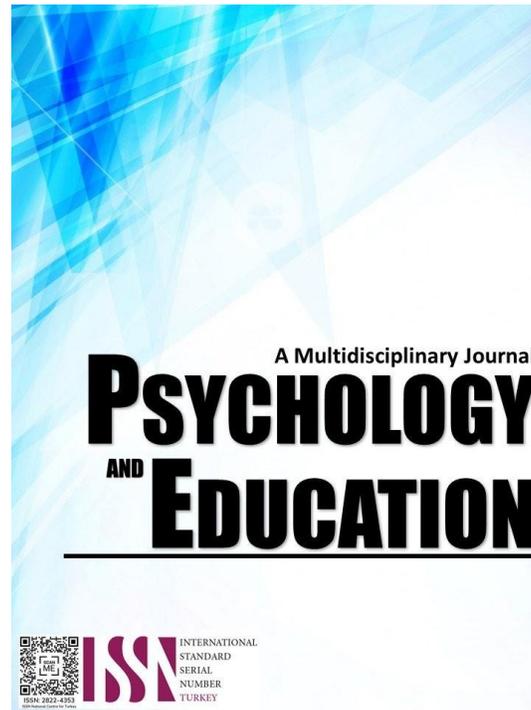


5I'S APPROACH IN CONCEPTUAL UNDERSTANDING, INTERESTS, AND BELIEFS IN STATISTICS AMONG GRADE XI STUDENTS OF MILBUK NATIONAL HIGH SCHOOL



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5I's Approach in Conceptual Understanding, Interests, and Beliefs in Statistics among Grade XI Students of Milbuk National High School

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Abstract

Understanding Statistics was essential for data-driven decision-making, yet students often struggle with its abstract intended nature, leading to low engagement and misconceptions. This study investigated the impact of the 5I's Approach – Impress, Identify, Inspire, Inspect, and Invoke – on students' conceptual understanding, interest, and belief in Statistics. Rooted in constructivist and student-centered learning paradigms, the 5I's Approach was designed to make statistical concepts more engaging, meaningful, and relevant to learners. A quasi-experimental design involving control and experimental groups was employed among Grade XI students. Data were collected through pre-test and post-test, attitudinal surveys, and focus group discussions to assess cognitive and affective learning outcomes. Results indicated that the students exposed to 5I's Approach showed statistically significant improvements in conceptual understanding and reported heightened interest and more positive beliefs toward Statistics. The approach effectively bridged the gap between theoretical knowledge and real-world application, encouraging active learning and critical thinking. The findings highlighted the pedagogical value of the 5I's framework in reshaping Statistics instruction and enhancing students' overall learning experience.

Keywords: *5I's approach, statistics education, conceptual understanding, student interest and beliefs, quasi-experimental design*

Introduction

Teaching and learning of Statistics often presented difficulties for both students and teachers, making it challenging to deliver in an engaging and meaningful way. While Statistics played a critical role in developing analytical thinking and informed decision-making, it was frequently perceived as abstract, difficult, and disconnected from real-life applications. Many learners approached the subject with anxiety, low confidence, and a limited understanding of its value. This study introduced the 5I's Approach – Impress, Identify, Inspire, Inspect, and Invoke as a teaching model designed to enhance students' conceptual understanding, spark interest, and strengthen beliefs in Statistics. The approach drew from the principles of constructivism and transformative learning, emphasizing meaningful engagement, reflective inquiry, and personal relevance in learning experiences. The narrative behind this study was rooted in a classroom experience where traditional approaches seemed insufficient in cultivating statistical thinking. This inspired the development of a more dynamic, learner-centered approach grounded in reflective and progressive pedagogies.

Globally, there was a growing concern about the statistical literacy of students across education levels. Despite reformed Mathematics curricula worldwide, students often underperformed in Statistics and many expressed a lack of confidence and engagement in the subject (Gal, 2002). The digital age demands that individuals be data literate, yet educational systems struggled to meet this demand effectively (Ben-Zvi and Garfield, 2004). Moreover, educators frequently reported a lack of pedagogical support and training in teaching Statistics conceptually, rather than procedurally (Chance, 2002). These challenges highlighted a global need for innovative instructional designs that can make Statistics more accessible, engaging, and relevant to learners.

At the national level, the Philippine education system has faced persistent issues in Mathematics and Statistics achievement. Results from national assessments indicated that a significant proportion of Filipino students perform below proficiency levels in quantitative subjects, including Statistics (DepEd, 2019). Despite the integration of statistical content in the K to 12 curriculum, teachers often relied on rote teaching methods that failed to promote deep understanding (Pascua & Bagui, 2021). Additionally, there was a recognized gap in fostering positive students' attitudes and beliefs toward Statistics, which in turn affects academic performance and interest in STEM fields (Orbe, 2017). These national patterns underscored the urgency to rethink pedagogical approaches for Statistics education.

Locally, Milbuk National High School and other schools in Sultan Kudarat Division have echoed similar concerns. Diagnostic tests in secondary schools revealed low performance in statistical topics such as probability, data interpretation, and graphical analysis. Teachers in the division have also reported challenges in engaging students with real-world data and fostering enthusiasm for statistical thinking. Moreover, there was limited implementation of student-centered strategies tailored to the unique needs of local learners, particularly those from under-resourced communities (Teacher Feedback Forum, 2023). These concerns presented a compelling case for contextual innovations in instruction.

These research gaps addressed in this study were both contextual and theoretical. Contextually, while existing literature explored teaching strategies in Statistics, few studies have focused on holistic, multi-dimensional approaches designed specifically for the Philippine secondary school context. Theoretically, this study built upon Vygotsky's Social Constructivist Theory, which emphasized the importance of social interaction and scaffolding in learning, and Mezirow's Transformative Learning Theory, which supported the development of critical reflection and perspective transformation – both key aspects in developing positive beliefs and attitudes in

Statistics. Also, Bandura's Social Cognitive Theory played a role in understanding how beliefs and motivation influence learning behavior. Current models often isolated cognitive, affective, and behavioral aspects of learning without integrating them to a cohesive pedagogical framework.

The 5I's Approach filled this gap by offering an interconnected model that considers how students perceived, engaged with, and applied statistical concepts – anchored both emotional and cognitive dimension of learning.

The urgency of this study lied in the critical need to uplift students' statistically literacy and academic performance while nurturing their interest and beliefs in the subject. This was especially crucial in the data-driven world where statistical knowledge was a key of competence. The purpose of this study was to examine the effectiveness of the 5I's Approach (Impress, Identify, Inspire, Inspect, and Invoke) in enhancing students' conceptual understanding, interest, and beliefs in Statistics. Grounded theories of constructivism, transformative learning, and social cognition, the 5I's model provided a structured yet flexible pathway to address individual learning needs while promoting meaningful real-world connections in the learning of Statistics and Mathematics.

Research Questions

In general, the study aimed to develop, and validate the 5I's approach in the teaching-learning process and assess its effectiveness of conceptual understanding, interest and beliefs in Statistics among Grade 11 students. Specifically, the study sought to address the following questions:

1. What is the level of conceptual understanding in Statistics among students from both the experimental and control groups before and after the intervention?
2. What is the level of interests in Statistics among students from the experimental and control groups before and after the intervention?
3. What is the level of beliefs in Statistics among students from the experimental and control groups before and after the intervention?
4. How do students differ in conceptual understanding in Statistics based on the type of intervention?
5. How do students differ in interests in Statistics based on the type of intervention?
6. How do students differ in beliefs in Statistics based on the type of intervention?

Methodology

Research Design

This research employed the pre-test and post-test control group design. A quasi-experimental approach involving two intact groups, the experimental group which received instruction through 5I's Approach (Impress, Identify, Inspire, Inspect, and Invoke) and the control group which was taught using traditional methods. Both groups were given a pre-test before the intervention and post-test after to assess changes in conceptual understanding, interests, and beliefs in Statistics

Participants

The participants of the study were officially enrolled students' Academic Year 2022-2023 at Milbuk National High School. The number of students were created two sections of Grade XI. Moreover, there were five Mathematics experts validated and assessed the acceptability of the 5I's (Impress, Identify, Inspire, Inspect, and Invoke) approach on the given criteria.

Instrument

In evaluating the impact of the 5I's approach on students, there were three instruments used in the present study, namely: Conceptual Understanding Test (CUT), and Interest and Beliefs Toward Mathematics (IBTM)

To assessed the 5I's Approach in Conceptual Understanding Test, there were 5 Mathematics teachers checked and evaluated the 5I models on the recommended criteria on Evaluation of Instructional Materials (EIM), adopted from the work of Cajandig (2020) with the following criteria: relevance to curriculum, instructional quality and cultural formulation which patterned from the works of Marquez (2017), Cruz (2014) and Saad (2004).

The instrument was subjected to face validity by three experts on educational technology. The degree of agreement among experts to validate the instrument was determined by the reliability coefficient using Krippendorff's alpha analysis. In the analysis of the degree of agreement among evaluators, Krippendorff's test revealed the $k\text{-alpha} = 0.7036$ coefficient, which means a high level of reliability.

A researcher-adapted instrument was used in measuring the level of conceptual understanding among students in Mathematics. The design of Conceptual Understanding Test was based on the questions which elicit the conceptual formulation of mathematical and statistical ideas.

To validate the constructed test items in CUTS, five experts in the field of Mathematics education evaluated its face validity. The instrument also underwent in the form of a try-out test

To determine the interests and beliefs of students in Mathematics, Interests and Beliefs toward Mathematics (IBTM), a researcher-made instrument was used. The design of IBTM was based on the different instruments related to the interests and beliefs in Mathematics such as the Mathematics and Technology Attitude Scale (MTAS) of Pierce, Staycey & Barkatsas (2007), Experience with Mathematics Questionnaire (EMQ) of Gourgey (1982), and Self-Concept Towards Mathematics of Ayodele (2011).

Additionally, reflection journals were employed in the experimental group to collect qualitative insights on students' learning experiences throughout the intervention. Teacher observation checklists and anecdotal notes also supplemented the data, allowing for triangulation and a more comprehensive analysis of the intervention's impact.

Procedure

The data collection process was carried out in several phases to ensure systematic implementation and alignment with the study's objectives.

To begin with, necessary permissions and ethical clearances were obtained from the school principal, the district supervisor, the Schools Division Superintendent (SDS), and the participating teachers. A meeting was conducted to orient the stakeholders on the objectives, scope, and the nature of the study. After this, the pre-testing phase was conducted simultaneously in both experimental and control groups, using the validated instruments to assess baseline data on conceptual understanding, interest, and beliefs in Statistics.

Following the pre-tests, the intervention phase commenced. The experimental group was taught Statistics using 5I's approach over a period of 11 weeks, while the control group received conventional instruction aligned with the regular educational program. Throughout the implementation process, the researcher regularly monitored the delivery of lessons and collected reflection journals and observational data from the experimental class.

After completing the instructional period, the post-test phase was conducted. Both groups were administered the same assessment tools to measure any changes or developments in the three target areas. The researcher compiled and analyzed the data using appropriate statistical methods to assess how successful the intervention.

In conclusion, the step-by-step administration of the pre-test intervention, and post-test with utilizing quantitative and qualitative instruments ensured the reliability of findings as well as offered a well-rounded understanding of how the 5I's approach influenced students' learning outcomes.

Data Analysis

To analyze the data collected and determine the effectiveness of the 5I's approach in improving students' conceptual understanding, interest, and beliefs in Statistics. The following statistical tools were employed:

Descriptive Statistics. This included mean, standard deviation, and percentage to describe the pretest and posttest scores of students in both experimental and control groups. This tool helped in identifying the general performance levels and trends within each group.

Paired-Sample t-Test. This test was used to determine the significant difference between the pretest and posttest scores within the same group (experimental and control) for each variable: conceptual understanding, interest, and beliefs. It measured the effectiveness of the instruction within each group.

Independent Sample t-Test. This statistical test was used to examine the significant difference between the experimental and control groups in terms of their posttest scores. It assessed whether the 5I's approach had a statistically significant impact compared to conventional teaching methods.

Effect Size (Cohen's d). To determine the magnitude of the intervention's effect, Cohen's d was calculated for each dependent variable. This provided a clearer understanding of how meaningful the observed differences were beyond statistical significance.

Qualitative data from reflection journals and teacher observations were analyzed using thematic analysis to identify recurring patterns, experiences, and changes in student perspectives that supported and explained quantitative results

Ethical Considerations

This study strictly adhered to ethical standards in conducting educational research. Informed consent was secured from both students and their parents/guardians prior to their participation of the study. They were made aware of the purpose of the research, the nature of their involvement and their right to withdraw at any time without any negative consequences.

To ensure confidentiality and anonymity, students' names were replaced with codes, and all responses were treated with strict confidentiality. Only the researcher had access to the raw data, which was used solely for academic purposes.

Moreover, equity in learning was considered. After the study, the control group was given access to the 5I's instructional materials to ensure that they also benefited from the intervention. The researcher also ensured that no physical, emotional, or psychological harm came to the participants during the study.

All procedures were aligned with the guidelines of the Department of Education (DepEd) and the institution's research protocols.

Results and Discussion

This section revealed the results and discussion of the study gathered from the data analysis and interpretation of the results based on the data gathered in the study.

The Level of Conceptual Understanding in Mathematics among Students Before and After the Intervention

Table 1. Mean Scores and Standard Deviation of the Levels of Students' Conceptual Understanding in Statistics

Group	Test	Mean	SD	Interpretation
Experimental	Pre-test	12.45	2.38	Low
Experimental	Post-test	21.78	2.95	High
Control	Pre-test	12.38	2.42	Low
Control	Post-test	15.90	2.76	Moderate

As shown in Table 1, students in the experimental group had mean pre-test score of 12.45 interpreted as low conceptual understanding. After the intervention, their mean score significantly increased to 21.78 interpreted as high. Meanwhile, the control group's mean score increased only slightly from 12.38 to 15.90, moving from a low to moderate level. This indicated a notable difference in the posttest scores between the two groups.

These findings suggested that the 5I's approach had a substantial positive impact on students' understanding of statistical concepts. The structure of impress, identify, inspire, inspect, and invoke provided scaffolding that helped students build meaning from concepts rather than memorize procedures. This supported the used of active and reflective teaching strategies in statistical instruction.

This outcome aligned with the findings of Garfield and Ben-Zvi (2008), who emphasized the effectiveness of conceptual and constructivist approaches in Statistics learning. Chick and Pierce (2009) also highlighted that deep understanding occurred when learners were encouraged to explore, reflect, and connect mathematical ideas with real-life experiences – core elements of the 5I's approach. Thus, this study supported global literature advocating from reform-based instruction in Statistics.

In conclusion, the significant improvement in the experimental group's conceptual understanding validated the effectiveness of the 5I's approach. This instructional model presented an innovative and effective framework for teaching Statistics that fostered deeper learning compared to traditional methods.

The Level of Interest in Mathematics among Students Before and After the Intervention

Table 2. Mean Scores and Standard Deviation of the Levels of Students' Interest in Mathematics

Group	Test	Mean	SD	Interpretation
Experimental	Pre-test	3.12	0.58	Moderate
Experimental	Post-test	4.21	0.44	High
Control	Pre-test	3.08	0.61	Moderate
Control	Post-test	3.32	0.56	Moderate

Table 2 showed that both groups had moderate levels of interest in Mathematics before the intervention. After the implementation of the 5I's approach, the experimental group's interest significantly increased from 3.12 to 4.21, indicating a high level of interest. In contrast, the control group only experienced a slight increased from 3.08 to 3.32 remained at a moderate level.

This indicated that the 5I's approach was highly effective in enhancing students' interest in Mathematics. The impress and inspire phases likely contributed to this changed by exposing students to relevant, engaging, and thought-provoking content early in the lesson.

These findings supported the works of Mitchell (1993) and Schiefele (1999), who emphasized the importance of situational interest and meaningful context in sparking students' long-term engagement in Mathematics. It also aligned with Ainley and Hidi (2002) theory that interest developed when students perceived learning as personally valuable and emotionally engaging.

The notable increase in the experimental group's interest levels affirmed the motivational power of the 5I's approach emphasized the need for relevance and engagement in Mathematics instruction.

The Level of Beliefs in Mathematics among Students Before and After the Intervention

Table 3. Mean Scores and Standard Deviation of the Levels of Students' Beliefs in Mathematics

Group	Test	Mean	SD	Interpretation
Experimental	Pre-test	3.05	0.67	Moderate
Experimental	Post-test	4.18	0.49	High
Control	Pre-test	3.02	0.63	Moderate
Control	Post-test	3.35	0.55	Moderate

The data in Table 3 revealed that both groups began with low to moderate beliefs in Mathematics. After the intervention, the experimental group's mean rose significantly to 4.18 (High), while the control group increased only slightly to 3.35 (Moderate).

This implied that the 5I's approach fostered a more positive mindset toward Mathematics. By guiding students through meaningful reflection and engagement. The strategy helped them to shift from a fixed mindset to a more growth-oriented beliefs system.

This supported the research of Pajares (1996) and Op't Eynde, De Corte, & Verschaffel (2006), which emphasized the influence of instructional design on students' mathematical beliefs. The invoke phase, in particular aligned with Boalers (2002) idea that self-reflection reshaped students' beliefs about their capabilities and potential in Mathematics.

Overall, the significantly growth in the experimental group's beliefs indicated the transformative effect of the 5I's approach in cultivating confidence and positive learning attitudes in Mathematics.

Comparison of Post-test Scores in Conceptual Understanding in Mathematics

Table 4. *Independent Sample t-Test on Post-test Scores in Conceptual Understanding in Mathematics*

Group	Mean	SD	t-value	p-value
Experimental	21.78	2.95	5.82	<0.001
Control	15.90	2.76		

*Significant @ $\alpha = 0.05$

Table 4 presented the post-test comparison between groups. The experimental group significantly outperformed the control group with a t-value of 5.82 and p-value < 0.001 indicated statistically difference in favor of the experimental group.

This highlighted that the 5I's approach was more effective in developing conceptual understanding compared to traditional teaching. Students benefited from the reflective and scaffolded structure that allowed them to connect ideas meaningfully.

The result supported Cobb and McClain (2004), who emphasized student engagement and social construction of knowledge in Statistics. It also confirmed the value of teaching approaches that focused on deep conceptual understanding rather than rote memorization as recommended by Shaughnessy (2007).

The significant difference confirmed that the 5I's approach had a strong and positive impact on students' conceptual understanding in Statistics.

Comparison of Post-test Scores in Interest in Mathematics

Table 5. *Independent Sample t-Test on Post-test Scores in Interest in Mathematics*

Group	Mean	SD	t-value	p-value
Experimental	4.21	0.44	4.73	<0.001
Control	3.32	0.56		

*Significant @ $\alpha = 0.05$

As shown in Table 5, there was a statistically significant difference in students' interest in Mathematics post-intervention. The experimental group reported significantly higher levels of interest that the control group ($t = 4.73$, $p < 0.001$).

This indicated that student-centered strategies that appeal to curiosity, relevance, and engagement – core featured of the 5I's approach were more effective in stimulating students' interest.

This supported the findings of Deci & Ryan (2000) in Self-Determination Theory suggested that autonomy-supportive environments increased motivation and interest. It also affirmed the role contextualized teaching in Mathematics learning (Boaler 1999).

Clearly, the 5I's approach proved superior in engaging students and fostering a genuine interest in Mathematics.

Comparison of Post-test Scores in Beliefs in Mathematics

Table 6. *Independent Sample t-Test on Post-test Scores in Beliefs in Mathematics*

Group	Mean	SD	t-value	p-value
Experimental	4.18	0.49	5.16	<0.001
Control	3.32	0.56		

*Significant @ $\alpha = 0.05$

Table 6 demonstrated a significant difference in Mathematics beliefs between the two groups after the intervention. The experimental group scored higher mean of 4.18 than the control group mean of 3.35, with $t = 5.16$ and $p < 0.001$.

The results implied that students' beliefs about Mathematics improved significantly through intentional instructional strategies that fostered confidence, relevance, and reflection.

These results aligned with Schoenfeld's (1985) and Bandura's (1997) theories, which stressed the role of instructional experience and self-efficacy in shaping beliefs. The positive shift seen here reaffirmed the effectiveness of a learning model that included personal

reflection and goal-setting as encouraged in the invoke phase.

The significant difference in beliefs highlighted the potential of the 5I's approach to fostered not just academic growth, but also psychological and attitudinal development in students.

Conclusions

Based on the findings of this study, the following conclusions were drawn: This study revealed several new insights and impactful implications for Mathematics education. The 5I's approach introduced an innovative instructional model that effectively combined conceptual rigor with motivational and reflective elements. Unlike traditional methods, it promoted deeper learning, emotional engagement, and metacognition. The approach yielded significant improvements not only in cognitive outcomes (conceptual understanding) but also in affective outcomes (interest and beliefs), validating its holistic design. A notable realization was that when students experienced instruction that is contextually relevant, inspiring, and reflective, they were likely to shift from passive recipients of knowledge to active participants.

The 5I's approach allowed educators to rethink traditional pedagogy, making space for meaningful innovation in teaching abstract content like Statistics. Most importantly, the study offered a generalization that integrating content, motivation, and mindset within a structured pedagogical model like 5I's led to transformative student learning experiences.

Based on the findings and conclusions of the study, the following recommendations are proposed: (1) Mathematics teachers may adopt the 5I's approach to improve students' conceptual understanding in Statistics. The structured yet engaging phases provided students with better scaffolding and active participation. (2) Teachers may incorporate real-life applications and emotional hooks through the impress and inspire phases to sustain and elevate student interest in Mathematics. (3) Use reflective strategies embedded in the invoke phase to promote positive beliefs and self-efficacy in learning Mathematics. Teachers may encourage students to track their learning progress and mindset changes. (4) Schools may consider institutionalizing the 5I's approach as part of their teaching-learning framework in Mathematics, supported by training and mentoring for teachers. (5) Encourage schools to create a more interest-rich learning environment, with supportive classroom dynamics and learner-centered resources that reflect the 5I's model. (6) Policy makers and instructional leaders may support professional development programs that emphasize belief-oriented teaching strategies, empowering teachers to build students' confidence in Mathematics. (7) Future researchers may explore the use of the 5I's approach in other strands or disciplines such as Science, English, or Social Studies. Qualitative studies such as interviews and focus groups may be conducted to capture student experiences, perceptions, and reflections during the intervention. Comparative studies may be done in other school divisions to test replicability and generalizability of the findings. Mixed-method designs can be used to triangulate quantitative results with in-depth qualitative insights. Investigate the long-term effects of the 5I's approach on students' performances and attitudes beyond one grading period.

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