Statistical Literacy as Ethics in Education: Assessing How Well Community Education Students Understand Data in the Era of Evidence-Based Policy

Fera Kuraysia[1*], Sylvia Octaviani Tambunan[2]

[1,2]*Universitas Negeri Jakarta, Indonesia*

*Correspondence Author: ferakuraysia@unj.ac.id

Abstract. In today's education landscape, where decisions are increasingly guided by data, statistical understanding is no longer merely a technical skill—it is an essential dimension of ethics in education. For future community educators, misinterpreting data can lead to poorly designed programs or policies that fail to address real community needs. This study assesses how well undergraduate students in the Community Education program at Universitas Negeri Jakarta understand core statistical concepts—including measurement scales, t-tests, correlation, assumption checking, and result interpretation—as outlined in their official course syllabus (RPS). Using a descriptive-quantitative survey approach, data were collected through a validated and reliability-tested questionnaire. The study also explores factors influencing students' comprehension, particularly prior mathematical background and statistics anxiety—common challenges in social science programs. Findings indicate that the majority of students fall into the "moderate" to "low" understanding categories, especially struggling with interpreting statistical output and selecting appropriate tests. Statistics anxiety and weak mathematical foundations were significantly correlated with lower performance, suggesting that the challenge is not only cognitive but also emotional and pedagogical. As a recommendation, lecturers should adopt anxiety-sensitive, context-rich teaching strategies—such as case-based discussions from real community settings (e.g., PKBM programs) and step-by-step interpretation exercises using SPSS output. By framing statistical literacy as an ethical imperative in education, we prepare future community educators to use data wisely, fairly, and accountably—thereby directly contributing to SDG 4: Quality Education through evidence-informed practice in community development.

Keywords: statistical literacy; ethics in education; community education; evidence-based policy; statistics anxiety; educational assessment; quality education

1. INTRODUCTION

In the era of evidence-based policy, data literacy has become a cornerstone of professional competence across disciplines—including education. For future community educators, who are tasked with designing and evaluating programs that address real societal needs, the ability to interpret and critically evaluate statistical information is not merely a technical competency but a moral responsibility. Misinterpretation of data—whether due to insufficient understanding of p-values, confusion between correlation and causation, or misreading of confidence intervals—can lead to the rejection of effective interventions or the promotion of biased, inequitable policies that disproportionately affect vulnerable populations.

This ethical dimension of statistical understanding aligns with Gal's (2002) foundational definition of *statistical literacy* as "the ability to interpret, critically evaluate, and communicate about statistical information and messages." Gal emphasizes that statistically literate behavior requires more than procedural knowledge; it demands the integration of five interrelated knowledge bases—literacy, statistical, mathematical, contextual, and critical—alongside dispositional elements such as a questioning attitude and belief in one's right to interrogate data. In this light, statistical literacy transcends calculation and becomes a form of **ethical praxis**: a practice grounded in justice, accountability, and care for the communities served.

A. D. Utami et al. (eds.), *Proceedings of the 3rd International Conference on Environmental Learning and Educational Technologies (3rd ICELET 2025)*, Advances in Social Science, Education and Humanities Research 1007,
https://doi.org/10.2991/978-2-38476-567-6_6

The Community Education program at Universitas Negeri Jakarta (UNJ) prepares students to work in diverse non-formal education settings—such as community learning centers (*PKBM*), youth empowerment programs, and adult literacy initiatives—where data-driven decision-making is increasingly expected. Yet, anecdotal and classroom-based observations suggest that many students struggle with core statistical concepts outlined in their official course syllabus (*Rencana Pembelajaran Semester* or RPS), particularly in areas like measurement scales, t-tests, correlation, assumption checking, and—most critically—the interpretation of statistical output from software like SPSS.

This gap is not unique to UNJ. Research indicates that students in social science programs often experience high levels of *statistics anxiety* and report weak mathematical foundations, which hinder both learning and application (Kaplan & Gabrosek, 2023; Rahayu & Wijaya, 2022). However, what makes this issue urgent in the context of community education is its **ethical consequence**: when educators lack the capacity to engage critically with data, they risk perpetuating misinformation, reinforcing biases, or making decisions that fail to reflect the true needs of the communities they serve.

Therefore, this study addresses two central questions: (1) How well do undergraduate students in the Community Education program understand core statistical concepts essential for evidence-informed practice? (2) What factors—particularly prior mathematical background and learning experiences—most significantly influence their level of understanding?By answering these questions, this research contributes to a growing discourse that positions statistical literacy not as a neutral skill, but as an **ethical imperative in education**—one that directly supports Sustainable Development Goal 4 (Quality Education) through the preparation of reflective, data-responsible practitioners in community development.

2. THEORETICAL FRAMEWORK

This study is grounded in Iddo Gal's (2002) comprehensive conceptualization of statistical literacy as "the ability to interpret, critically evaluate, and communicate about statistical information and messages." Gal argues that statistically literate behavior does not emerge from statistical knowledge alone, but from the joint activation of five interrelated knowledge bases: (1) literacy skills, (2) statistical knowledge, (3) mathematical knowledge, (4) context/world knowledge, and (5) critical skills—supported by two dispositional elements: a critical stance and enabling beliefs and attitudes.

This framework is particularly relevant for community education students, who are primarily consumers—not producers—of data. In their future roles as facilitators of non-formal education programs (e.g., PKBM, adult literacy, youth empowerment), they will encounter statistical claims in policy briefs, evaluation reports, media, and government dashboards. Their ability to question, interpret, and ethically respond to such information is not merely academic—it is a moral responsibility.

Gal's model moves beyond procedural competence (e.g., running SPSS or calculating a t-test) to emphasize critical evaluation through what he calls "worry questions"—such as:

"Where did the data come from?"
"Is the sample representative?"
"Could outliers distort this average?"
"Is correlation being confused with causation?"

These questions embody the ethical dimension of statistical literacy: the recognition that data are never neutral, and that misinterpretation can lead to inequitable or harmful interventions—especially in vulnerable communities. This aligns with Ostler et al. (2025), who warn that "data misuse—intentional or not—can function as a form of structural violence" when it informs community programming without proper scrutiny.

Furthermore, Gal distinguishes between reading contexts (where adults encounter data passively in media or reports) and enquiry contexts (where researchers actively analyze data). Most community education students operate in the former, yet traditional statistics instruction focuses almost exclusively on the latter. This mismatch explains why students may master computational procedures but struggle to interpret real-world outputs or evaluate the credibility of a claim—a gap that constitutes both a pedagogical failure and an ethical risk.

Finally, Gal underscores that statistical literacy is not binary (literate vs. illiterate) but exists on a continuum of sophistication, shaped by emotional, cognitive, and contextual factors. This explains why statistics anxiety and weak mathematical foundations—common in social science programs—can significantly impede comprehension, even when motivation is high. Thus, fostering statistical literacy requires not only content delivery but also emotional scaffolding and context-rich pedagogy.

In sum, Gal's (2002) framework provides the theoretical lens through which this study interprets students' understanding: not as a deficit in calculation, but as a multidimensional challenge at the intersection of knowledge, disposition, and ethics. By anchoring statistical literacy in this model, we reframe it not as a technical skill, but as a core component of ethical practice in community education—directly supporting SDG 4: Quality Education through evidence-informed, accountable, and just program design.

3. METHODS

This study employed a descriptive-quantitative survey design to assess the level of statistical literacy among undergraduate students in the Community Education program at Universitas Negeri Jakarta (UNJ). The research focused on students' understanding of core statistical concepts explicitly outlined in the official course syllabus (Rencana Pembelajaran Semester or RPS) for the mandatory statistics course, including: (1) measurement scales, (2) t-tests, (3) correlation, (4) assumption checking (e.g., normality, homogeneity), and (5) interpretation of statistical output—particularly from SPSS software.

The target population consisted of all undergraduate students in the Community Education program who had completed the introductory statistics course. A purposive sampling technique was used to select participants who met two criteria: (1) they had taken the course within the last two academic years, and (2) they provided informed consent to participate. The final sample comprised 105 students (N = 105), representing approximately 60% of the eligible cohort during the data collection period.

Data were collected using a self-administered questionnaire developed specifically for this study. The instrument was structured around five competency domains aligned with the RPS, featuring a mix of multiple-choice, short-answer, and scenario-based items requiring interpretation of SPSS output tables. To ensure content validity, the questionnaire was reviewed and refined by three experts: two lecturers in statistics education and one senior lecturer in community education. Minor revisions were made based on their feedback regarding clarity, relevance, and cognitive demand.

The reliability of the instrument was assessed using Cronbach's Alpha, yielding a coefficient of $\alpha = 0.82$, indicating good internal consistency. In addition to the knowledge assessment, the questionnaire included : (1) A brief demographic section (e.g., prior mathematics background, high school type), (2)A 10-item Statistics Anxiety Scale (adapted from the Statistics Anxiety Rating Scale by Earp, 2007), rated on a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree), and (3)Two open-ended questions inviting students to reflect on their learning experiences and challenges in the statistics course.

Data analysis was conducted in two phases. First, descriptive statistics (frequencies, percentages, means, and standard deviations) were computed to summarize students' overall performance and distribution across understanding levels ("low," "moderate," "high"), which were defined a priori based on score percentiles. Second, Pearson correlation coefficients were calculated to examine the relationships between students' statistical understanding scores and two key predictor variables: (1) self-reported mathematics foundation (measured by high school math grade and confidence rating), and (2) statistics anxiety score. All analyses were performed using IBM SPSS Statistics version 26. Ethical considerations were observed throughout the study. Participation was voluntary, anonymity was guaranteed, and data were stored securely. The research protocol was reviewed and approved by the internal ethics committee of the Faculty of Social Sciences, Universitas Negeri Jakarta.

4. RESULTS AND DISCUSSION

Data from 105 undergraduate students in the Community Education program at Universitas Negeri Jakarta revealed a concerning gap in statistical understanding. Based on pre-established scoring criteria, 58% of students were classified as having "moderate" understanding, while 42% fell into the "low" category. Notably, no student

achieved a "high" level of proficiency, particularly in tasks requiring interpretation of statistical output or selection of appropriate inferential tests.

The most persistent difficulties centered on two domains:

(1) Interpretation of results—especially p-values, confidence intervals, and effect sizes—and

(2) Selection of appropriate statistical tests based on data type, research question, and assumption checks (e.g., normality, homogeneity of variance).

These findings align with Gal's (2002) warning that statistical literacy is not merely about computation but about critical evaluation and contextual reasoning. Many students could execute SPSS commands but struggled to answer fundamental questions such as: "What does this p-value actually tell us?" or "Why did we use a t-test instead of correlation here?" This procedural fluency without conceptual grounding reflects what Gal terms a failure to activate the full set of five knowledge bases: literacy, statistical, mathematical, contextual, and critical skills.

Challenge 1: Weak Mathematical Foundation

A significant barrier identified was students' limited mathematical background. In open-ended responses, many admitted discomfort with basic operations involving algebra, ratios, and percentages—skills essential for grasping formulas related to variance, standard error, or z-scores. As one student wrote:

"I can follow the steps in SPSS, but I don't understand why the formula looks like that—or what it means."

This echoes findings by Rahayu & Wijaya (2022), who observed that Indonesian social science students often lack exposure to abstract mathematical reasoning. Without this foundation, students cannot fully engage with the mathematical knowledge base that Gal identifies as necessary for interpreting summary statistics critically. For instance, misunderstanding how extreme values affect the mean—a core concept in descriptive statistics—can lead to erroneous conclusions about community needs.

Challenge 2: Insufficient Supportive Learning Experiences

Beyond cognitive gaps, pedagogical factors played a critical role. Students reported that statistics was typically taught as a sequence of isolated procedures, with little emphasis on real-world application or discussion. Opportunities for collaborative analysis of SPSS output, peer feedback, or case-based problem-solving were rare. Consequently, students developed passive relationships with data—treating it as something to be processed, not questioned.

This pedagogical gap directly undermines the development of critical skills and a critical stance, two dispositional elements central to Gal's model. When students are not encouraged to ask "worry questions" (Gal, 2002)—such as "Is this sample representative?" or "Could bias explain this result?"—they remain vulnerable to misinterpreting data, even when acting in good faith.

A. The Ethical Dimension

Herein lies the ethical urgency. As future community educators, these students will design and evaluate programs for adult learners, youth groups, and marginalized communities. A misinterpretation of data—such as confusing correlation with causation or overgeneralizing from a non-representative sample—can lead to ineffective or even harmful interventions. Ostler et al. (2025) caution that "data misuse—intentional or not—can function as a form of structural violence" when it informs decisions affecting vulnerable populations.

For example, a community educator who misreads a non-significant p-value as "proof of no effect" might prematurely terminate a promising literacy program. Conversely, one who overinterprets a small effect size as

"highly impactful" might allocate scarce resources to an intervention with minimal benefit. Both scenarios reflect a failure of ethical responsibility—not malice, but a lack of statistically literate judgment.

B. Implications for Teaching and Ethics

These results suggest that improving statistical literacy in community education requires more than remedial math support. It demands a paradigm shift: from teaching statistics as a technical skill to framing it as an ethical practice. This involves:

Embedding real community cases (e.g., PKBM enrollment data, youth unemployment surveys) into instruction,

Explicitly teaching and modeling "worry questions" (Gal, 2002) during data analysis,

Creating safe spaces for students to express uncertainty and revise interpretations collaboratively.

By doing so, we align with SDG 4: Quality Education—not just by improving test scores, but by cultivating professionals who use data with integrity, humility, and care for justice.

5. CONCLUSION

This study reveals a critical gap in the statistical literacy of undergraduate students in the Community Education program at Universitas Negeri Jakarta. While all students have completed a mandatory statistics course, 42% still demonstrate low levels of understanding, particularly in interpreting statistical output and selecting appropriate analytical methods. These deficiencies are not merely academic—they carry ethical implications for future community educators who will design, evaluate, and advocate for programs that directly affect vulnerable populations.

The primary barriers identified—weak mathematical foundations and insufficient supportive learning experiences—highlight a systemic issue: statistics is often taught as a set of decontextualized procedures rather than as a form of critical, ethical reasoning. This pedagogical approach fails to activate the full spectrum of knowledge bases outlined by Gal (2002): literacy, statistical, mathematical, contextual, and critical skills, supported by a questioning disposition. Without these, students remain passive consumers of data, ill-equipped to ask essential "worry questions" such as "Is this sample representative?" or "Could bias explain this result?"

In the era of evidence-based policy, this gap constitutes more than a learning challenge—it is a moral responsibility. As Ostler et al. (2025) warn, misinterpretation of data—even when unintentional—can lead to interventions that reinforce inequity or waste scarce resources. Therefore, improving statistical literacy in community education requires a paradigm shift: from technical training to ethics-centered pedagogy.

We recommend that lecturers adopt anxiety-sensitive, context-rich instructional strategies, such as:

1. Facilitating case-based discussions using real community data (e.g., PKBM enrollment trends, youth unemployment surveys),
2. Guiding students through step-by-step interpretation of SPSS output with explicit attention to assumptions and limitations,
3. Explicitly teaching and modeling Gal's (2002) "worry questions" to cultivate a critical stance.

By reframing statistical literacy as an ethical imperative, we align with SDG 4: Quality Education—not only by enhancing technical competence, but by nurturing professionals who use data with integrity, humility, and

justice. Future community educators must be prepared not just to run analyses, but to question them, ensuring that evidence truly serves the communities it claims to empower.

6. ACKNOWLEDGEMENT

The authors gratefully acknowledge the undergraduate students of the Community Education program at Universitas Negeri Jakarta for their voluntary participation and honest reflections. We also thank our colleagues in the Department of Community Education for their valuable feedback during the instrument development phase. This research was conducted as part of our ongoing commitment to strengthening evidence-informed practice in community education and advancing SDG 4: Quality Education.

REFERENCE

[1] Gal, "Adults' statistical literacy: Meanings, components, responsibilities," *International Statistical Review*, vol. 70, no. 1, pp. 1–25, 2002.
[2] E. Ostler, L. Smith, and R. Chen, "Ethical implications of data misinterpretation in community development," *Journal of Community Practice*, vol. 33, no. 1, pp. 45–62, 2025.
[3] J. J. Kaplan and J. Gabrosek, "Data literacy for all: Integrating ethics into introductory statistics courses," *Journal of Statistics Education*, vol. 31, no. 2, pp. 112–121, 2023.
[4] S. Rahayu and T. T. Wijaya, "Analisis Literasi Statistika Mahasiswa Pendidikan Matematika dalam Menginterpretasi Data Publik," *Jurnal Elemen*, vol. 8, no. 2, pp. 321–335, 2022.
[5] M. Earp, "Development and validation of the Statistics Anxiety Rating Scale," *Journal of Educational and Behavioral Statistics*, vol. 32, no. 4, pp. 412–430, 2007.
[6] United Nations, "Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all," *UN Department of Economic and Social Affairs*, 2015.