The Development of Statistical Literacies in Colombian Applied Linguistics Teacher-Researchers

El desarrollo de literacidades estadísticas de docentes investigadores colombianos en lingüística aplicada

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The action research study reported in this paper aimed to develop the statistical literacy of five applied linguistics teacher-researchers enrolled in a doctoral programme at a Colombian public university. A 16-week statistics course was tailored to their needs. Evidence from pre- and post-tests, three assignments, and retrospective reflections indicated that participants improved in performing, interpreting, and reporting quantitative data analyses and results, as well as in critically analysing quantitative research studies. Positive perceptions were also reported about the course design. It is concluded that tailored statistical training at early stages of a doctoral programme helps applied linguistics teacher-researchers develop statistical literacies. Implications for statistical training in undergraduate and graduate applied linguistics programmes are also discussed.

Keywords: applied linguistics, Colombian teacher-researchers, professional learning, statistical literacy development

Esta investigación-acción buscó desarrollar la literacidad estadística de cinco docentes investigadores en lingüística aplicada inscritos en un programa doctoral de una universidad pública colombiana. Un curso de estadística de 16 semanas se adaptó a sus necesidades. Las pruebas de entrada y salida, las tareas pedagógicas y la reflexión retrospectiva mostraron cómo los participantes progresaron en la realización, la interpretación, el reporte de análisis y resultados estadísticos y en el análisis crítico de estudios cuantitativos. También se registraron percepciones positivas sobre el diseño del curso. Se concluye que la formación estadística al inicio del programa de doctorado ayudó a los participantes a desarrollar habilidades estadísticas. Además, se analizan las implicaciones para la formación estadística en lingüística aplicada en programas de pregrado y posgrado.

Palabras clave: desarrollo de literacidades estadísticas, docentes investigadores colombianos, formación docente, lingüística aplicada

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Introduction

The growing significance of quantitative research in applied linguistics has emphasised the need for applied linguistics researchers to develop statistical literacies. These refer to the ability to comprehend and employ statistical methods and results, which include selecting appropriate quantitative techniques, critically evaluating the quality of research, and accurately interpreting and reporting quantitative analyses (Loewen et al., 2014, 2020; Plonsky, 2021).

Recent research syntheses on quantitative research and previous survey studies that examined applied linguistics researchers' statistical literacies found that quantitative research remains prevalent in the field (Farsani et al., 2021; Khany & Tazik, 2019) and that applied linguistics scholars often possess a basic understanding of descriptive statistics but limited knowledge in advanced statistics (Gönülal, 2019; Loewen et al., 2014, 2020; Plonsky, 2021). A researcher with basic knowledge of statistics can understand 69.03% of the papers published in the field (Khany & Tazik, 2019), and the number of statistics courses taken influences the knowledge of and confidence in statistics among applied linguistics researchers (Zhang & Han, 2023).

While existing research has provided insights into the statistical literacy of applied linguistics researchers, there is limited information on the current state of statistical training and effective statistical instruction (Gönülal, 2018; Loewen et al., 2020; Zhang & Han, 2023). Further, previous studies investigated the statistical literacy of applied linguistics researchers in North America, Europe, Australasia, and Asia (Gönülal, 2019; Loewen et al., 2014, 2020; Zhang & Han, 2023), leaving a significant gap in underrepresented geographical contexts, such as Latin America.

In Colombia, undergraduate and graduate programmes in applied linguistics offer no or limited statistics training, and quantitative research is scarce in foreign language studies (Guapacha Chamorro & Chaves Varón, 2023; Rosado-Mendinueta et al., 2023).

In the doctoral programme where this study was conducted, the research methodology component primarily focused on qualitative approaches, with the quantitative component delivered by an external statistician due to a lack of skills among the applied linguistics faculty. The complex terminology used by the statistician posed a significant challenge, hindering both students and professors in grasping and applying statistical concepts. This situation underscores the argument that few applied linguistics faculty can effectively teach discipline-specific statistics courses, emphasising the need for in-house statistical training (Gönülal, 2019). The lack of appropriate training affected these teacher-researchers, as graduate students, who need to gain statistical knowledge during their research apprenticeship.

Addressing the statistical literacy of applied linguistics teacher-researchers is relevant given the increasing prevalence of quantitative research in language education. Applied linguistics teacher-researchers play a pivotal role in addressing language-related problems through complex questions and research designs. Thus, including quantitative methods courses, seminars, and adequate training can enhance their statistical experience (Loewen et al., 2020; Khany & Tazik, 2019; Zhang & Han, 2023) and contribute to the advancement of statistical training in Colombia. The lack of statistical literacy can lead researchers to erroneous conclusions and recommendations, compromising the credibility of applied linguistics and second language acquisition (SLA) research (Gönülal, 2018; Loewen et al., 2020). Conversely, strong statistical literacy and robust research designs can advance theory and inform practice (Loewen et al., 2020). Understanding the content of applied linguistics statistics courses and developing statistical literacies are crucial for informing statistics teaching and learning (Zhang & Han, 2023) and advancing the field (Gönülal, 2018; Loewen et al., 2014).

This study investigated the development of statistical literacies in five Colombian teacher-researchers enrolled

in an applied linguistics doctoral programme through the following research questions:

1. How statistically literate were the applied linguistics teacher-researchers before and after a semester-long statistics course in data analysis, interpretation, and reporting?

2. What were the participants' learning experiences and perceptions of the course?

Literature Review

Statistical Literacy

Statistical literacy refers to an individual's ability to understand and critically evaluate statistical information and results encountered in various contexts (Gal, 2004; Gönülal, 2019). Statistical literacy involves various skills, including critical thinking; the selection of statistical methods; and data management, analysis, interpretation, and accurate reporting (Gönülal, 2018, 2019; Loewen et al., 2014, 2020; Plonsky, 2021). To inform the design of this study's statistics course, several components of statistical literacy were reviewed, which are described in the following subsections.

Descriptive and Inferential Statistics

Descriptive statistics serve as a foundational aspect of statistical literacy, enabling applied linguistics researchers to describe the characteristics of a dataset and understand its distribution and patterns (Gönülal, 2019; Loewen et al., 2020; Plonsky, 2021). Measures of central tendency (e.g., mean, median, mode) and variability (e.g., standard deviation, variance) offer insights into the dispersion of data around the central value.

Inferential statistics allow researchers to draw inferences or make generalisations about a population based on sample data (Plonsky, 2015). Common techniques include t-tests, correlations, and analysis of variance (ANOVA), while more advanced methods encompass structural equation modelling, mixed-effects models, and Rasch and Bayesian analyses (Gönülal, 2019;

Loewen et al., 2020; Plonsky, 2021). Non-parametric tests (e.g., Wilcoxon signed-rank, Kruskal-Wallis) gain significance in SLA research, particularly when parametric test assumptions are violated (Khany & Tazik, 2019).

Statistical Resources

Statistical resources, such as software and textbooks, are relevant in quantitative research. Currently, there is a shift from traditional commercial statistical software (e.g., *IBM SPSS*) to more advanced and free alternatives (e.g., *R*, *Langtest*, *JASP*, *Jamovi*). Mizumoto and Plonsky (2016) advocate for the transparency and flexibility of *R*, a free and open-source statistical software. They developed *Langtest* (http://langtest.jp/), a user-friendly web application utilising *R*'s power with an intuitive graphical interface to address the challenge of *R*'s command-line interface. *JASP* (https://jasp-stats.org/), another free statistical software introduced by Love et al. (2019), is characterised by its user-friendly interface, Bayesian hypothesis testing, and parameter estimation implementation, promoting transparency and peer review of statistical algorithms.

Regarding statistics books, these contribute to the statistical literacy of applied linguistics researchers by providing guidance on quantitative analyses. The textbooks by Larson-Hall (2016), Loewen and Plonsky (2016), Lowie and Seton (2013), and Phakiti (2014) cover essential statistical concepts using *SPSS* and *R*, recognising the need for practical and cost-effective research solutions. Loerts et al.(2020) offer a concise introduction to using *R* or *JASP* for empirical work.

Interpreting and Reporting Data

Larson-Hall and Plonsky (2015) and Norris et al. (2015) provide criteria and guidelines for reporting quantitative data, which include reporting descriptive statistics, effect sizes, confidence intervals, instrument reliability, visual displays, and raw data. Including such data ensures transparency and comprehensiveness in

published reports, allowing for the interpretation of findings and facilitating future meta-analyses.

Overall, statistical literacy entails knowledge of descriptive and inferential statistics, as well as data management, analysis, interpretation, and reporting. Descriptive and inferential statistics equip researchers to interpret data trends and draw robust conclusions, while exposure to various statistical methods and software enhances their statistical experiences and knowledge. Adhering to reporting guidelines is crucial for promoting transparency, reproducibility, and sound interpretation of quantitative data in applied linguistics research. The present study underscores the importance of incorporating the above components into an introductory statistics course to develop the statistical literacies of Colombian teacher-researchers enrolled in an applied linguistics doctoral programme.

Previous Research on Applied Linguistics Researchers' Statistical Literacy

Previous research syntheses have identified the prevalence of quantitative research in applied linguistics journals, with classical statistical methods such as *t*-tests, correlations, chi-square tests, ANOVA, and MANOVA being commonly employed (Khany & Tazik, 2019). While parametric tests dominated, non-parametric equivalents were less frequent. More recent reviews also confirmed the prevalence of quantitative research (Farsani et al., 2021) and basic statistical techniques (Khany & Tazik, 2019) in research articles published in prominent applied linguistics journals.

Survey-based studies revealed a gap in statistical literacy among applied linguists. Loewen et al. (2014) surveyed 331 applied linguistics doctoral students and professors from North America, Australia, Europe, and Asia and found positive attitudes toward quantitative research. However, only 14% of students and 30% of professors felt adequately trained in statistics.

Gönülal et al. (2017) investigated the development of statistical literacy among 50 graduate students, noting substantial improvements in basic descriptive and common inferential statistics but weaker gains in advanced statistics. Later, Gönülal (2018) explored predictors of statistical literacy among 120 SLA doctoral students in North America, emphasising the significance of taking more statistics courses, having a quantitative research orientation, and engaging in self-training.

Gönülal's (2019) subsequent investigation with 120 SLA doctoral students in North America identified challenges in interpreting common and advanced statistics, suggesting improvements in course content and format. Loewen et al. (2020) assessed the statistical knowledge of 198 applied linguistics and SLA researchers from North America and Europe, revealing a gap in advanced statistics and emphasising the positive influence on performance of quantitative research orientation and the number of statistics courses taken. More recently, Zhang and Han's (2023) survey of 211 applied linguistics master's students in China highlighted a deficiency in overall statistical literacy despite positive attitudes toward statistics. The number of statistics courses taken, a quantitative research orientation, and self-training were identified as crucial predictors of statistical literacy, attitudes, and self-efficacy.

The findings from research syntheses and survey-based studies emphasise the significance of statistical literacy in applied linguistics research. While quantitative research is prevalent, there is a notable gap in statistical knowledge, emphasising the need for targeted training and improvements in course content. Direct evidence of participants' ability to perform statistical analyses is needed to understand the effectiveness of statistical training. The present study addresses this gap by incorporating performance and perception data, providing insights into the effectiveness and challenges of statistics training.

Method

Context and Participants

This study was conducted within an applied linguistics doctoral programme on English language teaching education at Universidad del Valle, Colombia. The pilot course stemmed from the need to develop the PhD candidates' statistical abilities and identify the appropriate content and methodology for these participants and the context. The participants were five third-year doctoral candidates—middle-aged language teachers with extensive teaching experience—who were enrolled in the statistics course I taught. I hold a PhD in applied linguistics and have experience with quantitative research. By obtaining online consent, the study secured confidentiality and anonymity. As shown in Table 1, the participants were unfamiliar with statistics and shared common academic and professional backgrounds.

Table 1. Participants' Profiles

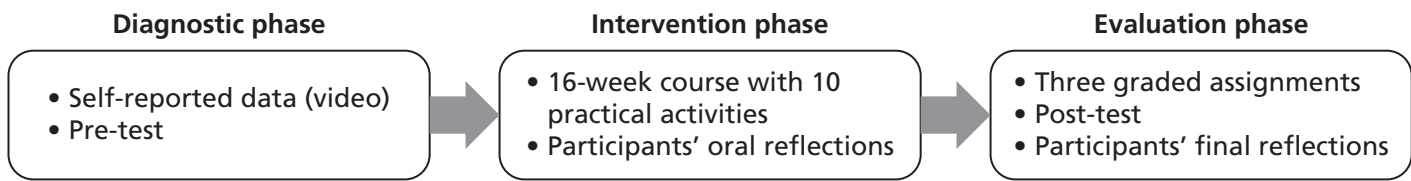|	**Antonio**	**Hector**	**Claire**	**Atahualpa**	**James**
Gender/Age	Male/40s	Male/30s	Female/40s	Female/30s	Male/30s
Qualifications	BA and MA in Languages	BA and MA in Languages Diploma in Marketing and Administration	BA and MA in Languages	BA and MA in Languages	BA and MA in Languages
Years of professional experience [a]	15	15	20	15	14
Topic of qualitative study	Integration of ICC in the curriculum	Material development with cultural aspects	Interculturalism in the curriculum	Multilingualism and interculturality	Meaning-making and language ideologies
Familiarity with quantitative research	Familiar with item reliability	Familiar with descriptive statistics	Unfamiliar	Unfamiliar	Familiar with descriptive statistics

[a] All the participants' professional experience was as school and university language teachers. ICC = Intercultural communicative competence.

Research Design

Action research was implemented to track the development of the participants' statistical literacies. Action research is suitable for positive change and improvement in the participants' social situation from a "socio-constructivist approach in which teachers are seen as agentive actors and investigators within their social contexts" (Burns, 2019, p. 166). As the course instructor and researcher, I collected classroom data and conducted three cyclical phases of action research: diagnostic, intervention (with cycles), and evaluation (see Figure 1).

The *diagnostic phase* inquired into participants' initial statistical performance through a pre-test and self-perception data, establishing a baseline for the 16-week intervention phase. The *intervention phase* consisted of implementing the course, utilising a theoretical-practical approach that featured collaborative learning. The course syllabus (see Appendix) was designed based on

Figure 1. Research Phases

Diagnostic phase	Intervention phase	Evaluation phase
• Self-reported data (video) • Pre-test	• 16-week course with 10 practical activities • Participants' oral reflections	• Three graded assignments • Post-test • Participants' final reflections

reputable textbooks (e.g., Lowie & Seton, 2013; Phakiti, 2014) and prioritised classical statistical methods due to the participants' needs. Software for quantitative data analyses included *Excel*, *SPSS*, *Langtest*, and *JASP*. Ten real-life statistics tasks included performing, interpreting and analysing data, reporting results, and evaluating the quality of quantitative research reports. The course was delivered online through Zoom, as most participants reside in different regions of Colombia. During the sessions, the participants' oral reflections provided valuable insights into their learning process and experiences with the course; however, due to space constraints, these interactions are not reported here. Their reflections related mainly to the pacing of the course content. The *evaluation phase* employed a post-test, graded assignments, and an oral final reflection to examine participants' performance, learning experiences, and perceptions of the course.

Data Collection Instruments

To address Research Question 1, I employed video recording, pre-test and post-test results, and three graded assignments. In the video, participants reported their qualifications, professional experience, research designs, familiarity with statistics, and opinions on Loewen et al.'s (2014, 2020) articles about statistical literacy among applied linguistics and SLA researchers. This provided qualitative insights into the participants' characteristics and their familiarity with quantitative research prior to the course.

The online pre-test and post-test (administered through Google Forms), along with three graded assignments, provided participants' performance data on the development of statistical literacy. The pre-test and post-test consisted of three sections (see Table 2), each containing 34 multiple-choice questions and one open-ended question. The option "I do not know" ensured thoughtful responses, avoiding random choices. Both tests' questions encompassed critical thinking, statistical methods selection, data analysis, interpretation, and reporting, and were informed by the research of Gönülal (2018, 2019), Gönülal et al. (2017), and Loewen et al. (2014, 2020). Prior to implementation, the pre-test was reviewed and piloted by a colleague with experience in quantitative research.

Table 2. Pre-Test and Post-Test Sections and Purposes

Sections	Purpose	35 items/points
Descriptive statistics	Understanding of descriptive statistics (e.g., types of variables and scales, mean, mode, standard deviation)	15
	Understanding visual data (e.g., outliers, normal distribution, box plots)	4
Inferential statistics	Understanding inferential statistics by choosing the appropriate statistical methods (parametric and non-parametric tests)	8
	Interpreting data results (significance and effect sizes)	7
Writing up the report	Writing/reporting results	1

The three graded assignments (see Table 3) gauged the participants' statistical learning. Table 4 shows a sample of Assignment 1. Continuous feedback was provided during the course through practical individual and group tasks, mirroring the structure of the graded assignments.

To answer Research Question 2, data were gathered through a final oral reflection in the last class session. Individual responses were recorded and then transcribed using the tool *Otter.AI*. This oral reflection included the following questions:

- How familiar were you with statistical methods before the course and how familiar are you now?

- What are your strengths and weaknesses regarding your understanding of variables, scales, assumptions, and descriptive and inferential statistics; the use of *JASP*, *Excel*, and *Langtest*; the selection of statistical tests; your interpretation of visual and numerical outputs; and the writing of the research results? Can you critically analyse the quality and robustness of a quantitative research report?

- What did you enjoy the most and what difficulties did you have during your learning process?

- How motivated are you now about doing statistics?

- What are your perceptions of the statistics course (objectives, content, methodology, assessment, resources) and its place in the curriculum?

Table 3. Assignments Description and Marking Criteria

Assignment	Description	Marking criteria (50 points each)
Critical analysis of a quantitative research report chosen by the instructor (30%)	Assessment checklist of 24 items divided into 10 sections, based on Norris et al.'s (2015) guidelines: population and participants, sampling and assignment, measurement, design and procedures, analysis, descriptive statistics and graphical analyses, effect sizes and confidence intervals, assumptions, statistical tests and final evaluation **Instruction:** Participants select whether the information was reported, partially reported, or unreported, and then justify their answers	60–64% (13 correct answers): 3.5 65–69% (15–14 correct answers): 3.8 70–74% (16 correct answers): 4.0 75–79% (17 correct answers): 4.3 80–84% (18 correct answers): 4.5 85–89% (19–20 correct answers): 4.8 90–100% (21–24 correct answers): 5.0
Quantitative data analysis and reporting (30%)	Participants analyse a fictional study given the purpose and research design **Instruction:** Choose <u>one</u> out of four studies and perform the appropriate analysis. Report all the information required (e.g., assumptions, descriptive and inferential statistics, confirmation of results from the non-parametric test) and the results	• Assumption checks and report: 10 points • Descriptive and inferential statistics reports: 15 points • Confirmation of results using the non-parametric test counterpart: 10 points • Written report: 15 points
Interpreting and reporting quantitative research results (40%)	Participants interpret and write the results of a published quantitative study when provided with the context, graphs, and tables **Instruction:** Participants receive the description, research questions, and results of three published quantitative studies. They must interpret the results of the tables and answer the research question	Provide detailed interpretations and reports of descriptive and inferential statistics. Answer the research questions directly and clearly for each study • Study 1: 15 points • Study 2: 15 points • Study 3: 20 points

Table 4. Assignment 1 Sample: Critical Analysis of a Quantitative Research Report

Objective	Analyse critically the report and robustness of a quantitative study
Instructions	Read the article by Al-Sumait et al. (2022) "Multicultural Educational Experiences and ICC in Arab Context" and Norris et al. (2015) "Guidelines to Report Quantitative Methods Results." Then, read the list of reporting recommendations for methods sections and results sections in this grid. Then, read the article again and tick the boxes whenever the information required in the grid is reported in the article. Answer the questions and provide your final assessment of the robustness and quality of the report of this quantitative study.

Reporting Recommendations for Method Sections					
Population and Participants	**Yes**	**Partially**	**No**	**N/A**	**Comments**
Define the human or other population(s) of interest for the study, including key demographic characteristics or other parameters that limit generalizability and help operationalize who/what is under investigation, such as age, gender, language (first, second, other), proficiency (using standardized or otherwise generalizable measures), language learning/use setting.	✓				Al-Sumait et al. (2022) provided a complete description of population and participants. Participants in the study were undergraduates and graduates ($N = 797$). There are percentages showing how participants are distributed (genre and languages).
Report precise frequencies of participants reflecting each key demographic characteristic or case feature, including how they were determined (e.g., language proficiency measures utilized and their range, minimum and maximum scores, central tendency, such as mean, and dispersion, such as standard deviation, estimates for participant scores).	✓				Most of the respondents were female (66%), reflecting a social trend in Kuwaiti universities. Further, 76% of the students were between the ages of 20–24, with a mean age of the overall sample of 22.75 with a standard deviation of 6.87, and values ranging from 17 to 77 years of age. Additionally, demographic factors is the section in which the authors provided detailed information.

Data Analysis

Due to the study's nature and small sample size, inferential statistics were deemed inappropriate (Gönülal et al., 2017). Descriptive statistics (mean and standard deviation) were employed for reporting the results of both tests and the graded assignments. Qualitative data, primarily derived from the participants' reflections, were analysed through content analysis, identifying the participants' learning experiences, strengths, weaknesses, and motivation toward statistics. The participants' perceptions of the course were analysed in relation to its components: objectives, content, methodology, resources, and assessment.

Validity, Ethics, and Researcher Positionality

This study drew on applied linguistics theory and research for conceptualisation and instrument design. The instruments were reviewed and piloted by an expert

in the field. To enhance triangulation and the validity of findings, data were collected from multiple sources (pre- and post-tests, assignments, and student reflections), which were compared to identify patterns and discrepancies, ensuring that findings were not solely reliant on any single measure. Member-checking was also incorporated to allow participants to provide feedback to their peers and comment on preliminary interpretations of their performance and views, thereby reducing potential misrepresentations of their perspectives.

To ensure reliability and provide an impartial perspective on participants' engagement, interrater agreement was employed by having two researchers independently code reflection data from two randomly chosen participants. Discrepancies were resolved through discussion until consensus was reached. For the remainder of the data, I conducted iterative data analysis.

I was granted permission to conduct this study, and participation was voluntary. Given that I was also the course instructor, I mitigated potential biases that could influence data collection and interpretation by engaging in constant reflection through my lesson plans and interactions with participants about my practices and expectations throughout the pedagogical intervention. To minimise desirability bias, where participants might provide overly positive evaluations due to the researcher's dual role, they were explicitly encouraged to critique the course and its materials. Feedback sessions emphasised the value of constructive criticism.

Findings

The development of five teacher-researchers' statistical literacy throughout the course is reported through five themes: *facing statistical literacy with concerns*, *cognitive struggles and breakthroughs*, *empowerment and use of statistics as a tool for inquiry*, *reflecting on growth and future applications*, and *navigating statistical literacy in the curriculum*.

Self-Perceptions of Statistical Literacy Before the Course: Facing Statistical Literacy With Concerns

At the outset, all participants acknowledged their lack of statistical knowledge and reported perceiving a deficiency in the quantitative component of Colombian undergraduate and graduate applied linguistics programmes. They expressed concerns about the low statistical literacy among applied linguistics researchers globally, referencing the findings of Loewen et al. (2014, 2020). They highlighted a broader concern about the scarcity of statistical literacy research in Latin America, emphasising the need for more studies in the region, as existing research mainly focuses on universities in North America, Europe, and Asia.

For instance, Antonio stated that he had experience with item reliability but was unfamiliar with other statistical concepts. He considers that "our students are unfamiliar with statistics [and that] our academic community's attitudes are negative toward numbers." Claire reported that she had never taken statistics courses. She usually "skip[ped] the results of quantitative research articles and jump[ed] to the conclusions." Atahualpa said she was "a qualitatively oriented researcher but was open to learning statistics," while Hector claimed that "there is a need for more studies in Latin America and more training on statistics in applied linguistics programmes."

This shared concern shaped the participants' initial engagement with the course, with all of them acknowledging the relevance of statistics to applied linguistics in our research context.

Statistics Performance Before and After the Course: Cognitive Struggles and Breakthroughs

Before the course, the participants encountered some struggles and cognitive dissonance, particularly in understanding and reporting quantitative research outputs. Their performance in the pre-test allowed

them to realise the need to develop statistical literacies. However, as the course progressed—and through guided practice and peer collaboration—all participants improved their performance and reported key breakthroughs.

As shown in Figure 2, the group's pre-test results (M = 4.6, SD = 5.3) were lower than the post-test outcomes (M = 32.2, SD = 2.9), indicating improvement in the teacher-researchers' statistical literacy at the end of the course.

Figure 2. Box Plots of Pre-Test and Post-Test Participants' Overall Performance
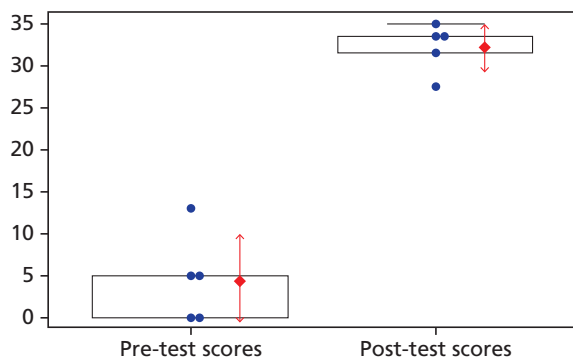
At the individual level, Table 5 also shows substantial gains (above 60%) in statistical knowledge

and performance, indicating advancements after completing the course. Claire and Atahualpa exhibited the greatest improvements (above 90%) as seen in their pre-test and post-test results. Overall, these results suggest that the course is effective in fostering participants' statistical literacy at both group and individual levels.

Table 6 provides a detailed report of the statistical literacy components assessed in the three sections of the pre-test and post-test.

As shown in Table 6, the participants demonstrated improvement in their knowledge of statistics across several components. Regarding Section 1, the teachers demonstrated enhanced comprehension of descriptive statistics in numerical and graphical data, which is essential for recognising patterns and assumptions in the data. In Section 2, the participants progressed in their understanding of common inferential statistics and in their ability to differentiate between parametric and non-parametric tests, choose appropriate statistical tests, and interpret alpha values and effect sizes. Section 3 also shows progress in participants' ability to report statistical analysis results, indicating an improvement in conveying quantitative findings.

Table 5. Individual Overall Performance on Pre- and Post-Tests

	Pre-test (35 points) Sum (%)	Post-test (35 points) Sum (%)	Individual gain (%)
Antonio	5 (14%)	27.5 (79%)	22.5 (64%)
Claire	0	33.5 (96%)	33.5 (96%)
Atahualpa	0	33.5 (96%)	33.5 (96%)
Hector	13 (37%)	35 (100%)	22 (63%)
James	5 (14%)	31.5 (90%)	26.5 (76%)
Group average M (%)	**4.6 (13%)**	**32.2 (92%)**	**27.6 (79%)**

Table 6. Participants' Detailed Statistics Performance on Pre- and Post-Tests

Section 1: Descriptive statistics (numerical and graphical data)			
Statistical components	**# of items**	**Pre-test scores M (SD)**	**Post-test scores M (SD)**
Scales	9	2.6 (3.7)	8.6 (0.5)
Variables	2	0.4 (0.9)	2.0 (0.0)
Mean	1	0.2 (0.4)	1.0 (0.0)
Median	1	0.2 (0.4)	1.0 (0.0)
Mode	1	0.2 (0.4)	1.0 (0.0)
Standard deviation	1	0.2 (0.4)	1.0 (0.0)
Histograms	1	0.4 (0.5)	1.0 (0.0)
Box and whisker plots	1	0	1.0 (0.0)
QQ & PP plots	1	0.2 (0.4)	0.8 (0.4)
Outliers	1	0	1.0 (0.0)
Subtotal	**19**	**4.4 (5.3)**	**18.4 (0.5)**
Section 2: Common inferential statistics (*t*-tests, ANOVAs, correlations, non-parametric tests) and significance level			
Statistical components	**# of items**	**Pre-test scores M (SD)**	**Post-test scores M (SD)**
Parametric vs non-parametric tests	5	0	4.6 (0.5)
Selection of appropriate statistical tests based on a study design.	3	0.2 (0.4)	3.0 (0.0)
P-value and effect sizes interpretation	7	0	5.2 (2.4)
Subtotal	**15**	**0.2 (0.4)**	**12.8 (2.5)**
Section 3: Reporting of results			
Statistical components	**# of items**	**Pre-test scores M (SD)**	**Post-test scores M (SD)**
Writing up, including descriptive and inferential results	1	0	0.6 (0.2)
Total average	**35**	**4.6 (5.3)**	**32.2 (2.9)**

Furthermore, the three course assignments showed notable improvements in the participants' development of statistical literacy, as evidenced by their high marks (see Table 7). Assignment 1 (critical analysis of a published quantitative study) posed fewer challenges to the participants compared to Assignments 2 and 3, which were related to performing, interpreting, and reporting quantitative data analyses and results. This suggests that it was easier for the participants to review and analyse a quantitative research report than to conduct more specific procedures. Nevertheless, the results from these assignments suggest that the participants increased their knowledge and use of descriptive and inferential statistics, assumptions, quantitative analysis, and use of statistical tools, as well as their ability to generate, interpret, and report data and critically evaluate quantitative studies.

Table 7. Group Performance on Three Course Assignments

Assignments	Grading mark from 1 to 5 *M* (*SD*)
Assignment 1: Critical analysis of a quantitative research report (30%)	5.0 (0.0)
Assignment 2: Quantitative data analysis and reporting (30%)	4.1 (0.0)
Assignment 3: Interpretation and reporting of quantitative research results (40%)	4.3 (0.0)
Total	4.5 (0.0)

Note. The marking scale goes from 1 (*poor*) to 5 (*excellent*).

My feedback to the participants on their assignments identified their strengths and weaknesses. Regarding Assignment 1:

> These excellent results mean that you were able to evaluate the robustness of a quantitative research report by identifying and critiquing information related to sampling, measurement and constructs, design and procedures, numerical and graphical outcomes, assumptions, descriptive and inferential statistics, significance levels, effect sizes, and confidence intervals.

Regarding Assignment 2, my feedback highlighted the participants' ability to perform data analysis and generate and interpret numerical and graphical outcomes. In contrast, participants needed to improve the written report, interpretation, and discussion of results considering the research questions and theoretical and pedagogical implications:

> Overall, you can select a parametric test and perform a quantitative analysis based on a research design. You can also check the assumptions and interpret the visual and numerical data. The only aspect to improve is the interpretations of results (contribution to knowledge). You need to go beyond the interpretation of statistical significance. You must interpret the findings considering the theory, context, or participants. You could have provided more theoretical or pedagogical interpretations.

My feedback for Assignment 3 highlighted the participants' ability to interpret data, although they had to be more accurate in the written report:

> You can interpret and report the results of quantitative studies that employ classical statistical tests. The written reports were accurate and similar to the original research reports. The only aspect to improve is the accuracy of the language used in reporting quantitative results. You will need more input and practice to improve that aspect. Nevertheless, you did an excellent job overall and understood the fundamental aspects of quantitative analyses, results, and reports.

Perceptions of Statistical Literacy After the Course: Empowerment and Use of Statistics as a Tool for Inquiry

After the course, most participants claimed their view of statistical literacy had changed, moving from concerns and struggles to confidence. Their reflections indicated a sense of empowerment and a shift in mindset, as they realised they could engage with quantitative data.

All the participants perceived a substantial increase in their statistical knowledge and skills, and were able to identify their strengths and weaknesses. They reported competence in identifying variables and scales; performing and interpreting descriptive and inferential statistics; using *Excel*, *SPSS*, and *Langtest*; selecting appropriate statistical tests; interpreting visual and numerical outputs; writing the results; and critically analysing quantitative research reports. However, they expressed a need for additional practice to strengthen concepts and procedures and enhance report-writing skills:

Now I know about interpreting, evaluating, and writing statistical results. I feel confident about reading an article and understanding the data. My weakness relates to writing the results, such as reminding the reader about the research question. (Antonio)

I feel more confident about interpreting data and critically evaluating a research report. However, the most challenging part is writing. I know there are formulaic expressions to report the results, but it is hard for me. (Hector)

A shift in perception emerged as they moved from limited knowledge to conceptual understanding, recognising patterns in data and developing confidence in their interpretations.

Motivation Towards Quantitative Research: Reflecting on Growth and Future Applications

In their reflections, the participants showed how their evolving statistical literacy reshaped their academic identity as applied linguistics researchers. They emphasised both their improved skills and their motivation and confidence in engaging with quantitative research in the future:

I am a qualitatively oriented researcher, but I want to do quantitative research because it could be helpful in my context. (Atahualpa)

I am highly motivated now because I see the purpose of quantitative research. Before, I used to say that I was not good at numbers, but now I can use them in my research. There are so many areas where statistics can be used. (Antonio)

I am more motivated now than before. I thought it would be challenging and not helpful because we are conducting qualitative research. Now, I see there are many possibilities to conduct mixed-methods or quantitative research. (Hector)

The participants also reported that guidance and the course resources were positive methodological

strategies that influenced their learning and motivation. For instance, Claire said she "liked the practical activities that guided [her] step by step." Similarly, Hector reported that he "loved designing tables using APA 7th style and performing analysis in *SPSS* and *Langtest*." James also "enjoyed performing the analyses in the software programmes because [he] didn't know about these programmes before." This newborn confidence suggests that, beyond skill acquisition, the intervention fostered a sense of agency in participants as researchers.

Perceptions of the Statistics Course: Navigating Statistical Literacy in the Curriculum

The participants' positive experience with the course allowed them to develop a critical view of the relevance of introducing statistics in applied linguistics programmes. In their reflections, they acknowledged the appropriateness of the course components in their formation. Regarding course content, participants considered it appropriate, although it was advanced. For Antonio, "this was not an introductory course but an advanced one." Hector said that "the feedback provided, planning, and course methodology allowed [him] to learn the course contents." The course learning objectives were also appropriate and achieved by the participants, as Hector claimed. Concerning the course methodology, the participants valued the course planning and practical activities, which were based on real-life statistical tasks. The ten practical tasks focused on understanding, performing, and reporting data analyses and results from correlations, *t*-tests, and ANOVAs. Participants also designed research studies based on real issues, their contexts, and realities and analysed published quantitative articles in their research areas.

The online modality was also appropriate, although participants preferred face-to-face interactions. James, Claire, and Atahualpa agreed that "on-site classes promote interaction, but online courses are necessary for students from other regions." Antonio mentioned that

"the online modality did not negatively impact [their] learning. It's just a matter of preference." The course resources (e.g., statistics books in applied linguistics and social sciences, research articles, videos on statistics, and software) were relevant and authentic, as highlighted by the participants. Special guests also complemented their knowledge. Participants preferred *Langtest* over *Excel* and *SPSS* because it is user-friendly and practical. However, *SPSS* offers good visual features, including histograms, box plots, and outlier detection. The limitation of *Langtest* is the lack of APA format tables. *JASP* was introduced at the end of the course and was not sufficiently explored.

> I used and felt more comfortable with Langtest. With SPSS, I had to go back to the videos, but I was able to use it. I like the box plots produced by SPSS because they show you the specific outliers. (Antonio)
>
> I started using SPSS and was getting familiar with it. Then, I realised that Langtest was user-friendly. In SPSS, the histograms and box plots look better. I prefer Langtest, although we had to design the tables and arrange the data. (Hector)
>
> The guest speakers also contributed to our knowledge of statistics. The materials were helpful. They can be published as a textbook for a doctoral programme because we need available and easy-to-understand materials. (Claire)

Regarding course assessment, the participants valued the detailed feedback I provided on each practical activity, which helped them scaffold their learning process. The participants expressed that the pre-test, post-test, and three assignments were appropriate for measuring their performance. As they noted, practical activities should have been graded as part of the process. On the other hand, collaborative work and group assessment allowed them to identify their strengths and weaknesses in statistics.

> The detailed feedback on our analyses and writing was helpful because we identified our strengths and weak-

nesses. The collaborative work was positive because we got together to work and understand the activities and assignments. We got to identify our abilities. (Claire)
>
> The feedback was relevant because the teacher highlighted the mistakes and told us how to correct them. I also share Antonio's opinion that the practical activities could have been graded and added to our final records in case we failed one assignment. (James)
>
> The pre-test and post-test were helpful because we could see the advances regarding the course's goals and our knowledge of quantitative research and statistics. (Hector)

Based on their positive experiences and analytical views, the participants suggested that at least two statistics courses should be offered in the doctoral programme: one compulsory introductory statistics course in the first year to familiarise candidates with quantitative research designs, and an elective course in the middle of the curricular stage for advancing this knowledge.

> This course should have been offered earlier in the curriculum because we could have chosen other research designs. Some of our classmates started with a mixed-methods approach but had to change because they didn't know about quantitative research. (James)
>
> This course should be offered in the first year so students can make informed decisions about their studies. We were told we could not conduct a mixed-methods study because we were unprepared. Two courses would cover more topics: One compulsory course at the beginning and one elective course in the middle for those conducting quantitative or mixed-methods studies. (Claire)

Discussion, Implications, and Conclusions

This study investigated the development of statistical literacy among applied linguistics researchers through an action-research approach, emphasising the challenges and breakthroughs experienced by the participants.

Their lack of statistical literacy affirmed the broader trend of low statistical literacy among applied linguistics researchers (Gönülal, 2018, 2019; Gönülal et al., 2017; Loewen et al., 2014, 2020; Zhang & Han, 2023). Findings indicate that while initial unfamiliarity with and concerns toward statistics were common, structured instruction, practical engagement, and reflective practice helped participants develop confidence in using statistical tools for applied linguistics research. These results highlight the importance of integrating quantitative literacy into applied linguistics programmes in ways that acknowledge students' struggles while fostering their analytical and critical thinking skills.

Findings on performance and perceptions indicate that participants developed competence in (a) understanding and performing classical statistical methods (i.e., t-tests, correlations, ANOVAs, non-parametric tests) using data analysis tools (*Excel*, *SPSS*, and *Langtest*) and in (b) critically analysing quantitative research. These abilities might help these teacher-researchers solve complex language-related problems in their contexts through appropriate research designs. Despite the participants' advancements in conducting statistical tests, one difficulty they faced was integrating statistical results into coherent, research-oriented narratives and broader discussions on language acquisition and development. Although writing samples, templates, and resources were provided, developing this writing ability requires practice, scaffolding, and time. To address these challenges, future iterations of the course should include explicit and prolonged instruction on writing statistical reports. Additionally, engaging students in peer-review exercises may help them critique and refine their statistical interpretations.

This study's findings align with research suggesting that students become more confident and motivated in tackling statistical problems after taking appropriate statistics courses (Loewen et al., 2014, 2020; Zhang & Han, 2023). The participants' development of statistics is beneficial for their academic and professional lives and

institutions, as it enables them to conduct experiments, correlations, and quantitative surveys commonly used in applied linguistics and SLA research to investigate L2 instruction, interculturality, and assessment, among other topics. Schools and universities can benefit from these researchers because they could provide statistical training to their communities and introduce statistics in undergraduate and graduate curricula.

Unlike previous research—in which participants had taken at least one course (Gönülal, 2018, 2019; Gönülal et al., 2017; Loewen et al., 2014, 2020; Zhang & Han, 2023)—this study's participants had not received any statistical training. This suggests that statistical literacy development can be achieved through adequate statistical training and early exposure to quantitative research during undergraduate and graduate programmes.

Regarding the participants' perceptions of the statistics course, they deemed the course content and learning objectives advanced and not basic, as thought. Despite the need for advanced statistical methods in our field (Loewen et al., 2020), this study prioritised classical statistical methods as many applied linguists enter graduate programs with little to no formal training in statistics. Classical methods provide an essential starting point before progressing to more advanced techniques. Previous reviews of statistical methods in applied linguistics journals suggest that many studies still rely on classical inferential tests to analyse experimental and survey data and that familiarity with basic statistical techniques facilitates access to a significant portion of the applied linguistics literature (Khany & Tazik, 2019). Ensuring that applied linguistics researchers have a strong grasp of these core techniques is necessary to engage with more complex methodologies and ongoing training (Gönülal, 2019; Lowen et al., 2020). Bearing in mind that classical statistics are foundational for researchers and that new data-driven methodologies seem to populate journals in applied linguistics and ESL work (network analysis, natural language processing,

machine learning, and AI-driven language models), applied linguistics programmes can provide researchers with the analytical tools necessary for rigorous and innovative linguistic inquiry in the region.

Methodologically, the participants assessed the practical statistics tasks whereby they performed, interpreted, and reported data analysis using real datasets. The balance between theoretical and practical knowledge, as applied to specific research scenarios, helped them enhance their abilities (Zhang & Han, 2023). Based on the findings, a hybrid course format is also recommended to accommodate doctoral students from diverse regions and favour in-person interactions.

Authentic resources, such as applied linguistics statistics videos, textbooks, journals, books, and academic writing guidelines, enhanced the participants' statistical literacy. For instance, Larson-Hall and Plonsky's (2015) and Norris et al.'s (2015) guidelines were valuable for developing a critical assessment of quantitative studies. *SPSS* and *Langtest* were useful tools for performing quantitative data analyses. *SPSS* produces tables and more descriptive graphs than *Langtest*. However, the participants preferred *Langtest* for its practicality and comprehensible graphs and results. This supports Mizumoto and Plonsky's (2016) advocacy that using *R* in applied linguistics has advantages over *SPSS*, and that *Langtest* is a user-friendly web application that offers an intuitive graphical interface for conducting a wide range of statistical analyses. Further research might explore alternative free software (e.g., *JASP* and *Langtest*) for statistical instruction.

The assessment component boosted the participants' confidence and self-identification of their strengths and weaknesses in statistics. Their positive attitudes toward statistics were fostered by a friendly, supportive, and collaborative teaching, learning, and assessment environment that instilled the importance of statistics for the participants' academic and professional contexts (Zhang & Han, 2023). For future implementations, the course assessment may also incorporate a process-product-

oriented approach through tests and tasks that evaluate participants' progress during the course. Further studies would also benefit from delayed post-testing to provide more robust evidence of long-lasting learning, given the short-term nature of the assessment in the present study. Although pre- and post-intervention reflections and assignments provided useful data on participant learning, a longitudinal approach would offer deeper insights into how statistical literacy evolves over time.

Regarding the introduction of statistics courses in applied linguistics programmes, this study advocates for compulsory statistics courses at both undergraduate and graduate levels, emphasising early exposure and appropriate sequencing of content based on complexity and students' needs (Loewen et al., 2020; Zhang & Han, 2023). Graduate programmes must promote quantitative research and statistical knowledge to form independent researchers (Loewen et al., 2020). At least two or three statistics courses or levels—including essential, intermediate, and advanced statistics—might help teacher-researchers make informed decisions about their research. Other opportunities for applied linguistics researchers to develop statistical knowledge include conference workshops, extracurricular statistical seminars, and quantitative reading groups (Loewen et al., 2020).

The action-research approach implemented in this study facilitated positive change (Burns, 2019), paving the way for future mixed-method studies with larger samples and hands-on experiences through projects. One limitation was the potential for researcher bias, given that the instructor was also the researcher. While steps were taken to mitigate desirability bias—such as triangulating data sources, incorporating external reviewers in data analysis, and employing member checking—the dual role may still have influenced participants' responses. Future research could incorporate external facilitators or co-instructors to further reduce this potential bias. Additionally, while this study offers valuable insights, its findings are based on a limited sample of participants within a specific educational

setting. Expanding the sample size, making case study comparisons, and including diverse institutional contexts would strengthen the generalisability of the results.

In conclusion, the study demonstrated that a tailored 16-week introductory statistics course helps develop the statistical literacies of applied linguistics teacher-researchers. The findings emphasise the importance of early exposure to statistics, recommending compulsory statistics courses at both undergraduate and graduate levels, as well as their strategic placement in the curriculum.

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Appendix: Statistics Course Syllabus

Components	Characteristics
	Statistical methods in applied linguistics research
Goals	1. To familiarise students with statistical methods and tools in applied linguistics quantitative research 2. To perform analyses, select the appropriate method, generate and interpret numerical and visual outputs, and write the report in an academic style 3. To critically evaluate the quality of quantitative research reports
Methodology and materials	The course followed a theoretical-practical approach, requiring both independent and group work. Applied linguistics research articles were used for analyses, samples, and assignments. Ten individual and group tasks were designed for conducting, interpreting, and reporting statistical analyses. *Excel*, *SPSS*, *Langtest*, and *JASP* statistical tools were used.
Assessment	Assignments could be submitted in pairs or individually. Assignment 1: Critical analysis of the report of a quantitative study (30%) Assignment 2: Statistical analysis using a dataset (30%) Assignment 3: Interpretation of data and written report of the results (40%)
Course development	
Week	Activities
1	Introduction to the course and quantitative research (research designs and variables)
2	Descriptive and inferential statistics Reporting descriptive statistics Assumptions
3	Analysis of quantitative reports
4	First synchronous session: review and practice
5	Non-parametric vs. parametric tests Means comparisons: paired-samples *t*-test Analysis, interpretation, report, and alternative non-parametric test
6	Means comparisons: independent samples *t*-test Analysis, interpretation, report, and alternative non-parametric test
7	Second synchronous session: review and practice
8	Means comparisons: one-way ANOVA Analysis, interpretation, report, and alternative non-parametric test
9	Means comparisons: two-way ANOVA Analysis, interpretation, report, and alternative non-parametric test
10	Work and submission of Assignment 1
11	Third synchronous session: review and practice
12	Optional: MANOVA and mixed-effects designs
13	Correlations: analysis, interpretation, report, and native non-parametric test
14	Review and practice
15	Fourth synchronous session: review and practice
16	Post-test and submission of Assignments 2 and 3