tool was adapted from Rosmawan (2017) that was also adapted from the ESL Teachers Portfolio Assessment Group, Fairfax County Public Schools, Virginia.. Learners output on their writing skills were evaluated by three seasoned proficient language teachers.

Data Gathering Procedure

The research procedure was carried out over a structured eight-day period, beginning with the administration of the pre-achievement test on Day 1 to establish baseline data. On Day 2, learners were introduced to the I^2 strategy for interpreting statistical graphs, followed by the administration of the pre-writing skill activity. Instructional sessions took place from Day 3 to Day 6, with each day focusing on a specific graph type: line graphs (Day 3), bar graphs (Day 4), pie charts (Day 5), and stem-and-leaf plots (Day 6). The intervention phase concluded on Day 7 with the administration of the posttest and self-reflection questionnaire. Finally, the post-writing skill activity was conducted on Day 8 to assess growth in writing performance.

Data Analysis Procedure

Quantitative data were analyzed using the non-parametric Wilcoxon signed-rank test to determine significant differences between pretest and posttest scores of both achievement and holistic writing skills. Also, the Normalized Gain Score, often referred to as Hake's Gain (Hake, 1998) were used to calculate how much the learners improved relative to the potential improvement could have made in the achievement test. To evaluate the consistency of the inter-rater reliability of the holistic writing assessments, Kendall's Coefficient of Concordance (W) was computed for the three independent evaluators. This was made to measure the degree of agreement among the raters regarding the rank order of the challenged learners' writing performance.

Qualitatively, content analysis was applied to learners' reflections to identify recurring themes. Data were systematically coded to preserve respondent anonymity and uphold ethical standards.

Study Limitations

The findings of this study are subject to several key methodological and assessment limitations. Methodologically, the use of a one-group pretest-posttest design with a small, purposive sample of only N=12 learners limits the statistical power, prevents definitive attribution of gains to the I^2 strategy, and means the results may not apply to all students or educational contexts. This constraint, coupled with the short, eight-day intervention period, suggests the results are best viewed as exploratory. Furthermore, writing skills assessment relied on a holistic evaluation tool rather than a detailed analytic scale, meaning specific details of student writing skills may have been missed. Finally, inter-rater consistency was challenged by variations in evaluator strictness, which influenced the absolute scores despite a moderate ranking order.

Ethical Considerations

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This study was conducted in strict adherence to the fundamental ethical principles of respect for persons, beneficence, and justice. Prior to the commencement of data collection, participants and their legal guardians were fully apprised of the research objectives, procedural protocols, and their voluntary right to withdraw at any stage without fear of academic repercussions. Written informed consent was rigorously obtained to ensure transparency. To preserve participant anonymity and confidentiality, personal identifiers were replaced with alphanumeric codes, and all research-related documents were secured accessible exclusively to the researchers only.

RESULTS AND DISCUSSION

Achievement Test Results of the Challenged Learners in the Implementation

The results of the achievement test, as presented in Table 1, indicate a significant difference between students' scores from the pretest and posttest. A Wilcoxon Signed-Ranks Test revealed that the post-test ranks were statistically significantly higher than pre-test ranks ($z = -2.341^*$, $p < 0.033$). Notably, the rank total of difference scores favored the posttest. This finding suggests that the I^2 strategy significantly contributed to students' achievement. This outcome aligns with the strategy's core function, as promoted by the Biological Sciences Curriculum Study (2012), which advocates for the I2 strategy to explicitly scaffold the complex process of reading and summarizing graphs by breaking it into the distinct phases of observation ("What I See") and inference ("What It Means"). Furthermore, the result is supported by the studies of Lucci and Cooper (2019) and Calingacion et al. (2025) that I^2 strategy is instrumental in guiding and enhancing the ability of students in the interpretation of data.

Table 1: Comparison of Pre- and Post-Achievement Tests

Pretest-Posttest	**N**	**Rank Average**	**Rank Total**	**Z**	**p**
Positive Ranks	8	7.19	57.5	-2.134*	0.033
Negative Ranks Ties	3 1	2.83	8.5		

Based on the positive rank

To further assess the effectiveness of the intervention, the normalized gain score was calculated. The challenged learners achieved a normalized gain (g) of 0.23. While this falls within the 'low gain' classification ($g < 0.3$), it represents a measurable improvement in statistical literacy among challenged learners. Given the learners' history of academic difficulties and 'frustration-level' reading proficiency, this gain indicates that the I^2 strategy successfully helped learners close approximately 23% of the gap between their prior knowledge and the mastery level.

Writing Results of the Challenged Learners in the Implementation

Inter-Rater Ratings of Pre- and Post Holistic Writing Skills

Table 2 presents the summary of the concordance analysis for both the pretest and posttest phases. The analysis yielded a coefficient of $W = .442$, $\chi2\ (11) = 14.590$, $p = .202$ for the pre-writing activity, and $W = .525$, $\chi2\ (11) = 17.333$, $p = .098$ for the post-writing activity.

Table 2: Test of Concordance for Inter-Observer Ratings on Holistic Writing Skills

Assessment Phase	**Raters (k)**	**Kendall's W**	**χ2**	**df**	**p**

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Pretest	3	0.442	14.59	11	0.202
Posttest	3	0.525	17.333	11	0.098
df = degrees of freedom					

These coefficients indicate a moderate level of agreement among the three evaluators. The increase in the *W* value from the pretest (.442) to the posttest (.525) suggests a slight improvement in scoring consistency as the study progressed. However, the results did not reach statistical significance ($p > .05$). This lack of significance is attributed to the small sample size (*N*=12), which limits the statistical power to detect strong concordance, as well as distinct variations in the scoring severity of the evaluators (e.g., Scorer 3 consistently assigned higher ratings compared to Scorers 1 and 2). Despite these variations in absolute scores, the moderate *W* values confirm that the evaluators maintained a relatively consistent standard regarding the ranking of student performance.

Table 3: Distribution of Descriptive Ratings for Writing Skills (Pretest vs. Posttest)

Mean Score Range	Descriptive Level	Pretest Status	Posttest Status	Interpretation of Skill Level
1.00 – 1.99	**Emerging**	**Majority**	None	No evidence of idea development; uses single words, pictures, or patterned phrases; copies from a model with little awareness of mechanics.
2.00 – 2.99	**Beginning**	Significant	Minimal	Begins to convey meaning but writes predominantly in phrases or simple sentences; uses limited vocabulary and temporary (phonetic) spelling.
3.00 – 3.99	**Developing**	Minimal	Significant	Writes sentences around an idea but may lack cohesion; run-on sentences are common; errors in capitalization and punctuation often interfere with meaning.
4.00 – 4.99	**Expanding**	None	**Majority**	Organizes ideas logically and begins to write a paragraph; experiments with compound/complex sentences and verb tenses (though inconsistent); errors sometimes interfere with meaning.
5.00 – 5.99	**Fluent**	None	Some	Writes single or multiple paragraphs with main ideas and supporting details; uses transitions and varied vocabulary; errors do not detract from meaning.

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6	**Proficient**	None	Few	Writes multiple paragraphs with clear introduction and conclusion; uses complex sentences effectively and precise vocabulary; occasional errors do not detract from meaning.

Descriptive Interpretation of the Holistic Writing Skills

To further contextualize the quantitative inter-rater ratings, the learners' writing performance was interpreted using the study's specific 6-point holistic rubric (Rosmawan (2017) . This descriptive analysis highlights the qualitative shift in writing skills following the intervention.

As shown in Table 3, the pre-intervention phase was characterized by learners clustering in the "Emerging" and "Beginning" stages. Qualitatively, this reflects a significant struggle in data literacy; prior to the intervention, learners mostly used patterned phrases, relied on phonetic spelling, and showed little awareness of proper mechanics, often copying models rather than generating original interpretations

However, a marked upward shift was observed in the posttest, where the majority of learners advanced to the "Expanding" level. This transition indicates that the I^2 strategy successfully scaffolded learners to move beyond simple sentence construction. By the posttest, learners began to organize ideas in a logical order and attempt paragraph writing. While they still exhibited inconsistent verb tenses—a characteristic of the "Expanding" level—they demonstrated the ability to use compound sentences and vocabulary appropriate for interpreting the graphs, signifying a fundamental improvement in their ability to convey meaning.

Comparison of Pre- and Post- Holistic Writing Ratings

A Wilcoxon signed-rank test was conducted to evaluate the impact of the intervention on the challenged learners' holistic writing skills. The analysis was based on the consolidated inter-observer ratings from three evaluators. The results revealed a statistically significant improvement in writing performance ($Z = -2.706$, $p = .007$).

As indicated in Table 4, nine learners demonstrated positive ranks (improved writing scores), while only one learner showed a negative rank, and two learners retained their pretest scores. The low p-value ($p = .007$) confirms that the observed improvements in writing composition are not due to chance. This suggests that the I^2 strategy, combined with the scaffolded activity sheets, effectively enhanced the challenged learners' ability to articulate their statistical interpretations in written form.

Table 4: Comparison of Pre- and Post-Holistic Writing Ratings (Inter-Observer)

Pretest-Posttest	**N**	**Rank Average**	**Rank Total**	**Z**	**p**
Positive Ranks	9	5.89	53	-2.706*	0.007
Negative Ranks	1	2	2		
Ties	2				
Based on the positive rank					

Perceptions Drawn from the Challenged Learners using the I^2 Strategy

The study utilized the I^2 strategy as an intervention tool to assist challenged learners in interpreting and drawing conclusions from statistical graphs. Table 5 presents the perceptions drawn from the learners' responses to the

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question, *"How do you find the I^2 strategy helpful and interesting while understanding and learning Mathematics? Why?"*

The qualitative data indicates that the learners perceived the I^2 strategy as a highly effective tool. The impact extended beyond the simple remediation of mathematical errors; it fundamentally altered both their cognitive approach to problem-solving and their affective attitude toward learning.

Learners explicitly reported that the strategy helped them "*concentrate better*" (L5, L11) and "*sharpen their minds*" (L3). This suggests that the I^2 strategy reduced the cognitive load for students who typically find it difficult to process dense information. By decomposing the complex task of graph analysis into two manageable steps—"What I see" and "What it means"—the strategy provided a clear, replicable structure. Instead of feeling overwhelmed by visual data, learners utilized this method to organize their observations. This scaffolding enabled learners who were previously "struggling" to transition from random guessing to systematic, step-by-step thinking.

A significant finding was that learners recognized the strategy's value in enhancing linguistic proficiency, not just numerical skills. Respondents noted that the activity *"enhances some grammars"* (L4) and aids in "*speaking or reading in English*" (L9). This impact is particularly critical given that these participants were identified as instructional or frustration-level readers. The I^2 strategy effectively bridged the gap between mathematics and literacy; by compelling students to articulate their observations and interpretations, they were actively practicing sentence construction and vocabulary usage. Consequently, the intervention transformed a mathematics lesson into a dual-purpose literacy exercise that learners perceived as relevant to their future careers, noting that it "*helps in future work in companies*" (L9).

Historically, challenged learners exhibit avoidance behaviors toward mathematics due to fear of failure. However, study participants admitted that the activity was "*enjoyable*" (L8, L11). This feedback marks a substantial shift in the learners' emotional relationship with the subject. The I^2 strategy acted as a support system that fostered a sense of competence. When the approach made the analytical work feel "*easy*" (L3, L18), the learners' self-efficacy grew, naturally increasing their intrinsic motivation to participate.

Table 5: Learners' Perception in Using the I^2 Strategy

Themes	Code	Quotes
Data interpretation easier to handle.	Ease of Use	*"Yes, it's very important because answering the activities is very easy with the strategy."* (L3)
	Helpful	*"Yes, it could help you understand the questions easily, the what I see and what it means is helpful for people who are struggling in math especially in line, bar graph, pie chart and stem and leaf plot"* (L10)
	Learn the graph	*"I think the I^2 and mathematics is important to me to learn and how to solve the number and how to describe the solution. I learn the bar graph, line graph, pie chart and how to learn the graph and how to describe the solution"* (L6)
	Solve the problems	*"I find the I^2 strategy helpful and interesting while understanding learning mathematics because it helped me understand the topic easier and it helped me solve problems about charts and graphs and interpreting graphs, charts and stem-and-leaf plot"* (L12)

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Holistic development	Concentration	*"Yes because I believe that doing this activity is useful for improved concentration."* (L5)
		"It helps me think about the questions." (L7)
		"I found out that the I^2 strategy helpful and interesting because I enjoyed answering those questions and I learned a lot using the strategy because it's so easy but because it helps me improve my concentration and learning skills." (L11)
	Enhance grammar	*"I think that it is enjoyable because it enhances some grammars and observations."* (L4)
	English speaking and reading	*"The I^2 strategy is helpful because it improves your skills beyond just understanding Math. It sharpens your mind and enhances your English speaking and reading, which is useful for future work in companies, financial agencies, or weather forecasting."* (L9)
	Observation	*"Yeah because it's good for observations, making interpretation, organizing and analyzing"* (L2)
Long-term value	Enjoyment and interest	*"I found out that the I^2 strategy helped and interesting because I enjoyed answering those questions and I learned a lot using the strategy because it's so easy but because it helps me improve my concentration and learning skills."* (L11)
	Willingness	*"Yes because I am willing to do this activity again because I think it is somewhat useful and I was thinking about how much I enjoyed it"* (L8)
	Future ready	*"I found the I^2 strategy helpful because it improves your skills. It doesn't just help you learn and understand Math; it also stimulates your brain and improves your English speaking and reading skills. This helps prepare you for future work in companies, financial agencies, or weather forecasting."* (L9)

In summary, the qualitative data suggests that the I^2 strategy is effective not merely because it simplifies the content, but because it systematizes the thinking process. It empowers challenged learners by providing a concrete entry point ("What I see"), thereby lowering the barrier to complex analytical tasks and cultivating a learning environment where they feel capable, focused, and engaged.

CONCLUSIONS

Based on the detailed results and discussion provided, here are the formal conclusions drawn from the study. These conclusions synthesize the quantitative statistical data and the qualitative student feedback regarding the implementation of the I^2 (Identify and Interpret) Strategy among challenged learners.

The intervention proved effective in improving the academic performance of challenged learners in statistics. The statistical analysis of the achievement test ($Z = -2.341$, $p < 0.033$) confirms that the improvement was not due to chance. Although the normalized gain ($g = 0.23$) is classified as "low gain," in the specific context of learners with "frustration-level" reading proficiency and a history of academic difficulty, this represents a substantial educational victory. Therefore, the I^2 strategy successfully scaffolds the learning process, allowing students to close nearly a quarter (23%) of the gap between their prior knowledge and mastery. It is a viable intervention for remediation in mathematics.

One of the most profound conclusions is that the I^2 strategy transcends simple mathematical calculation; it functions as a linguistic scaffold. The shift in writing proficiency from the "Emerging/Beginning" stages (copying models, phonetic spelling) to the "Expanding" stage (logical organization, compound sentences) is statistically significant ($Z = -2.706$, $p = 0.007$). By forcing a distinction between "What I see" (observation) and "What it means" (interpretation), the strategy provides the necessary structure for students to organize their thoughts before writing. Hence, the I2 strategy effectively improves data/ statistical literacy. It transforms students from passive observers who copy text into active analysts who can articulate mathematical reasoning using appropriate vocabulary and sentence structures.

The qualitative data reveals that the I^2 strategy alters the *cognitive approach* of the learners. Students reported that the strategy helped them "concentrate" and made the work feel "easy." Challenged learners often feel overwhelmed by visual data (graphs/charts). The I^2 strategy breaks this complex task into manageable, replicable steps. However, the strategy reduces cognitive load. By systematizing the thinking process, it lowers the barrier to entry for complex analytical tasks, allowing learners to focus their mental energy on analysis rather than trying to decode the format of the problem. In addition, historically, challenged learners exhibited avoidance behaviors and fear of failure regarding math. But the post-implementation feedback ("enjoyable," "willing to do this activity again") indicates a shift in self-efficacy. The feeling of competence generated by successfully using the scaffolded steps led to increased engagement. Therefore, the intervention successfully converted "math anxiety" into "math confidence" for these learners. The I^2 strategy fosters a positive learning environment where challenged learners feel capable and safe to take intellectual risks.

RECOMMENDATIONS

Based on the findings and conclusions of this study regarding the implementation of the I^2 (Identify and Interpret) Strategy among challenged learners, the following recommendations are proposed:

1. For Mathematics Instruction and Remediation: Mathematics educators should utilize the I^2 strategy specifically for learners identified with "frustration-level" reading proficiency or high math anxiety. The study confirms that decomposing graph analysis into distinct steps ("What I see" vs. "What it means") effectively lowers cognitive load. Teachers should explicitly model this separation to prevent learners from becoming overwhelmed by visual data.

2. For Cross-Curricular Integration (Math and English): School administrators and department heads should encourage collaboration between Mathematics and English departments. Math teachers can provide data sets, while English teachers use the I^2 framework to teach expository paragraph writing and transitional devices.

3. For Assessment and Evaluation: Future studies should use more detailed scoring tools for writing skills to better evaluate student performance.

4. For Future Research: As the current study was limited to a small sample (N=12), future researchers should replicate this study with a larger population to increase statistical power and generalizability.

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