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Research Article

Pedagogical Innovation in Statistics Teaching and Learning Using 5I's Framework with Teachers and Teacher Educators: An Action Research Study

Sam Ol Kong[1], Seng Set[2], Chanphearun Sam[2]

[1]Department of Science, Phnom Penh Teacher Education College, Phnom Penh, Cambodia
[2]Phnom Penh Teacher Education College, Phnom Penh, Cambodia

Abstract
This action research study sought to investigate how the implementation of the 5I's pedagogical framework (Impress, Identify, Inspire, Inspect, Invoke) facilitates pedagogical innovation in statistics teaching and learning among teacher educators and teachers enrolled in a Master of Education program at Phnom Penh Teacher Education College (PTEC). The research employed a mixed-methods study, addressed the historical legacy of teacher-centered, rote-learning approaches in teaching and learning, and gathered data from participants over the course of a 15-week intervention using conceptual understanding pre- and post-test assessments, attitude surveys, and reflective learning logs. The Quantitative data were compared using paired samples *t*-tests with effect sizes calculated using Cohen's *d* and inferential statistics, while survey responses were analyzed using descriptive statistics and Wilcoxon signed-rank tests. Qualitative data were analyzed using a combination of deductive and inductive approaches. The results demonstrated statistically significant improvements in conceptual understanding and positive shifts in interest, beliefs, and self-efficacy. While the qualitative analysis revealed transformative learning experiences characterized by emotional transitions from anxiety to agency, enhanced professional relevance, and the development of statistical habits of mind. The study illuminates how the 5I's framework serves as a catalyst for pedagogical change by providing a structured yet flexible model that reconciles traditional Cambodian educational values with contemporary constructivist approaches. Findings also contribute to understanding how contextually responsive pedagogical innovations can facilitate meaningful pedagogical change in statistics teaching and learning within the Cambodian context, effectively enhancing conceptual understanding, fostering interest, and transforming beliefs about statistics among Cambodian teachers and teacher educators.

Keywords: Action Research, Professional Development, Pedagogical Innovation, Statistics Teaching and Learning, Teacher Educators, 5I's Framework

✉ Correspondence
Sam Ol Kong
kong.samol@ptec.edu.kh

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1. INTRODUCTION

Since the post-Khmer Rouge reconstruction era, Cambodian education has undergone substantial change. Within this evolution, teacher education occupies a particularly strategic position, as the quality of teacher educators directly influences the entire educational ecosystem (Ministry of Education, Youth and Sport [MoEYS], 2019). In the reform, Teacher Education Colleges (TECs) have been established and serve as crucial institutions in the system, responsible for preparing future teachers and upgrading the qualifications of practicing educators and teachers. According to Tishkovskaya and Lancaster (2012), within Master of Education programs at the institution, statistics teaching and learning represent both a critical competency and a persistent challenge. Moreover, pedagogical practices in mathematics and statistics are still primarily based on transmission-based approaches that place a higher value on procedural knowledge

than conceptual understanding (Clayton, 2006; Roath, 2015). Because statistics teaching and learning naturally requires contextual reasoning, critical interpretation, and problem-solving skills- abilities that traditional Cambodian teaching methods have frequently overlooked- this pedagogical orientation presents unique challenges (Tan, 2015). Lopez (2023 stated that the historical development of mathematics education in Cambodia, in addition, has been significantly shaped by French colonial influences, followed by socialist pedagogical models, resulting in a predominant emphasis on algorithmic proficiency and rote memorization. The teacher educators and teachers enrolled in Master of Education programs at Phnom Penh Teacher Education Colleges (PTEC), which play an important role in this context, as mentioned by Lo (2021) and Ogisu (2022) that both potential agents and recipients of pedagogical change. Therefore, the need for pedagogical transformation and/or innovation in statistics teaching extends beyond content delivery to address deeply embedded cultural and epistemological orientations toward teaching and learning. Cambodian educational traditions place a strong emphasis on collective knowledge transmission, clear procedural guidance, and respect for teacher authority (Dy, 2004). According to Tishkovskaya and Lancaster (2012), the development of higher-order statistical thinking, which is necessary for evidence-based educational research and practice, is now hampered by these values, despite the fact that they have supported education during times of scarcity. This study presents pedagogical innovation as a process of adaptive integration rather than a rejection of traditional values, creating methods that respect the educational legacy of Cambodia while embracing modern pedagogical understandings.

1.2. The 5I's Framework as a Spark for Pedagogical Change

The 5I's framework was developed based on Flores and Dalayap (2025) and used as a contextually responsive pedagogical model designed to facilitate meaningful change in statistics teaching and learning, with contextualization to Cambodian education considered. The framework is divided into five stages of iteration:

- Impress: establishing personal relevance and capturing attention through engaging, culturally relevant scenarios that provide compelling first experiences with statistical concepts.
- Identify: Guiding learners to recognize statistical concepts and principles within authentic contexts, building bridges between concrete examples and abstract understanding.
- Inspire: Fostering confidence and self-efficacy through scaffolded, successful engagements that demonstrate learners' capacity to understand and apply statistical reasoning.
- Inspect: Developing critical evaluation skills through careful examination of statistical claims, evidence, and interpretations, cultivating intellectual uncertainty and accuracy.
- Invoke: Encouraging meaningful application of statistical reasoning to professional contexts, research questions, and educational decision-making, promoting transfer and integration.

The theoretical framework is fundamentally informed by social constructivism (Vygotsky, 1978), particularly in its focus on collaborative processes of meaning-making. It is also grounded in experiential learning (Kolb, 2014), as evidenced by its cyclical structure. Moreover, it incorporates self-efficacy theory (Bandura, 1997) through its design aimed at fostering confidence, and it is influenced by culturally responsive pedagogy (Gay, 2018). The framework addresses the specific educational contexts and values relevant to Cambodian classrooms. The 5I's framework, in contrast to prescriptive pedagogical models, provides a flexible framework that educators and teachers can modify while upholding theoretical integrity- a crucial component for long-lasting change in diverse Cambodian classroom contexts.

1.3. Research Purpose and Questions

The purpose of this action research study was to find out how the 5I's framework supports pedagogical innovation in statistics teaching and learning for teacher educators and teachers. The study addressed three research questions:

1. How does implementation of the 5I's framework influence teacher educators' and teachers' conceptual understanding of statistical concepts and the pedagogical approaches to teaching and learning statistics?
2. In what ways does engagement with the framework transform participants' beliefs about statistics and their identities as teachers of statistical content?

3. What processes and mechanisms within the 5I's framework support or constrain pedagogical change in the Cambodian educational context?

By examining these questions, this study contributes to understanding how pedagogical innovations can be effectively introduced and sustained in contexts with strong traditional teaching cultures, offering insights relevant to educational reform in Cambodia.

2. LITERATURE REVIEW

2.1. Pedagogical Traditions and Their Change in Cambodian Education

It is important to understand the historical, cultural, and institutional factors that influence teaching methods in order to comprehend the pedagogical change in Cambodia. According to Clayton (2006), the French colonial era created hierarchical educational structures that prioritized rote memorization and respect for the roles of teachers in society. These methods were strengthened during the post-independence era and, in spite of the Khmer Rouge era's devastation of the education system, reappeared during reconstruction as workable solutions to a lack of resources and underqualified teachers (Dy, 2004). Contemporary research identifies persistent challenges in Cambodian mathematics pedagogy; for example, the studies by Yen (2017) and Tan (2007) document classrooms where teachers predominantly use chalk-and-talk methods, students memorize procedures without conceptual understanding, and assessment prioritizes correct answers over reasoning processes. These practices are particularly problematic for statistics education, which requires active engagement with data, tolerance for ambiguity, and emphasis on interpretation over calculation (Garfield & Ben-Zvi, 2008).

Recent educational reforms, particularly Cambodia's Education Strategic Plan 2019-2023 (MoEYS, 2019), advocate student-centered pedagogy and critical thinking. However, implementation faces significant barriers including large class sizes, limited resources, inadequate teacher preparation, and deeply ingrained traditional practices (Mamaile & Omodan, 2023; Kioko et al., 2025; Song, 2018). Within this context, teacher educators represent strategic leverage points for pedagogical change, as their transformed practices can influence generations of teachers and future teachers (Cochran-Smith, 2003).

2.2. Statistics Teaching and Learning and Pedagogical Innovation

International research on statistics teaching and learning has increasingly emphasized pedagogical approaches that develop statistical literacy- the ability to interpret, critically evaluate, and communicate about statistical information (Gal, 2002). Effective approaches typically share several characteristics: they use real datasets with contextual relevance (Gould, 2010), emphasize conceptual understanding over procedural calculation (Cobb & McClain, 2004), integrate technology to handle computational complexity (Ben-Zvi, 2000), and address affective dimensions including anxiety and self-efficacy (Onwuegbuzie & Wilson, 2003). The challenges of pedagogical change in statistics teaching and learning involve not only introducing new techniques but also transforming underlying beliefs about the nature of statistics and how it should be taught (Budgett & Pfannkuch, 2010). Teachers often hold "folk pedagogies" based on their own learning experiences that may contradict research-based approaches (Leatham, 2006). Changing these deeply held beliefs requires approaches that create cognitive dissonance while providing viable alternatives and supportive conditions for change (Guskey, 2002).

2.3. Cultural Considerations in Pedagogical Change

Cultural values significantly influence how pedagogical innovations are perceived, adopted, and adapted (Hollins, 2015). The successful pedagogical innovation in Cambodia requires sensitive engagement with deeply held cultural values that shape classroom interactions and expectations (Tan, 2007; Tan, 2015). Based on the research synthesis, four key values are particularly relevant to mathematics and statistics teaching and learning:

- Present (Teacher Reverence): Deep respect for the teacher as an unchallenged authority and source of knowledge. This can create a passive learning culture where students hesitate to ask questions or engage in critical dialogue for fear of showing disrespect.
- Practice (Procedural Correctness): An emphasis on following established methods and formulas precisely to attain the single "correct" answer. This aligns with rote memorization but conflicts with the interpretive, conceptually focused nature of modern statistics.
- Product (Hierarchical Nurture): A teacher-student relationship modeled on family hierarchy, where the teacher provides care and guidance in exchange for student deference and obedience. While nurturing, this dynamic can limit student agency and peer-to-peer learning.
- Practice (Community Harmony): A collective orientation that values group cohesion, consensus, and avoiding public disagreement. This supports collaborative work but may suppress individual critical thinking or the expression of alternative problem-solving approaches.

The successful pedagogical change in this context requires approaches that honor these values while gradually expanding pedagogical collections. For example, rather than rejecting teacher authority, effective innovations might redefine it from knowledge transmission to expert guidance in inquiry processes (Cochran-Smith & Boston College Evidence Team, 2009). Similarly, rather than dismissing procedural correctness, innovations might expand it to include conceptual understanding and multiple solution strategies (Isaksen et al., 2010).

2.4. Action Research as a Methodology for Pedagogical Change

Action research offers particular promise for facilitating pedagogical change in contexts like Cambodia, as it positions teachers as active agents rather than passive recipients of innovation (Kemmis et al., 2014). Through cyclical processes of planning, acting, observing, and reflecting, teachers systematically investigate their practice while implementing changes (Mertler, 2017). Moreover, the spiral procedure can be translated into actual practice: Plan1 → Act1 → Observe1 → Reflect1 → (Revised) Plan2 → Act2 → Observe2 → Reflect2, guaranteeing that instruction is constantly changing in response to direct, localized evidence and that teachers become empowered, evidence-based decision-makers as a result of this cyclic rigor, according to Mertler (2017). This approach aligns with Cambodian cultural values of experiential learning and community-based knowledge construction of CPD and PLC through providing structured support for pedagogical experimentation. Participatory action research specifically emphasizes collaboration, local knowledge, and empowerment elements, particularly relevant in contexts (McTaggart, 1997). By engaging Cambodian teachers and teacher educators as co-researchers investigating their own practices, this study aims to foster sustainable pedagogical change grounded in local realities rather than imported models.

3. METHODOLOGY

3.1. Research Design

This study employed an action research design following the iterative spiral model of planning, acting, observing, and reflecting (Kemmis et al., 2014). The pragmatic orientation (Creswell & Clark, 2017) permitted methodological flexibility to address the multifaceted research questions, integrating quantitative measures of learning outcomes with qualitative exploration of participant experiences. The research was conducted over one academic semester (15 weeks) with two complete action research cycles (see Figure 1).

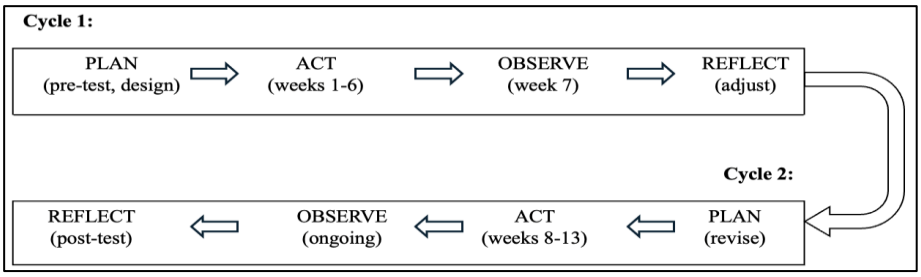

Figure 1. The Two Complete Action Research Cycles

Cycle 1 (weeks 1-7) focused on foundational concepts (descriptive statistics, data visualization), while Cycle 2 (weeks 8-14) addressed inferential concepts (sampling, correlation, basic hypothesis testing). Based on the action research model described by McNiff (20009), this study was guided, and its protocol was illustrated in Table 1, summarising the action research stages conducted in the study. The participatory nature of the research involved participants not only as subjects but as co-investigators of pedagogical change. Regular reflection sessions provided opportunities for collaborative analysis of emerging findings and adjustment of implementation strategies. This approach recognized participants as experts in their own context while providing structured support for pedagogical innovation.

Table 1. Summary of Action Research Stages

Stage	Key Activities
	Cycle 1: Foundational Concepts
Plan1	Designed 5I's lessons, developed Cambodian examples, prepared tests and surveys
Act1	Implemented 5I's for Data Types, Central Tendency, Normal Distribution
Observe1	Analyzed learning logs, reviewed quizzes, facilitated focus group
Reflect1	Synthesized findings, identified adjustments for Cycle 2
	Cycle 2: Inferential Concept
Plan2	Revised lessons based on Cycle 1 reflection, developed new case studies
Act2	Implemented 5I's for Sampling, Correlation, t-Tests with adjustments
Observe2	Weekly learning log analysis, mid-cycle survey, observation
Reflect2	Final evaluation: post-test, post-survey, focus group

3.2. Research Context and Participants

The study was conducted at Phnom Penh Teacher Education College (PTEC) in Cambodia. The institution serves mainly to produce teacher resources for Cambodia. Participants involved all 27 teacher educators and teachers enrolled in the required statistics course for the Master of Education program. Table 1 summarizes participant demographics. The participants in this study included 4 science educators, 8 maths educators, 8 Khmer educators, 7 social sciences educators, and myself. The mathematics was instructed from primary stage to introductory year classes (year 1 and 2) at the college level. At the time of this research, Statistics, a branch of mathematics, had been taught for a semester to teacher educators and teachers. Their role involved participating in the ongoing action research, whereas my role was that of a participant researcher. The class gathered weekly to prepare for upcoming lessons throughout a semester (14 weeks): create worksheets, anticipate potential responses from teacher educators and teachers, and strategize instructor reactions. The data sources comprised weekly planning and reflection meetings, activity worksheets, reflective journals, and recordings of lesson learning logs. Table 3 presents details regarding the execution of specific statistical subjects. Utilizing various topic sources improved statistical knowledge by allowing researchers to contrast information, identify and verify patterns across datasets, and gain a thorough insight into the data.

Table 2. Participant Demographics (N=27)

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	9	34.62
	Female	18	65.38
Age	21-25	5	18.52
	26-30	2	7.41
	31-35	9	33.33
	36-40	6	22.22
	41-45	5	18.52
Teaching Experience	5-10 years	8	29.63
	11-15 years	13	48.15
	16+ years	6	22.22
Academic Background	Sciences	4	15.38
	Maths	8	30.77
	Khmer	8	30.77
	Social Sciences	7	23.08

Ethical procedures followed international standards with local contextualization. The study was approved by the institution, and informed consent was obtained after a detailed explanation in Khmer. Participants were assured of privacy and their right to withdraw without penalty. Special attention was given to power dynamics given the researcher's dual role as instructor and investigator, with transparent communication and voluntary participation emphasized throughout.

3.3. Intervention: The 5I's Framework in Practice

The 5I's framework structured all learning activities throughout the course. Each week followed the five-phase sequence with increasing complexity. Table 2 illustrates implementation for selected statistical topics, showing how traditional content was approached through the innovative framework.

Table 3. Implementation of 5I's Framework for Selected Topics

Weeks	Statistical Topics	Key 5I's Activities	Data Collected	Observations & Adjustments
Pre-week 1	-	- Designed 5I's teaching and learning s for descriptive statistics, data types, central tendency, variability, normal distribution - Developed Cambodian-specific examples (achievement disparities, teacher salaries, height distribution) - Prepared software tutorials	Pre-test, baseline survey	Established baseline conceptual understanding and initial beliefs/interest levels
Weeks 1-2	Data Types & Visualization	- Impress: Cambodian educational achievement disparities - Identify: Categorical vs. quantitative variables - Inspire: Creating basic graphs with class data - Inspect: Comparing effectiveness of different visualizations - Invoke: Planning data collection for classroom research	Learning logs, software outputs	High engagement with real-world data; some confusion about variable classification
Weeks 3-4	Central Tendency & Variability	- Impress: Salary distribution in Cambodian teaching profession - Identify: Appropriate measures for different distributions - Inspire: Calculating measures with software - Inspect: Interpreting what measures reveal about distributions - Invoke: Applying to analysis of student assessment results	Learning logs, formative quiz	Clear understanding of mean/median; variability concepts required additional scaffolding
Weeks 5-6	Normal Distribution	- Impress: Height distribution in Cambodian population - Identify: Characteristics of normal distributions - Inspire: Using software to find probabilities - Inspect: Assessing normality of real datasets - Invoke: Considering implications for standardized testing	Learning logs, observation notes	Visualizing normality helped; need for more practice with z-scores identified
Week 7	-	- Analyzed learning logs for emerging themes (anxiety, relevance, collaboration) - Reviewed quiz performance - Facilitated weekly reflection with participants	Learning logs (Weeks 1-6), observation notes, formative quiz scores	Noted: (a) participants valued collaborative "Inspire" tasks, (b) "Inspect" phase needed more time, (c) some still struggled with interpreting variability

Weeks	Statistical Topics	Key 5I's Activities	Data Collected	Observations & Adjustments
End of Week 7	-	- Conducted focus group reflection on Cycle 1 experiences - Discussed cultural alignment (e.g., *Community learning* through group work) - Planned adjustments for Cycle 2	Focus group notes, researcher journal	Adjustments: (a) increase time for "Inspect" phase, (b) introduce peer teaching for inferential concepts, (c) provide visual glossaries of key terms
Pre-week 8	-	- Revised teaching and learning plans based on Cycle 1 reflections - Developed additional Cambodian case studies (election polling, class size vs. achievement, teaching methods) - Created simplified explanation sheets for p-values and effect sizes	Revised teaching and learning plans, new case study materials	Addressed identified gaps; built on successful collaborative structures
Weeks 8-9	Sampling & Estimation	- Impress: Election polling in Cambodia - Identify: Random vs. non-random sampling - Inspire: Simulating sampling distributions - Inspect: Evaluating bias in sampling methods - Invoke: Designing sampling for school-based research	Learning logs, simulation outputs	Sampling variability became concrete through simulation; bias discussion was lively
Weeks 10-11	Correlation	- Impress: Relationship between class size and achievement - Identify: Direction and strength of relationships - Inspire: Computing and interpreting correlation coefficients - Inspect: Distinguishing correlation from causation - Invoke: Investigating relationships in educational practice	Learning logs, correlation outputs	"Correlation ≠ causation" was a breakthrough insight; peer teaching effective
Weeks 12-13	t-Tests	- Impress: Comparing teaching methods - Identify: When to use different *t*-test types - Inspire: Conducting analyses with software - Inspect: Interpreting p-values and effect sizes - Invoke: Designing experimental comparisons in teaching	Learning logs, *t*-test outputs	Understanding of p-values improved after simulation; effect sizes remained challenging for some
Week 14	Research Integration	- Impress: Ethical use of statistics in educational research - Identify: Matching methods to research questions - Inspire: Complete analysis of provided dataset - Inspect: Critical evaluation of published research statistics - Invoke: Final research proposal with statistical design	Post-test, final survey, final learning log, research proposal	Demonstrated synthesis of all concepts; proposals showed meaningful application
Ongoing throughout Cycle 2	-	- Analyzed learning logs weekly - Conducted mid-cycle survey (Week 11) - Facilitated weekly participant reflections - Monitored software activity outputs	Learning logs (Weeks 8-14), mid-cycle survey, observation notes	Noted: increased confidence in interpreting inferential results; participants began designing their own studies spontaneously

Weeks	Statistical Topics	Key 5I's Activities	Data Collected	Observations & Adjustments
End of Week 14	-	- Final collaborative reflection session - Reviewed post-test and final survey results - Discussed pedagogical changes participants would take to their own teaching - Identified ongoing challenges (e.g., teaching effect sizes)	Post-test, final survey, focus group reflection, researcher journal	Confirmed overall effectiveness; participants requested follow-up support for implementing 5I's in their own classrooms

Instructional sessions (3 hours weekly) balanced direct instruction, collaborative activities, and hands-on software practice. Technology integration utilized Google Classroom, Microsoft Excel, and SPSS, selected for its convenience. All examples and datasets drew from Cambodian educational contexts, including MoEYS statistics, local school data, and regional assessment results, to maximize relevance.

3.4. Data Collection and Instruments

3.4.1. Conceptual Understanding Assessments

Pre- and post-intervention assessments measured conceptual understanding through a test focusing on interpretation and reasoning rather than calculation. The test covered four domains: descriptive statistics, correlation/regression, inferential statistics, and interpretation/communication. All items used Cambodian educational scenarios. Test development followed established principles (Skorupiński, 2015) with content validity established by statistics teaching and learning specialists familiar with the Cambodian context. Reliability analysis indicated Cronbach's α=0.84. The parallel forms design with item randomization minimized practice effects.

3.4.2. Pedagogical Beliefs and Attitudes Survey

A survey measured changes in beliefs and attitudes relevant to pedagogical change. The instrument included four subscales:

- Statistics Teaching Efficacy: Beliefs about capacity to teach statistics effectively
- Pedagogical Orientation: Preferences for student-centered versus teacher-centered approaches
- Statistics Value Beliefs: Perceptions of statistics' relevance for teaching and learning
- Change Readiness: Openness to pedagogical innovation

Items used a 5-point Likert scale (1=strongly disagree to 5=strongly agree). The survey adapted items from established instruments including the Teachers' Statistical Reasoning Beliefs (Harradine et al., 2011) and the Culturally Responsive Teaching Self-Efficacy (Siwatu, 2007), modified for the Cambodian context. Translation followed back-translation procedures with attention to conceptual equivalence.

3.4.3. Reflective Learning Logs

Participants maintained structured learning logs with weekly prompts designed to elicit reflection on both statistical understanding and pedagogical implications. The researcher-made prompts included:

- What statistical concepts did you engage with this week, and how has your understanding changed?
- Which pedagogical approaches used this week were most effective for your learning? Why?
- How might you adapt these approaches for your own teaching context?
- What challenges did you experience, and how might these inform your teaching?
- How has your thinking about teaching statistics changed this week?

The learning Logs were submitted electronically, allowing for timely review and responsive adjustment of instruction. For research purposes, participants granted permission for anonymized analysis.

3.5. Data Analysis

3.5.1. Quantitative Analysis

Pre-test and post-test scores were compared using paired samples t-tests with descriptive and inferential statistics analysis and effect sizes calculated using Cohen's d. Survey responses were analyzed using descriptive statistics and Wilcoxon signed-rank tests for each subscale. Additional analysis examined relationships between conceptual gains and belief changes.

3.5.2. Qualitative Analysis

Learning Logs were analyzed using a combination of deductive and inductive approaches. Deductive analysis used the 5I's framework as an organizing structure, examining how participants experienced each phase. Inductive thematic analysis (Braun & Clarke, 2006) identified emergent themes related to pedagogical change. Analysis followed the six-phase process of familiarization, initial coding, theme development, review, definition, and reporting. Trustworthiness was enhanced through triangulation across data sources, member checking with participants, peer debriefing with Cambodian educational researchers, and researcher reflexivity documented in a methodological journal.

3.5.3. Mixed Methods Integration

Following Greene's (2007) complementary approach, quantitative and qualitative findings were integrated to develop a comprehensive understanding of pedagogical change processes. Integration occurred at multiple stages: during data collection (connecting survey responses with learning log reflections), analysis (comparing quantitative patterns with qualitative themes), and interpretation (developing coherent explanations drawing on both data types).

4. RESULTS

4.1. Quantitative Results: Measuring Change

4.1.1. Conceptual Understanding Gains

Analysis of pre-test and post-test scores revealed substantial and statistically significant improvements in conceptual understanding across all participants. The overall mean test scores increased from 43.6% (SD = 11.8) on the pre-test to 76.0% (SD = 9.9) on the post-test, representing a 32.4 percentage point gain. A paired samples *t*-test confirmed statistical significance ($t(26) = 12.91$, $p < .001$) with the exceptionally large effect size (Cohen's $d = 1.88$). Table 3 details gains by content domain. The largest absolute gains occurred in inferential statistics, while the greatest percentage improvement was in interpretation/communication skills- particularly relevant for pedagogical applications.

Table 4. Conceptual Understanding Gains by Domain

Domain	Pre-test Mean (%)	Post-test Mean (%)	Gain	*t*-value	*p*-value	Cohen's *d**
Descriptive Statistics	47.2	78.8	31.6	10.24	<.001	1.75
Correlation/Regression	45.8	77.5	31.7	10.87	<.001	1.86
Inferential Statistics	41.1	75.9	34.8	12.03	<.001	2.06
Interpretation/Communication	40.5	76.8	36.3	9.92	<.001	1.69
Overall	43.6	76.0	32.4	12.91	<.001	1.88

Note: *The effect size is as follows: 0.2 = small effect 0.5 = moderate effect 0.8 = large effect

4.1.2. Changes in Pedagogical Beliefs and Attitudes

Survey results revealed significant shifts across all measured dimensions of pedagogical beliefs and attitudes, as detailed in Table 4.

Table 5. Changes in Pedagogical Beliefs and Attitudes

Subscale	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Change	*p*-value
Statistics Teaching Efficacy	2.34 (0.81)	3.88 (0.72)	+1.54	<.001
Pedagogical Orientation	2.67 (0.76)	3.95 (0.68)	+1.28	<.001
Statistics Value Beliefs	2.72 (0.74)	4.06 (0.65)	+1.34	<.001
Change Readiness	2.95 (0.79)	4.11 (0.70)	+1.16	<.001

Wilcoxon signed-rank tests confirmed statistical significance for all changes ($p < 0.001$). Particularly notable was the increase in Statistics Teaching Efficacy, suggesting growing confidence in participants' capacity to teach statistics effectively, whereas the Statistics Value Beliefs gain showed significant change. The shift in Pedagogical Orientation indicated greater preference for student-centered approaches, while increased Change Readiness suggested greater openness to pedagogical innovation.

4.2. Qualitative Results: Processes of Pedagogical Transformation

Analysis of Learning Logs revealed four interconnected themes characterizing the process of pedagogical change through the 5I's framework.

4.2.1. Theme 1: From Transmission to Facilitation- Reconceptualizing the Teacher's Role

Participants described fundamental shifts in their understanding of teaching: Redefining Teacher Authority: "I used to believe being a good statistics teacher meant having all the answers and explaining them clearly. Now I see it's more about asking good questions and creating opportunities for discovery." (Participant 8). Embracing Productive Struggle: "At first, I felt guilty when students struggled-like I hadn't explained well enough. Now I understand some struggle is necessary for real learning. My role is to support productive struggle, not eliminate all difficulty." (Participant 15). Valuing Student Thinking: "Before, I focused on whether students got the right answer. Now I'm more interested in how they're thinking about the problem. Even wrong answers can reveal important thinking." (Participant 3).

4.2.2. Theme 2: Integrating Tradition and Innovation-Cultural Negotiation of Pedagogy

Participants navigated the integration of new approaches with traditional values: *Reconciling Respect with Inquiry*: "In Cambodian culture, we show respect by not questioning teachers. But statistical thinking requires questioning. I'm learning how to create classroom culture where questioning shows engagement, not disrespect." (Participant 19). *Adapting Rather Than Adopting*: "The 5I's framework gives structure but allows adaptation. I can maintain classroom practices that matter in our culture while changing what happens within those practices." (Participant 6). *Community-Enhanced Learning*: "The collaborative aspects of the framework fit well with our value of learning community. Learning together strengthens both understanding and relationships." (Participant 22).

4.2.3. Theme 3: Developing Pedagogical Judgment-Beyond Procedure Following

Participants moved from seeking fixed procedures to developing contextual judgment: *From Recipes to Principles*: "I used to want teaching recipes-do this, then this. Now I'm learning pedagogical principles I can adapt to different contexts. The 5I's gives a framework, not a script." (Participant 11). *Contextual Decision-Making*: "I'm learning to make decisions based on what students need in the moment rather than following a fixed plan. When to extend the Inspire phase, when to move to Inspect- these are judgment calls." (Participant 17). *Tolerating Pedagogical Uncertainty*: "Teaching used to feel secure- I knew what I would do each minute. This approach has more uncertainty, but also more life. The classroom feels more like real conversation now." (Participant 9).

4.2.4. Theme 4: Identity Transformation- Becoming a Teacher of Statistics

Participants described evolving professional identities: *From Content Deliverer to Learning Designer*: "My identity is shifting from someone who delivers statistical content to someone who designs statistical learning experiences." (Participant 14). *Developing Statistical Pedagogical Content Knowledge*: "I'm not just learning statistics and not just learning pedagogy. I'm learning how to teach statistics- this is different knowledge." (Participant 5). *Embracing Dual Identity*: "I used to feel divided between my subject (literature) and having to teach statistics. Now I see myself as a teacher who can work with different contents using good pedagogical principles." (Participant 23).

4.3. Integrated Analysis: The Change Process Through the 5I's Lens

Mixed methods integration revealed how the 5I's framework structure supported pedagogical change: *Impress as Cognitive and Emotional Engagement*: Quantitative gains in interest correlated with qualitative descriptions of engaging learning scenarios. The emotional hooks created cognitive readiness for new learning while lowering affective barriers to pedagogical change. *Identify as Bridging Mechanism*: Participants' ability to identify statistical concepts in authentic contexts supported both conceptual understanding (quantitative gains) and pedagogical transfer (qualitative descriptions of adapting examples for their teaching). *Inspire as Confidence Building*: Significant self-efficacy gains measured quantitatively aligned with qualitative narratives of successful experiences building confidence to experiment pedagogically. *Inspect as Critical Pedagogy Development*: The inspect phase fostered both statistical critical thinking (quantitative gains in interpretation) and pedagogical reflection (qualitative descriptions of examining teaching approaches). *Invoke as Integration and Transfer*: The invoke phase supported application to professional contexts, connecting statistical learning with pedagogical change through authentic design tasks.

5. DISCUSSION

The study illuminated how the 5I's framework facilitates pedagogical transformation by providing structure for change while allowing cultural adaptation. The framework serves as what Wenger (1999) calls a "boundary object"- a flexible structure that maintains core integrity while being adaptable across different contexts. This adaptability proved crucial in the Cambodian setting, where successful innovation requires honoring traditional values while expanding pedagogical possibilities.

The findings suggest that pedagogical change proceeds not through rejection of existing practices but through their expansion and recontextualization. Participants did not abandon respect for teacher authority but redefined it from knowledge transmission to expert guidance in inquiry processes. They did not dismiss procedural correctness but expanded it to include conceptual understanding and multiple solution strategies. This pattern aligns with research on successful educational change in culturally conservative settings (Hollins, 2015), which emphasizes adaptation over replacement.

A key finding concerns the interdependence of statistical understanding and pedagogical transformation. Participants developed their statistical understanding through pedagogical experiences that they could then adapt for their own teaching- what might be termed "pedagogical content learning." This reciprocal process challenges the common sequencing in teacher professional development that addresses content knowledge before pedagogical application (Ball et al., 2008). The 5I's framework appears particularly effective in supporting this integrated learning because it models pedagogy while teaching content. Participants experienced student-centered approaches as learners, then reflected on how to adapt these approaches as teachers. This dual perspective aligns with "pedagogical content knowledge" (Shulman, 1987) but extends it to include the experience of learning through the pedagogy one will implement.

The study reveals complex cultural negotiations involved in pedagogical change. Participants actively worked to reconcile the 5I's framework with Cambodian educational values, creating hybrid practices that maintained cultural integrity while embracing innovation. The finding challenges deficit perspectives that view traditional cultures of education as barriers to change, instead highlighting their potential as resources for contextual adaptation. Notably, some Cambodian cultural values aligned surprisingly well with aspects of the 5I's framework. The emphasis on community-supported collaborative learning in the Identify and Inspire phases. The value placed on proper conduct translated into careful attention to methodological precision in the Inspect phase. These alignments suggest that culturally responsive pedagogy involves not

only adapting innovations to context but also recognizing how cultural resources can enhance innovation (Leonard, 2018; Johnson, 2011).

The findings suggest several implications for Cambodia's ongoing educational reforms: Professional Development Design: Teacher professional development should integrate content and pedagogical learning through immersive experiences in innovative approaches that align with the study of Germuth (2018) on professional development that changes teaching and improves learning. The 5I's framework offers one model for such integration. Change Leadership: Educational leaders should support pedagogical innovation by providing structural support (time, resources) while allowing adaptation to local contexts, similar to Frost (2016) in the study of professional development to system change: teacher leadership and innovation. Therefore, prescriptive mandates are less likely to succeed than flexible frameworks. Cultural Resource Recognition: Reform efforts should identify and build upon cultural values that align with desired changes rather than positioning tradition and innovation as opposed. Gradual Change Processes: The study supports incremental change models that expand rather than replace existing practices, recognizing that pedagogical transformation occurs through evolution rather than revolution. However, the study limitations include single-institution sampling, a relatively short intervention period, and the researcher's dual role as instructor and investigator. The successful changes must be culturally responsive and meaningfully leads must shape the development of strategies to fit their institution's unique cultural landscape (Kezar & Eckel, 2002). However, the study seems to be limited due to the timeframe and population. Therefore, future research should examine longitudinal impacts, investigate transfer to participants' teaching practices, explore adaptation of the framework in different Cambodian regions, and compare the 5I's framework with other pedagogical innovation models. Particularly valuable would-be research examining how pedagogical changes initiated with teacher educators' cascade through the system to affect pre-service teacher education and ultimately school classrooms. Such research would illuminate the systemic potential of focused interventions with strategic leverage points.

6. CONCLUSION

This action research demonstrates that the 5I's pedagogical framework- through its structured yet flexible integration of Impress, Identify, Inspire, Inspect, and Invoke phases- can facilitate meaningful pedagogical change in statistics teaching and learning within the Cambodian context. It effectively enhances conceptual understanding, fosters interest, and transforms beliefs about statistics among Cambodian teachers and teacher educators. By providing structured yet flexible approaches that honor cultural values while expanding pedagogical possibilities, the framework supports teachers and teacher educators in developing both statistical understanding and innovative teaching practices. The study contributes to understanding how pedagogical transformation occurs in culturally conservative educational settings, offering insights relevant to similar contexts. As Cambodia continues its journey toward educational quality and relevance, such contextually grounded, teacher-empowering approaches offer promising pathways for sustainable improvement. Perhaps most significantly, the research illuminates the transformative potential of well-designed statistics teaching and learning. When teachers and teacher educators move from anxiety to agency, from seeing statistics as an abstract hurdle to a professional tool, they become better equipped not only as researchers but as pedagogical leaders. In a country where educational quality remains a pressing national concern, developing such capacity represents more than individual achievement- it contributes to systemic improvement with potential ripple effects throughout Cambodia's educational ecosystem. The 5I's framework, while developed in a specific context, addresses universal challenges in statistics teaching and learning. Its emphasis on conceptual understanding, affective engagement, and professional relevance offers principles that could inform statistics pedagogy across diverse settings, particularly in teacher education colleges. As higher education generally grapples with developing quantitative literacy, approaches that honor both the discipline's rigor and learners' humanity offer promising paths forward.

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