SEMINAR WORKSHOP: AN INTERVENTION FOR STATISTICAL ANALYSIS FOR RESEARCH

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ABSTRACT

The study, "Seminar Workshop: An Intervention for Statistical Analysis for Research", aimed to develop a seminar workshop to enhance the statistical proficiency of senior high school students in a coastal school. Using a mixed-method research design, the study involved 38 Grade 12 students and employed a pretest-posttest approach to assess changes in their skills. Instruments included are researcher-made survey questionnaire, pre- and post-tests, proposal evaluation rubrics, and a Focus Group Discussion Interview Guide.
Results showed a significant improvement in statistical analysis after the seminar. The mean scores rose from 9.37 in the pretest to 15.13 in the posttest, with a mean gain 5.76. A paired t-test yielded a t-value of 8.20, confirming statistically significant improvement. The Cohen's d value of 1.45 indicated a large effect size, emphasizing the seminar's impact. Students notably improved in hypothesis testing, sampling techniques, and statistical analysis using both manual methods and software tools like JAMOVI. Qualitative data from focus group discussions revealed that participants found the seminar engaging and practical, with strengths in delivery and interactive sessions. Observers highlighted its role in addressing gaps in textbooks and existing resources. Suggestions for improvement included extending the seminar's duration and incorporating more individual activities. The study concluded that the seminar effectively enhanced statistical skills, combining theoretical and practical learning. Educators and administrators are encouraged to adopt a similar workshop to prepare students for research projects and deepen their understanding of statistical concepts.

Keyword: *data analysis, quantitative research, seminar workshop, statistical analysis*

1. INTRODUCTION

In the Philippines, the K to 12 Curriculum, a 13-year educational program, concludes with two years of Senior High School (SHS), designed to equip students for future careers or higher education [1]. This curriculum includes mandatory courses like Practical Research 1 (Qualitative Research) and Practical Research 2 (Quantitative Research). These courses aim to build essential knowledge and skills necessary for conducting meaningful research.

Despite the curriculum's focus on research development, a significant gap exists in assessing students' research abilities. Santiago and Valtoribio, noted that current evaluation tools are insufficient, prompting their development of a questionnaire to identify areas needing support [2]. Students also struggle to apply research skills in real-world scenarios, suggesting a need for hands-on activities that mimic real-life situations [3]. Without this practical experience, students often struggle to apply their learning effectively, impacting their research education's long-term effectiveness.

One of the biggest challenges in teaching research skills, especially in Probability and Statistics, is the impact of the COVID-19 pandemic. Gratela, Dio, and Deri (2023) found a reduction in learning competencies for these subjects in K to 10, creating gaps, particularly in Grade 9 where no lessons were delivered [4]. This lack of foundational knowledge often leaves Senior High School students underprepared for quantitative research tasks. Ebio and Deri (2023) found a similar issue in Grade 8 Mathematics, with some statistics topics entirely omitted [5].

Ultimately, these gaps in statistical knowledge and preparation directly affect students' ability to perform well in research. Without a solid understanding of statistical tools and concepts, students often struggle to complete their research projects on time and to the expected standard. This delay and lack of rigor in their research output highlight the specific problem this study addresses: the critical need to enhance Senior High School students' statistical proficiency for effective research.

1.1 Significance of Statistical Skills in Research

In today's data-driven world, statistical literacy has become an essential skill, enabling students to make informed decisions across various fields [6]. Statistics fundamentally underpins study design, data analysis, and result interpretation; however, a weak grasp of basic statistical concepts can jeopardize research outcome validity [7]. Mastering basic statistical tools is crucial for producing accurate and honest data analysis [8]. For Senior High School students, acquiring statistical knowledge is increasingly critical, as many struggle with core concepts despite recognizing its importance [9].

The growing digitization of society amplifies the need for data literacy, with research highlighting effective teaching strategies like authentic problem-solving and real-world data integration [10]. Beyond analysis, a holistic approach to data literacy, particularly through project-based learning, is needed, as students often struggle with proper data collection [11]. Teachers also play a critical role in fostering students' statistical literacy; teacher preparation programs are crucial to equip educators with effective strategies for teaching these concepts [12]. Teachers require appropriate support to confidently guide students in interpreting and analyzing data, ensuring future readiness as data becomes more central in society.

1.3 Students' Performance in Research

The research outputs of Grade 12 students at Danao National High School were evaluated using structured tools [13], yet significant challenges hindered project completion. Students notably struggle with certain aspects of their research, particularly data analysis, statistical reasoning, and applying statistical tests. They frequently encounter difficulties in selecting appropriate tests and presenting data correctly. Advanced statistical tests often overwhelm them, leading to delays or subpar outputs.

While comparative studies, such as Servado's (2024), show Grade 12 STEM students display superior research capabilities compared to Grade 11students [14], Kadusale et al. (2024) revealed many Grade 12 students still struggle with identifying and collecting relevant data, emphasizing the need for contextualized training [15]. This insufficient mastery of statistical reasoning and problem-solving is essential for rigorous research [16]. Consequently, research performance is compromised, with many students unable to meet expected project standards.

1.4 Factors Affecting Students' Performance in Research

A person's attitude significantly impacts knowledge acquisition and application [17], with positive attitudes enhancing communication, engagement, and analytical thinking, especially in statistics [18]. Conversely, anxiety negatively impacts students' cognitive processes and academic performance in statistics, highlighting the importance of anxiety-reducing teaching methods [19]. Time constraints also hinder research completion due to various activities and limited focus time, with poor time management impacting academic performance [20].

Finally, teachers' expertise is crucial; inadequate student support often stems from teachers handling subjects outside their specialization, leading to insufficient guidance in complex statistical procedures [21]. Out-of-field teaching has been shown to negatively affect both teacher effectiveness and student comprehension [22]. Furthermore, teaching outside one's specialization can lead to teacher burn-out and hinder the learning process [23]. The specific case at Danao National High School, where an English major with limited quantitative data analysis background handles both Practical Research 1 and 2, exemplifies this challenge, posing significant obstacles to enhancing students' crucial statistical skills for high-quality quantitative research outputs.

These combined challenges, like statistics anxiety, time constraints, and out-of-field teaching, emphatically highlight the necessity for targeted interventions to enhance students' research performance. Implementing structured

programs and specialized training can significantly improve completion rates and quality of research projects among senior high school students. Fostering positive attitudes toward statistics, proactively addressing anxiety, improving time management, and ensuring teachers possess specialized knowledge will better prepare students to navigate the complexities of Practical Research 2 and produce high-quality outputs. Addressing these multifaceted factors is crucial to strengthening educational support systems and comprehensively promoting student success in their research endeavors.

Given these identified challenges, there is an urgent need for targeted interventions. Motivated by this situation, the researcher aimed to evaluate the statistical skills of Grade 12 students to identify gaps and design a Seminar Workshop in Statistical Analysis. This work-shop will address existing deficiencies and enhance students' proficiency in applying statistical concepts to Practical Research 2 projects. These efforts align with the Sustainable Development Goal (SDG) 4, which emphasizes ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. By addressing gaps in teacher expertise and student competencies, this initiative contributes to fostering a quality learning environment, equipping students with the skills necessary for academic and professional success, and adding to the existing literature on effective interventions.

1.5 Interventions in Improving Students' Performance

Students must improve their knowledge and skills to prosper in today's technology-driven world. Equipping learners for success requires educators to examine flaws in the educational system. Jaudinez (2019) highlighted obstacles in teaching senior high school mathematics, including curriculum topic overlap and insufficient instructional resources, recommending efficient topic discussion and investment in licensed software [24]. Obrial and Lapinid (2020) stressed enhancing teaching methodologies for statistical reasoning and problem-solving, advocating for incorporating real-world data and fostering active learning environments [25]. Patricio (2022) found that despite improving research and writing abilities, and strong collaborative skills, students' research output quality was poor, highlighting the need for interventions [26].

Lucas, Bernal, and Lucas (2021) discovered successful approaches in teaching Practical Research focusing on mentorship, structured activities, and teamwork, which will serve as the basis for developing this data analysis seminar workshop aimed at improving students' statistical skills [27]. Teachers within the Department of Education should also enhance their skills to deliver transformative classroom instruction, creating contextualized learning activities. Lago and Ortega-Dela Cruz (2021) showed that contextualized teaching positively impacted students' attitudes and performance in statistical hypothesis testing, advocating for strategies like real-world scenarios and collaborative activities that align with the suggested program's objectives [28]. Tabuena and Hilario (2021) considered data analysis the most complex stage of research, emphasizing systematic approaches and suggesting diverse data analysis techniques to boost quality, aligning with the research's objective of enhancing students' statistical proficiency [29].

The study aimed to develop an intervention on statistical analysis for research of senior high school students in a coastal school. Specifically, it aimed to 1) determine the perceived skills of the Grade 12 students in Statistical Analysis, 2) design and develop an intervention on Statistical Analysis for Research, 3) validate the intervention on Statistical Analysis for Research, 4) test the effectiveness of the intervention on Statistical Analysis for Research, and 5) identify the feedback of the participants on the intervention.

2. METHODOLOGY

This study employed a Mixed-Methods Research Design, integrating both quantitative and qualitative approaches to comprehensively investigate the perceived statistical skills of Grade 12 students at Danao National High School for the School Year 2024-2025 and to evaluate the effectiveness of a developed seminar workshop aimed at enhancing these skills.

2.1 Quantitative Phase

The quantitative phase utilized a Pre-Experimental Design, specifically the One-Group Pretest-Posttest Design. This involved a single group of participants, Grade 12 students, who underwent a pre-test to assess baseline statistical skills, participated in a seminar workshop intervention, and then completed a post-test to measure changes. The

study setting was Danao National High School, a coastal school in the Philippines. The sample consisted of all 38 Grade 12 students (21 male, 17 female) enrolled in the General Academic Strand (GAS, n=10) and TVL-Cookery strand (n=28) for the academic year 2024-2025. The entire Grade 12 population was selected as they represent the most appropriate candidates for the study.

The research instrument for the quantitative phase was a researcher-made survey questionnaire assessing students' self-reported proficiency in various statistical concepts. It covered topics such as sampling procedures, frequency distribution tables, measures of central tendency and spread, data presentation and interpretation, hypothesis formulation, understanding Type I and Type II errors, and various statistical tests (t-tests, ANOVA, Chi-square, Pearson and Spearman correlation, and regression analysis). Instrument development was informed by K to 12 curriculum guides for Practical Research 2 (Quarter 2), which emphasize quantitative research design, sampling, instrument development, and data analysis procedures. The questionnaire underwent validation by 10 experts (Master Teachers and Teacher III teaching Probability and Statistics and Practical Research 2) using a Survey Validation Rating Scale. Feedback from validators improved the questionnaire, and a pilot test with Grade 12 GAS students at San Francisco National High School yielded a Cronbach's alpha of 0.84, indicating good internal consistency.

To measure students' statistical skills before and after the seminar, an adopted pre-test and post-test consisting of 30 multiple-choice questions was used. The test items were aligned with a Table of Specifications and adapted from validated self-learning modules in Practical Research 2 and Statistics and Probability from the Department of Education - NCR, Division of Pasig City. The test assessed three key learning competencies: describing sampling procedures and samples (5 items), illustrating key concepts in hypothesis testing (5 items), and applying statistical techniques for data analysis (20 items).

2.2 Qualitative Phase

The qualitative phase involved a focused group discussion with a subset of 24 students, selected using simple random sampling from the 38 seminar participants, to gather their firsthand experiences with the seminar workshop, including what they found most valuable and engaging. Additionally, three observers (Master Teachers and Teacher III with MAEd in Mathematics), purposively selected for their expertise in teaching Probability and Statistics and Practical Research 2, provided feedback on the seminar's content, delivery, and overall effectiveness.

2.3 Intervention

The intervention was a seminar workshop on Statistical Analysis for Research, designed and developed based on the self-perceived skill gaps identified in the initial survey. The content of the seminar was aligned with the K to 12 curricula for Practical Research 2. The seminar was facilitated by three resource speakers from different schools and a university over three days (November 6-8, 2024). The Training Proposal Evaluation Rubric, adopted from the Maryland State Department of Education, was used by five expert validators (Master Teacher II with PhD in Mathematics Education, Master Teacher I pursuing PhD, Secondary School Principal I pursuing PhD in Mathematics, Master Teacher I pursuing PhD in Mathematics Education, and Teacher III with MAEd in Mathematics and IT expertise) to assess the seminar workshop's content, organization, and presentation before implementation. The rubric required a minimum score of 80 points for approval.

2.4 Data Collection Procedures

Formal approval was obtained from the School Principal of Danao National High School, followed by consent from the students and their Class Adviser. The researcher-made survey questionnaire was administered on August 9, 2024. The validated seminar workshop was conducted from November 6 to 8, 2024. The pre-test was administered on November 5, 2024, and the post-test and focus group discussions were conducted on November 8, 2024.

2.5 Data Analysis

Quantitative data from the self-reported statistical skills survey were analyzed using descriptive statistics (means and standard deviations) and interpreted based on a five-point Likert scale. The effectiveness of the seminar workshop was evaluated by comparing pre-test and post-test scores using a paired t-test and Cohen’s D for effect size, with

proficiency levels interpreted based on DepEd Order No. 31, series of 2012. Qualitative data from the focus group discussions and observer feedback underwent thematic analysis to identify common themes related to the seminar's impact and participant experiences.

3. RESULTS

3.1 Perceived Statistical Skills of the Grade 12 Students:

Table 1 summarizes the self-reported proficiency levels of Grade 12 students in various statistical skills. The findings indicate that students perceived their skills as "Beginning" in performing different sampling procedures (Mean=1.75, SD=0.57), explaining the difference between Type I and Type II errors (Mean=1.63, SD=0.71), and solving t-tests (independent: Mean=1.09, SD=0.30; dependent: Mean=1.03, SD=0.18), ANOVA (Mean=1.00, SD=0.00), Chi-square (Mean=1.06, SD=0.25), Pearson correlation coefficient (Mean=1.00, SD=0.00), Spearman rank correlation coefficient (Mean=1.00, SD=0.00), and regression analysis (Mean=1.00, SD=0.00).

Students reported "Developing" proficiency in constructing frequency distribution tables (Mean=2.25, SD=0.98) and formulating research hypotheses (null and alternative) (Mean=2.03, SD=0.86). In skills categorized as "Approaching Proficiency," students included solving measures of central tendency (Mean=2.78, SD=1.07), solving measures of spread (Mean=2.66, SD=0.87), presenting data in tabular or graphical forms (Mean=2.63, SD=0.87), and interpreting data in tabular or graphical forms (Mean=2.66, SD=0.94).

Table -1: Summary Results on Self-reported Statistical Skills Proficiency

Indicator	Mean	SD	Verbal Interpretation
I can…			
perform different sampling procedures.	1.75	0.57	Beginning
construct frequency distribution table.	2.25	0.98	Developing
solve measures of central tendency (Mean, Median).	2.78	1.07	Approaching Proficiency
solve measures of Spread (Variance, Standard deviation)	2.66	0.87	Approaching Proficiency
present data in tabular or graphical forms.	2.63	0.87	Approaching Proficiency
interpret data in tabular or graphical forms.	2.66	0.94	Approaching Proficiency
formulate research hypotheses (null and alternative).	2.03	0.86	Developing
explain the difference between Type I and Type II errors.	1.63	0.71	Beginning
solve t-tests for independent samples.	1.09	0.30	Beginning
solve t-tests for dependent samples.	1.03	0.18	Beginning
solve Analysis of Variance (ANOVA).	1.00	0.00	Beginning
solve Chi-square.	1.06	0.25	Beginning
solve Pearson correlation coefficient.	1.00	0.00	Beginning
solve Spearman rank correlation coefficient.	1.00	0.00	Beginning
perform regression analysis.	1.00	0.00	Beginning

3.2 Design and Development of a Seminar-Workshop as an Intervention on Statistical Analysis for Research

The design of the seminar workshop was theoretically grounded in the Constructivist Learning Theory, Socio-Cultural Theory, and the Theory of Statistical Reasoning and Literacy. The workshop utilized the LAAW format (Lecture, Activity, Assessment, Wrap-Up) and was aligned with the Department of Education's Learning and Development (L&D) system and the ADDIE model. The six-session workshop, delivered over three days, covered

foundational to advanced statistical concepts with hands-on application using Jamovi software. Key features included a data-driven basis, comprehensive content coverage, emphasis on collaboration, and alignment with educational objectives.

3.3 Validation of the Seminar-Workshop in Data Analysis for Practical Research Projects

This section outlines the validation process for the seminar workshop along Organization, Content, and Presentation. Five validators were involved in the assessment, with each evaluating the workshop based on specific criteria. The Organization category was rated on a scale of 30, Content on a scale of 45, and Presentation on a scale of 25, with a total score of 100. The validators' ratings provide a comprehensive evaluation of the seminar workshop, offering insights into its strengths and areas for potential improvement.

Table -2: Summary Results on the Validation of Seminar-Workshop along Organization

Criteria	V1	V2	V3	V4	V5	Average
Written materials including handouts, PowerPoint slides, trainer note pages, planning template, etc., use quality writing, grammar, spelling, and mechanics.	4	5	5	5	5	4.8
Materials consistent with DepEd-recommended font style, size, color, bullet points, slide numbers, readability.	5	5	5	4	5	4.8
Maintains consistency throughout proposal description, learning objectives, content, and methods.	4	5	5	5	5	4.8
Specifies realistic and measurable learning objectives (minimum of 3; maximum of 5, aligning with competency identifiers).	5	5	4	5	5	4.8
Includes 3 reputable references/resources cited within 5-7 years, appropriate as training content foundation.	5	5	4	4	4	4.4
Timeline allows adequate time for content, activities, assessment, and evaluation.	5	5	4	4	4	4.4
Total	28	30	27	27	28	28

Table 2 provides an evaluation of the seminar materials based on organizational criteria. Each criterion was scored on a scale of 1 to 5, and the average scores highlight areas of strength and opportunities for improvement. The seminar materials excelled in several areas, earning the highest average score of 4.8 across four key indicators. These include the quality of written materials, which scored highly for grammar, spelling, and mechanics, as well as the consistency of materials, ensuring alignment between proposal descriptions, learning objectives, content, and methods. The specification of clear, realistic, and measurable learning objectives also stood out, as did the adherence to DepEd-recommended formatting guidelines, such as font style, size, and readability. These scores highlight the seminar's strong focus on professionalism, clarity, and alignment with educational standards. However, two criteria received slightly lower average scores of 4.4, indicating areas for improvement. The inclusion of three reputable references cited within the last 5-7 years fell short of the highest mark, suggesting there's room to enhance the quality or relevance of sources. Additionally, the timeline for content delivery, activities, and assessments was rated slightly lower, hinting those adjustments could be made to optimize the schedule.

Table 3: Summary Results on the Validation of Seminar-Workshop along Content

Criteria	V1	V2	V3	V4	V5	Average
Training title uses strength-based language and appropriately refers to the subject(s) of training.	5	5	4	5	5	4.8
Training description clearly explains content, need, and benefits to participants.	5	5	5	4	4	4.6
Training proposal provides sufficient information specific to content and objectives.	5	5	5	4	4	4.6
Incorporates learning objectives and methods to measure learning.	5	5	5	5	5	5
Addresses special needs, including adaptations, modifications, inclusionary practices, and person-first language.	4	5	5	4	5	4.6
Addresses cultural sensitivity and diversity for participants and the population they serve.	4	4	5	5	3	4.2
Addresses challenges faced by participants, such as financial constraints, academic pressure, and mental health concerns.	4	4	5	4	5	4.4
Addresses targeted Core of Knowledge areas.	5	5	5	5	5	5
Reflects current national standards/guidelines, DepEd regulations, and best practices.	4	3	5	4	5	4.2
Total	41	41	44	40	41	41.4

Table 3 evaluates the content of a training proposal across various criteria. The highest-scoring indicators, each with a perfect average of 5, demonstrate the proposal's strengths. These include the incorporation of learning objectives and methods to measure learning, addressing targeted Core of Knowledge areas, and ensuring a training title that uses strength-based language relevant to the subject. These scores reflect the proposal's strong alignment with educational standards and its focus on measurable outcomes and clarity in its objectives.

Conversely, the criteria with the lowest scores highlight areas needing improvement. The inclusion of cultural sensitivity and diversity for participants and the population they serve received an average of 4.2, suggesting the need for greater emphasis on this aspect. Similarly, reflecting current national standards, DepEd regulations, and best practices scored 4.2 on average, indicating room to better integrate these elements into the proposal.

Table 4: Summary Results on the Validation of Seminar-Workshop along Presentation

Criteria	V1	V2	V3	V4	V5	Average
Provides quality, user-friendly materials/handouts with reference information.	5	5	5	5	4	4.8
Content and methods appropriate for topic and training length.	5	4	4	4	5	4.4
Includes objectives and summary/wrap-up in slides.	5	5	5	5	5	5
Content connects to practical application and meets participant needs.	5	5	5	4	5	4.8
Methods promote active learning and reflect varied learning styles.	5	5	4	5	5	4.8
Total	25	24	23	23	24	23.8

Table 4 evaluates the presentation aspect of the training materials. The highest-scoring indicator, with a perfect average of 5, is the inclusion of objectives and a summary/wrap-up in the slides. This reflects a well-structured presentation that ensures clarity and provides participants with a clear understanding of the training goals and conclusions.

On the other hand, the lowest-scoring criteria, with averages slightly below the maximum, include the appropriateness of content and methods for the topic and training length, which scored 4.4 on average, and the provision of quality, user-friendly materials/handouts with reference information, which averaged 4.8. These scores indicate that while the presentation is strong, there is minor room for enhancement in aligning content with the duration and ensuring handouts fully meet user needs.

Table 5: Summary Results on the Validation of the Seminar-Workshop on Three Categories

Category	Validator 1	Validator 2	Validator 3	Validator 4	Validator 5	Average
Organization (30)	28	30	27	27	28	28
Content (45)	41	41	44	40	41	41.4
Presentation (25)	25	24	23	23	24	23.8
Total (100)	94	95	94	90	93	93.2

Table 5 shows the scores given by each validator and calculates the average scores for each category. The Organization category received high scores, averaging 28.0 out of 30, indicating well-structured materials and alignment with objectives. The Content category averaged 41.4 out of 45, reflecting strong relevance and sufficiency of information. Presentation averaged 23.8 out of 25, showcasing clarity, practical application, and active learning strategies.

The total average score is 93.2 out of 100. According to the training evaluation rubric, a training proposal must meet a minimum score of 80 to be approved. All scores exceeded the required minimum, confirming that the workshop meets the standards for approval.

3.3 Effectiveness of the Seminar-Workshop as an Intervention

Table 6: Summary Results on the Pretest and Posttest Scores of students in the Seminar workshop in Data Analysis for Practical Research Projects

Type of test	Mean	Mean gain	Standard Deviation	t-value	critical t-value	Interpretation	Cohen's *d*	Effect Size
Pretest	9.37	5.76	3.07	8.2	±2.03	Significant	1.45	Large Effect Size
Posttest	15.13		4.73					

Table 6 provides a statistical summary of the pretest and posttest scores of students who participated in a seminar workshop on data analysis for practical research projects. The pretest had a mean score of 9.37 with a standard deviation of 3.07, representing the baseline performance of the students before the intervention. Following the seminar, the posttest mean score increased to 15.13, with a standard deviation of 4.73, indicating a significant improvement in performance. The mean gain of 5.76 highlights the effectiveness of the seminar in enhancing students' knowledge and skills.

A paired t-test was conducted to evaluate the statistical significance of the improvement, yielding a t-value of 8.20. This value far exceeds the critical t-value of ±2.03, confirming the result's significance at the α=0.05 level. Furthermore, the effect size, measured by Cohen's *d*, was calculated to be 1.45, indicating a large effect of the seminar on the students' performance.

3.4 Feedback and Insights Gathered from the Participants

The thematic analysis of the focus group discussion with the Grade 12 students revealed the following key themes: *Enhanced Understanding of Statistical Concepts:* Students reported a better grasp of the statistical topics covered in the seminar. *Effective Use of Technology, Engaging Sessions*: Participants found the use of Jamovi software and the interactive nature of the sessions to be beneficial and engaging. *Extended Duration, Individual Activity:* Some students suggested a longer duration for the seminar and more opportunities for individual practice.

3.5 Feedback and Insights Gathered from the Observers

The thematic analysis of the focus group discussion with the observers highlighted the following themes: *Relevant and Practical Content with Skilled Facilitation Using Various Teaching Methods:* Observers noted the relevance and practicality of the seminar content and the effective teaching methods employed by the facilitators. *Integration of More Interactive, Hands-On Activities, Alternative Tools, and Engagement Strategies:* Observers suggested incorporating even more interactive activities, exploring alternative statistical tools, and employing diverse engagement strategies. *Seminar Addresses Essential Skills and Provides Additional Topics Essential for Practical Research 2:* Observers recognized that the seminar addressed crucial statistical skills and included additional relevant topics for Practical Research 2.

In summary, the results indicate that the developed seminar workshop was validated by experts, significantly improved the statistical skills of the Grade 12 student participants, and received positive feedback regarding its content and delivery. Participants suggested minor adjustments related to duration and individual practice, while observers offered recommendations for further enhancing interactivity and exploring alternative tools.

4. DISCUSSION

4.1 Proficiency of Grade 12 Students on Statistical Analysis

The self-assessment of Grade 12 students revealed a "Beginning" level of proficiency in most statistical competencies, especially in advanced areas such as hypothesis testing and statistical analysis techniques. This was corroborated by their poor performance on the 30-item test, particularly in sampling procedures, hypothesis formulation, and various statistical tests (t-tests, ANOVA, Chi-square, correlation, regression). Students themselves indicated a lack of prior instruction in some of these areas, attributing it to the curriculum coverage in their Grade 11 Probability and Statistics subject. This perception is consistent with the study by Ebio (2024), which concluded that few teachers have sufficient time to cover all required learning competencies within a quarter [30].

While students reported slightly higher proficiency in basic concepts like frequency tables and central tendency, their test performance showed difficulty in applying this knowledge to more complex tasks such as statistical hypothesis testing and data analysis. This discrepancy between perceived and actual proficiency highlights the need for targeted instructional strategies focusing on foundational statistical knowledge, hypothesis testing, data analysis, and statistical software use. The findings underscore the importance of interventions like seminars and hands-on training to enhance students' statistical skills for advanced research applications, aligning with the study by Morata (2024), which emphasized the importance of targeted interventions in developing statistical skills for practical research [31].

4.2 Features of The Seminar-Workshop

The Statistical Skills Enhancement Workshop is structured to ensure comprehensiveness, covering both fundamental and advanced topics while integrating Jamovi as a user-friendly analysis tool. It provides diverse learning resources like session guides, presentations, and QR-accessible handouts, which enhance engagement and cater to various learning styles [32]. Pre-tests and post-tests are used to assess learning progress, and participant feedback is gathered through Focus Group Discussions (FGDs), a valuable method for in-depth insights and collaborative idea generation [33] [34].

A key feature of the workshop is its data-driven approach, unlike generic programs, which involves making decisions based on data analysis and interpretation [35]. The workshop's design was informed by survey results indicating "Beginning" proficiency in specific statistical topics, ensuring a targeted intervention that aligns content with identified gaps. This approach ensures relevance and direct applicability for participants, supported by research emphasizing data-driven decision-making in education for improving learning outcomes and tailoring content [36]. The integration of user-friendly statistical tools like Jamovi also facilitates accessibility and reduces the learning curve [37].

Collaboration is strongly promoted through group activities in all learning sessions, fostering teamwork, problem-solving skills, and communication, leading to increased self-esteem and confidence [38]. The workshop also incorporates resource speakers from different fields, promoting interdisciplinary collaboration that brings valuable insights and inspires participants [39] [40].

Furthermore, the workshop is aligned with educational objectives, specifically supporting DepEd's goal of enhancing statistical skills to improve research competencies. This aligns with the Basic Education Research Fund (BERF), which promotes a culture of research and evidence-based decision-making [41], and DepEd's Research Management Guidelines and Quality Control Checklist [42], which emphasize statistical literacy and high-quality research. By integrating these elements and leveraging research-backed strategies, this seminar delivers a targeted, practical, and impactful learning experience, significantly outperforming generic or theory-focused programs.

Table 7: Key Features of the Statistical Skills Enhancement Workshop

Key Feature	Description
Data-Driven Basis	Based on survey results revealing "Beginning" proficiency in statistical topics like t-tests, ANOVA, Chi-square, regression, and Type I and II errors.
Comprehensiveness	Covers fundamental and advanced topics, including hypothesis testing, regression, correlation; Follows a systematic learning format (LAAW); Introduces Jamovi as a user-friendly tool for data analysis; Provides guides, presentations, and QR-accessible handouts; Provides Pre-tests and post-tests to assess knowledge gained and skills before and after the workshop; Feedback actively gathered through participant focus groups (FGDs).
Collaboration	Provides group work that promotes collaboration with the participants and incorporates resource speakers from different fields.
Aligned with Educational Objectives	Supports DepEd's goal of enhancing statistical skills for better research competencies.

4.3 Validity of the Seminar Workshop as an Intervention on Statistical Analysis for Research.

The Seminar-Workshop in Data Analysis for Practical Research Projects demonstrated strong validity as an intervention, achieving an impressive average score of 93.2 out of 100 during its evaluation by five experts using the Training Proposal Evaluation Rubric [43]. This high score, significantly above the 80-point approval threshold, was consistent across its organization, content, and presentation.

The workshop's organization was highly commended for its quality of writing, consistent formatting, and clear, measurable learning objectives (each averaging 4.8/5), reflecting meticulous planning emphasized by Guskey (2014) [44]. While areas like reputable references and timeline allocation (both 4.4/5) were identified for minor improvement, aligning with Sergiadis et al.'s (2024) focus on intentionally developed educational resources, the overall structural integrity was strong [45].

Similarly, the content received high marks (41.4/45), praised for its measurable learning objectives, strength-based language, and alignment with Core of Knowledge areas, consistent with Freeman et al.'s (2014) emphasis on impactful learning strategies [46]. Opportunities for improvement in cultural sensitivity and alignment with national standards (both 4.2/5) were noted, underscoring the importance of inclusivity [47] and relevance in training [48].

The presentation of materials was also strong (23.8/25), with high scores for clarity, practicality, and the effective promotion of active learning, further validating Freeman et al.'s (2014) findings on engaging strategies [49]. Minor refinements were suggested for aligning methods with training duration and enhancing handouts.

4.4 Enhancing the Student's Statistical Analysis through a Seminar Workshop

Beyond its strong validation, the seminar proved highly effective in enhancing students' statistical analysis skills. A significant improvement was observed in post-test scores (mean = 15.13, SD = 4.73) compared to pre-test scores (mean = 9.37, SD = 3.07), with a mean gain of 5.76. A paired t-test (t-value = 8.20, critical t-value = ±2.03) indicated this improvement was statistically significant. Furthermore, a Cohen's d effect size of 1.45 signifies a large and practically meaningful impact, firmly establishing the seminar as a valuable educational intervention for improving data analysis skills. These findings resonate with Castillo's (2024) research, which also highlighted the effectiveness of integrating evidence-based strategies, such as "Share and Model Concepts" and "Nurturing Metacognition," in significantly improving students' statistical literacy and critical thinking skills [50].

4.5 Students' and Observers' Insights on the Seminar Workshop

A thematic analysis of feedback from both students and observers involved in the seminar workshop on statistical analysis for Grade 12 students in Practical Research 2 revealed the seminar's impact on enhancing statistical understanding, the effectiveness of teaching methods, and technology application, alongside areas for refinement.

Students consistently reported an enhanced understanding of statistical concepts, frequently highlighting the value of learning topics such as hypothesis testing, t-tests, ANOVA, and sampling techniques. For instance, one student emphasized the long-term utility of interpreting statistical data for current and future research. Other students specifically valued hypothesis testing, specifically the understanding when to reject or fail to reject the null hypothesis in manual computations and grasping the applications of t-tests (paired vs. independent) and ANOVA for comparing groups. Exposure to sampling techniques, including Slovin's formula and stratified sampling, was also a significant takeaway, enhancing their understanding of representative sampling. This improved grasp of fundamental statistical methods demonstrates the seminar's effectiveness in bridging knowledge gaps and improving statistical literacy, mirroring Castillo's (2024) findings on how evidence-based strategies, like modeling concepts and fostering metacognition, significantly enhance students' statistical comprehension [51].

The effective use of technology, particularly laptops and JAMOVI software, emerged as a critical strength. Students lauded JAMOVI for its convenience and efficiency in statistical computations, which significantly aided their research projects. This integration of user-friendly tools not only simplifies complex calculations but also fosters independent learning and confidence in data analysis, aligning with Owan and Bassey (2018), who found computerized techniques to be faster and more efficient than manual methods, thereby enhancing the learning experience [52]. The blend of traditional and technology-driven approaches ensured diverse learning styles were accommodated.

Students also appreciated the clarity and structure of the seminar's engaging sessions. Many highlighted how well-explained content and clear delivery solidified their understanding of complex concepts. The practical application of topics through activities allowed immediate application of learning, reinforcing comprehension. The involvement of professional speakers was a significant factor, as they actively involved participants through group activities and discussions, fostering a participatory learning atmosphere. This interactive and participatory approach significantly enhances engagement and comprehension in statistical education, consistent with Freeman et al.'s (2014) research demonstrating that active learning strategies improve student performance by increasing engagement and comprehension [53].

Despite overwhelmingly positive feedback, students offered constructive suggestions for improvement. A common recommendation was to extend the seminar duration, with one student suggesting a five-day format to allow more in-depth learning, especially for those who learn at a slower pace. This highlights the need for paced learning to accommodate diverse learning speeds, aligning with studies advocating for extended learning opportunities [54]. Another prevalent suggestion was to incorporate individual activities, as some students observed unequal participation in group tasks, with members over-relying on leaders. Individual assessments could ensure

accountability and more accurately gauge each participant's understanding. Lastly, students noted the need for logistical improvements, such as selecting venues with fewer distractions, to enhance focus and ensure participants could fully concentrate on the content. Overall, students found the seminar an effective tool for acquiring essential, immediately applicable data analysis skills, praising its balance of theory and practice, engaging methods, and accessible resources.

Thematic analysis of the observers' feedback underscored the relevance and practical content of the seminar, coupled with its skilled facilitation. Observers highlighted the comprehensive content, particularly the focus on statistical tools and their application in research. They noted the enhancement of participants' learning through exposure to statistical treatments and credited the expertise of the speakers for the seminar's effectiveness. The simplicity and relevance of the content, supported by varied media and relatable examples, were also praised. The proficient use of multiple languages by the speakers to facilitate learning was an additional strength. These observations imply that a well-structured seminar workshop with expert facilitation and real-world applications significantly enhances participants' comprehension and engagement in statistical learning, resonating with Long and Koehler (2024), who emphasized the role of expert instructors in fostering deeper understanding through content expertise and cognitive congruence [55], and Chetan Kumar et al. (2021), who underscored the value of engaging delivery methods and accessible examples [56].

Observers also provided constructive suggestions for enhancing the seminar, emphasizing the integration of more interactive hands-on activities, alternative tools, and engagement strategies. They recommended providing participants with laptops and training in software like Excel in addition to JAMOVI, to broaden technological competence, aligning with Stemock and Kerns (2019), who found that exposure to multiple software tools enhances statistical understanding [57]. Suggestions included incorporating more hands-on exercises and introducing alternative apps accessible on personal devices, which aligns with Tiamuh's (2020) meta-analysis on the effectiveness of integrating technology and interactive activities [58]. One observer proposed implementing a reward system to increase student engagement, a suggestion supported by Wong and Thomson (2014), who found that reward systems can enhance student motivation and engagement when carefully designed [59].

Finally, all three observers unanimously recommended the dissemination of the seminar to other schools, recognizing its ability to address essential skills and provide additional topics crucial for Practical Research 2. They highlighted its significance for senior high school students struggling with selecting and applying appropriate statistical tools. They suggested re-echoing the seminar with more examples and activities to enhance its comprehensiveness, noting that it fills gaps in existing DepEd textbooks and provides practical knowledge essential for quantitative research. This aligns with Nolan and Temple Lang's (2015) findings on how well-designed seminars and authentic data workshops improve students' understanding of data analysis through practical engagement [60]. This strong endorsement underscores the seminar's potential to bridge significant knowledge gaps in data analysis education and serve as a valuable model for broader implementation, especially considering challenges like the lack of proper training and materials in subjects like Media and Information Literacy in Philippine senior high schools, as identified by Bautista (2021) [61].

4. CONCLUSIONS AND RECOMMENDATIONS

The study concluded that Grade 12 students initially demonstrated a "Beginning" level of proficiency in crucial statistical concepts, highlighting a need for targeted instructional support. To address this, it is recommended that future assessments incorporate comprehensive pre-assessment tools to accurately gauge students' skill levels and tailor interventions accordingly.

A structured seminar workshop, integrating theoretical knowledge with hands-on application of statistical software, was developed and found to be effective. Future iterations should enhance its impact by including real-world case studies, industry-relevant datasets, and interactive digital resources, while also adapting dynamically based on pre-assessment results.

The validation process affirmed the seminar's effectiveness through positive feedback from participants and observers. To further refine this process, future seminars should involve a more diverse panel of validators.

Post-test results indicated significant improvements in students' statistical proficiency. To sustain these outcomes, research teachers should integrate key seminar activities into their regular lesson plans, and schools should consider institutionalizing similar workshops with adequate resources and extended durations.

Participants provided valuable feedback, suggesting extending session durations, incorporating individual assessments, and securing distraction-free venues. Future seminars should consider these suggestions by offering more time for in-depth learning, exploring alternative statistical tools, implementing structured individual assessments, and ensuring conducive learning environments.

For future research, longitudinal studies are recommended to assess the long-term impact of the seminar. Expanding the study to different schools and educational settings would also provide a broader understanding of its effectiveness. Implementing these recommendations can contribute to the continuous improvement of statistical education.

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