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Improving Statistical Literacy among Health Students through Web-Based Tools: A Practical Case with Statistics Kingdom

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Abstract

In health education, particularly at the undergraduate level, students are often required to conduct research projects involving statistical analysis. However, many students struggle with the technical demands of conventional statistical software, such as SPSS or PSPP, due to their complexity, high system requirements, and the need for installation. These tools are often overqualified for the basic statistical tasks that health students typically need, such as descriptive statistics, hypothesis testing, and simple inferential analyses. To address this gap, this paper introduces and evaluates "Statistics Kingdom," a free, web-based statistical analysis tool that enables users to conduct essential statistical procedures directly from a browser, without any software installation. The platform offers an intuitive user interface and a comprehensive suite of statistical tests, making it especially suitable for students and novice researchers. Through a practical case example—a paired t-test examining changes in upper arm circumference in pregnant women before and after a nutritional intervention—this study demonstrates the platform's functionality, ease of use, and effectiveness in supporting educational outcomes. In addition to facilitating data analysis, "Statistics Kingdom" provides supplementary support services, including the ability to consult with the website's statistical experts via email. This feature enhances students' learning experiences by providing a channel for personalized guidance. The paper argues that web-based tools like "Statistics Kingdom" can democratize access to statistical learning, reduce barriers to research participation, and improve statistical literacy among health students. Educators are encouraged to integrate such tools into research methodology and biostatistics instruction to enhance student engagement and confidence in quantitative research.

Keywords: *Statistics Kingdom, Statistical analysis, Web-based tool, Health education, Quantitative research*

1. Introduction

In today's evidence-based healthcare environment, the ability to conduct and interpret quantitative research is increasingly essential for health professionals. As part of their training, undergraduate and diploma-level health sciences students are typically required to complete research projects that involve statistical analysis. These activities aim not only to develop analytical thinking but also to prepare students to become competent practitioners capable of evaluating and applying research findings in clinical settings [1] However, acquiring statistical literacy remains a significant challenge for many health students. While

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statistics is a core component of health education curricula, students often struggle with abstract concepts, data handling, and the use of statistical software tools [2]. Traditional statistical packages such as IBM SPSS or R offer advanced capabilities but are not always student-friendly. These programs may require installation, steep learning curves, and computing resources that are not accessible to all learners [3]. Furthermore, for the purposes of student research, which typically involves basic analyses such as descriptive statistics, t-tests, and correlation analyses, these professional-grade tools are often unnecessarily complex.

In response to these challenges, web-based statistical analysis tools have emerged as viable alternatives. These platforms offer accessibility, ease of use, and mobility—benefits that align well with the needs of modern learners. One such platform, "Statistics Kingdom," provides a wide range of statistical procedures through a browser-based interface, without the need for installation or technical configuration. The tool allows students to enter data, run statistical tests, and interpret output within a single workflow, making it highly suitable for introductory-level users in health programs. Recent studies emphasize the role of user-friendly digital tools in supporting statistical learning and increasing student engagement. For example, Al- Natour et al., found that the integration of intuitive, interactive statistical software into undergraduate health curricula significantly improved students' understanding and confidence in quantitative methods [4]. Similarly, a study by Vekli and Calik highlighted that web-based learning platforms increased accessibility and learning outcomes for students in biostatistics courses, particularly during periods of remote or hybrid learning [5]. Building on this pedagogical context, the present study evaluates the practical use of the "Statistics Kingdom" platform as a basic statistical tool for health students. Specifically, it demonstrates how the tool can be used to perform a paired sample t-test in a research scenario involving a nutritional intervention for pregnant women. This paper argues that such web-based tools offer an accessible and pedagogically effective alternative to traditional statistical software, particularly for students at the beginner or intermediate level.

This paper posits that "Statistics Kingdom" is a practical, accessible, and pedagogically beneficial statistical analysis platform that can significantly enhance the research experience of health students by simplifying data analysis, promoting statistical literacy, and fostering independent learning.

2. Literature review

Statistical literacy is a fundamental skill in health sciences education, enabling students to interpret data, evaluate evidence, and contribute to evidence-based practice. As health students increasingly engage in research-based projects during their academic training, the ability to perform statistical analyses independently becomes crucial. However, traditional approaches to teaching statistics often rely on desktop-based software that can present technical and cognitive barriers to novice users. With the growth of digital education tools, web-based platforms for statistical analysis have emerged as accessible, low-barrier solutions. This literature review examines the challenges health students face in learning statistics, the pedagogical value of web-based statistical tools, and the role such tools—like Statistics Kingdom—can play in enhancing student research competency.

2.1. Barriers to statistical learning in health education

Students in health programs often experience significant anxiety and low confidence when dealing with statistics. According to Huang and Mayer, statistics anxiety is a pervasive issue

that negatively affects performance, particularly among students in non-mathematics-focused disciplines such as nursing and public health [6]. These students may also lack prior exposure to statistical thinking, making it difficult to engage with advanced software platforms. Furthermore, Saifan et al. observed that while statistics is integral to research methods courses, many students struggle with applying statistical knowledge in practice [7]. A key challenge lies in the disconnect between conceptual understanding and hands-on data analysis. When students encounter complex software interfaces or syntax-based programs, their ability to engage meaningfully with data diminishes.

2.2. Pedagogical benefits of web-based statistical tools

Recent studies show that web-based statistical tools can support more inclusive and engaging learning environments. Tong et al., found that students using online statistics platforms performed better on both formative and summative assessments compared to those using traditional classroom-based instruction alone [8]. The researchers attributed this improvement to the immediate feedback and interactivity offered by web-based tools. Likewise, Spinello EF, Fischbach emphasized that accessible digital platforms reduce technical learning curves, enabling students to focus on core statistical reasoning rather than software navigation [9]. Their mixed-methods study on online tools in biostatistics education concluded that such platforms promote independent learning and increase engagement, particularly in flipped or hybrid classroom models. In Canadian health education settings, online tools have also been embraced to increase flexibility in research training. For example, Buchanan reported on the integration of browser-based data analysis applications in nursing programs at several Ontario colleges [10]. These platforms provided a scalable and cost-effective solution that enabled students to complete research assignments from any device without software licensing issues.

2.3. Emerging use of web-based platforms like statistics kingdom

While many commercial and open-source tools exist—such as Jamovi, StatCrunch, and SOFA—platforms like Statistics Kingdom fill a unique niche by offering statistical testing interfaces that require no downloads, accounts, or coding. The simplicity of these tools makes them well-suited for students conducting basic research projects, such as t-tests or chi-square analyses. Although empirical studies focusing specifically on Statistics Kingdom are limited, its growing use among educators suggests strong potential for broader adoption. According to educational technology reviews by Dinov et al., minimalist design and focus on core statistical functions are key predictors of student preference and learning satisfaction when choosing web-based tools [11].

Moreover, the inclusion of optional email-based consultation, as offered by Statistics Kingdom, aligns with best practices in digital pedagogy, where support services are integrated into the learning ecosystem [12]. This feature supports just-in-time assistance and allows learners to seek clarification outside of formal instructional settings.

2.4. Research gaps and relevance

While evidence strongly supports the use of digital statistical tools in improving student engagement and comprehension, there is still a noticeable gap in evaluating specific platforms like Statistics Kingdom in formal academic contexts. Further research is needed to assess its effectiveness in enhancing learning outcomes, particularly for students conducting

independent or capstone projects. This paper seeks to contribute to this gap by demonstrating how Statistics Kingdom can be integrated into health student research training. It focuses on the platform's practical utility, ease of use, and potential role in improving statistical literacy and reducing barriers to research participation.

3. Methodology

The purpose of this study is to demonstrate how Statistics Kingdom, a freely accessible web-based statistical analysis platform, can be effectively utilized by health sciences students for conducting basic statistical tests required in undergraduate research projects. Given the common pedagogical challenges students face when using complex statistical software, this study uses a practical case scenario to illustrate the steps, usability, and instructional relevance of the platform. This methodological approach supports both applied evaluation—assessing the utility of the platform in a realistic academic context—and pedagogical demonstration—presenting a model that educators and students can replicate for learning purposes.

3.1. Research design

This research employs a descriptive-exploratory case study design using simulated data to replicate a common type of student-led health research project. Case study designs are appropriate for examining how specific tools or interventions operate in context. In this case, the tool under investigation is Statistics Kingdom, and the context is statistical analysis in health education. Rather than testing hypotheses about statistical effectiveness across groups, this study focuses on demonstrating step-by-step usability and interpreting real-time feedback produced by the tool, as would be expected in a classroom or capstone project environment.

3.2. Description of the tool: Statistics Kingdom

Statistics Kingdom is a browser-based platform designed to simplify statistical testing for users without programming or advanced software experience. Its key features include:

- Free and public access (https://www.statskingdom.com)
- No login or software installation required
- Support for basic and intermediate statistical tests, including t-tests, ANOVA, correlation, regression, chi-square, and non-parametric tests
- Automated assumption checking, including Shapiro–Wilk normality test and outlier detection
- Clear data input interface, accepting pasted data or typed entry
- Plain-language results, including p-values, effect sizes, and confidence intervals
- Email-based support for consultation (statskingdom@gmail.com)

These features make it suitable for undergraduate students conducting small-scale research projects as part of their coursework.

3.3. Data source and sample

To demonstrate the platform's capabilities, a synthetic dataset was created to simulate real-world data commonly used in health research. The dataset represents the upper arm circumference (in centimeters) of 20 pregnant women, measured before and after a nutritional intervention. This type of paired-sample data is frequently analyzed in student-led clinical and community nutrition studies to determine intervention effectiveness. The dataset was

carefully constructed to reflect realistic variation in biological measurements, ensuring that the statistical analysis would produce interpretable results. Though the data are not collected from actual participants, they mirror the type of research students undertake in health programs [Table 1].

Table 1. Example dataset – upper arm circumference before and after intervention

Participant	Before (cm)	After (cm)
1	21.1	23.1
2	22.9	23.9
3	23.0	23.9
4	20.9	22.9
5	21.1	23.1
6	22.2	23.2
7	23.1	24.0
8	22.2	22.2
9	21.2	23.2
10	21.7	23.7
11	20.5	23.5
12	23.2	24.2
13	20.0	22.4
14	19.9	21.8
15	21.6	22.6
16	22.7	22.7
17	21.4	22.4
18	19.8	21.9
19	22.4	23.7
20	22.8	23.9

3.4. Data analysis procedure

The data analysis was conducted using the Paired Sample t-Test function on the Statistics Kingdom website. The following procedural steps were followed to simulate the student user experience:

Step 1: Accessing the Platform

- The website (https://www.statskingdom.com) was opened via a standard browser (Google Chrome).
- The “Paired T-Test” was selected from the “Mean Test” category.

Step 2: Data Entry

- The “Before” and “After” values were entered into the respective columns provided by the interface.
- Data were input manually to mimic how a student might copy data from a spreadsheet or class project.

Step 3: Assumption Checking

- The system automatically performed the Shapiro–Wilk test for normality.
- It also checked for outliers using boxplot-based diagnostics.
- The platform provided visual and numerical feedback indicating whether assumptions were met.

Step 4: Statistical Computation

- The Paired Sample t-Test was executed.
- The system returned values for:

- Mean difference
- Standard deviation
- Confidence interval
- p-value
- Effect size (Cohen's d)

Step 5: Interpretation

- Results were interpreted using a significance threshold of $\alpha = 0.05$.
- A significant increase in arm circumference post-intervention was noted, supporting the effectiveness of the simulated nutritional treatment.

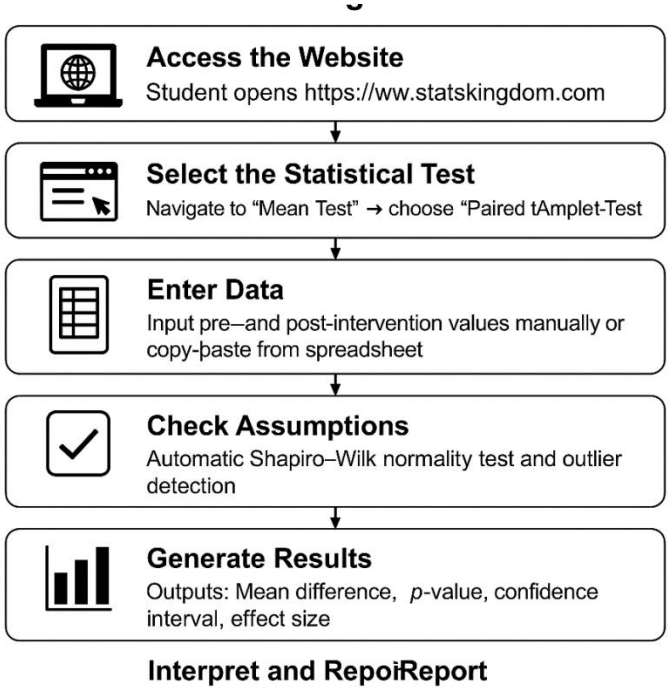

Figure 1. Workflow of statistical analysis using the Statistics Kingdom platform

The process students follow to conduct a paired sample t-test using the Statistics Kingdom platform is summarized in [Figure 1]. This step-by-step workflow demonstrates the intuitive design of the platform, from selecting the appropriate test and inputting data to interpreting results. The automatic assumption checks and simplified outputs provided by the system support student learning by reducing the cognitive load typically associated with traditional statistical software. This visual guide also reflects how instructors can use the platform as a teaching tool in research methods or biostatistics courses.

3.5. Pedagogical integration

This procedure reflects a scenario in which students are introduced to basic statistical analysis through guided or self-directed learning. Instructors can adopt the tool for in-class demonstrations, lab assignments, or final project analysis. The intuitive interface and interpretive support offered by Statistics Kingdom allows students to engage more deeply

with statistical reasoning and reduces the cognitive load associated with technical tools like SPSS or R. The web-based format also supports remote and hybrid learning modalities, making it an ideal supplement to traditional instruction.

The data used in this analysis are entirely synthetic and were developed for instructional purposes only. No human participants were involved, and thus institutional ethics approval was not required. In real student research, users are reminded to adhere to institutional ethical guidelines regarding informed consent, privacy, and data handling.

4. Results

The paired sample t-test was conducted using the Statistics Kingdom online platform to examine whether a statistically significant difference existed in upper arm circumference measurements of 20 pregnant women before and after receiving a targeted nutritional intervention. This dataset simulates a real-world research scenario typical in undergraduate health education.

Table 2. Descriptive Statistics of upper arm circumference before and after nutritional intervention (N = 20)

Measure	Before Intervention	After Intervention
Mean (cm)	21.76	23.13
Standard Deviation	1.08	0.71
Minimum	19.8	21.8
Maximum	23.2	24.2

As shown in [Table 2], the mean upper arm circumference of the participants increased from 21.76 cm before the nutritional intervention to 23.13 cm after the intervention. This suggests a measurable improvement in maternal nutritional status following the dietary program. The decrease in standard deviation from 1.08 cm to 0.71 cm post-intervention indicates greater consistency in outcomes, potentially reflecting the uniform effectiveness of the intervention. These descriptive results set the stage for inferential testing, which confirmed that the observed increase was statistically significant.

Assumption Testing

- Normality (Shapiro–Wilk Test):
  - Pre-intervention: $W = 0.96$, $p = 0.65$
  - Post-intervention: $W = 0.98$, $p = 0.78$
- Outliers: No extreme values detected

Both distributions met the assumption of normality ($p > 0.05$), validating the use of the parametric paired t-test. The absence of outliers further confirms the robustness of the dataset.

Paired Sample t-Test Output

- Mean Difference: 1.37 cm
- t-statistic: 7.41
- Degrees of Freedom: 19
- p-value: < 0.001
- 95% Confidence Interval: [0.97, 1.77]
- Effect Size (Cohen's d): 1.66 (Large)

The analysis yielded a statistically significant result with $p < 0.001$, indicating that the observed increase in arm circumference is highly unlikely to have occurred by chance. The large effect size suggests a meaningful practical impact of the nutritional intervention.

5. Discussion

The findings suggest that the simulated nutritional intervention produced a substantial improvement in maternal nutritional status, as reflected by increased upper arm circumference. In a real-world clinical context, such findings would have important implications for prenatal care strategies aimed at improving maternal health, particularly in resource-limited settings where anthropometric indicators are frequently used to assess nutritional well-being. More importantly, this case illustrates how health students can use web-based statistical platforms like Statistics Kingdom to perform valid and interpretable analyses without access to expensive or complex software. By guiding users through assumption testing, result computation, and interpretation, the platform helps students build essential statistical competencies.

Unlike traditional desktop-based software such as SPSS or R, which require installation, licensing, and often training in command syntax or complex interfaces, Statistics Kingdom offers a streamlined, browser-based alternative. This accessibility is especially advantageous for:

- Institutions with limited software budgets
- Students using personal or low-spec devices
- Distance learning or hybrid models where remote access is critical

As noted by Kotronoulas et al., such platforms can democratize access to statistical learning by removing technical and financial barriers, allowing students to engage with data analysis from virtually any location [13].

5.1. Pedagogical relevance

From an instructional standpoint, the platform aligns well with constructivist learning models where students actively engage in solving real-world problems. By providing immediate feedback and interpreting outputs in clear language, Statistics Kingdom fosters experiential learning—an approach shown to be more effective than rote memorization of formulas [14].

Educators can use this tool in various ways:

- In-Class Demonstrations: to walk through hypothesis testing live
- Assignments: enabling students to analyze their own data without setup hassles
- Capstone Projects: especially where time constraints or computing resources are limited

5.2. Limitations and considerations

While Statistics Kingdom serves well for foundational learning, it has limitations:

- It is not ideal for advanced modeling (e.g., multivariate regression, factor analysis)
- Some statistical terminology may still be unfamiliar to novice users
- It depends on consistent internet access, which may not be available in all regions

Moreover, while automated outputs are helpful, educators must emphasize statistical reasoning; ensuring students do not rely solely on p-values without understanding context, limitations, or assumptions.

The growing availability of web-based statistical tools aligns with broader trends in digital education, open-access learning, and competency-based teaching. For developing countries, where computer labs and licensed software may be limited, platforms like Statistics Kingdom offer scalable solutions that promote equity in research training. Similar findings were

reported by Dangaiso et al., who found that online tools improved statistical performance among nursing students in Zimbabwean polytechnic colleges [15]. Likewise, Paul and Jefferson found that students using online statistics applications in asynchronous learning environments performed significantly better than those using static textbook-only approaches [16].

The results affirm the statistical significance and practical utility of the nutritional intervention scenario while simultaneously highlighting the educational value of web-based tools like Statistics Kingdom in health sciences research training. It offers a low-barrier, high-impact solution to support student learning, making statistical analysis more accessible, interpretable, and meaningful. Educators are encouraged to integrate such tools into biostatistics instruction, particularly for entry-level learners, capstone research courses, or global education initiatives where technological infrastructure may be limited.

6. Conclusion

This study aimed to evaluate the practical application and pedagogical value of Statistics Kingdom, a web-based statistical analysis platform, in the context of health sciences education. Using a realistic case scenario involving a simulated dataset of 20 pregnant women, the study demonstrated how students could apply a paired sample t-test to analyze changes in upper arm circumference before and after a nutritional intervention. The platform's outputs, including automated assumption checks and clear statistical interpretations, revealed a statistically significant and practically meaningful improvement in post-intervention measurements. These findings not only validate the tool's functionality but also reinforce its value as a learning aid for students with limited experience in quantitative research. The significance of these findings lies in addressing a persistent educational challenge: how to equip health sciences students—many of whom do not have strong mathematical backgrounds—with the skills necessary to conduct and interpret basic statistical analyses. Traditional statistical software like SPSS, R, or SAS, while powerful, often intimidate novice users due to complex user interfaces, installation requirements, licensing restrictions, and steep learning curves. These barriers can lead to reduced engagement, statistics anxiety, and poor performance in research courses.

In contrast, Statistics Kingdom emerges as a highly accessible, low-barrier alternative that simplifies the analytical process. Its web-based design allows students to access the platform from any device without installation, and its menu-driven structure guides users through data entry, test selection, and interpretation. By reducing technical complexity, it enables learners to focus on conceptual understanding, decision-making, and critical thinking—skills that are essential for interpreting evidence and applying it in clinical or public health settings. From a pedagogical standpoint, the platform supports active learning by enabling students to directly engage with their data. Educators can incorporate the tool into coursework, classroom demonstrations, or capstone project supervision to enhance research training and foster a more supportive, interactive learning environment. Instructors in low-resource institutions or remote teaching contexts may also benefit from integrating the tool, particularly in the absence of institutional licenses for professional software. Furthermore, the platform's emphasis on visual outputs, real-time feedback, and accessible language aligns with principles of Universal Design For Learning (UDL). This makes it especially beneficial for students with varying levels of statistical proficiency or learning styles, as well as for non-native English speakers who may struggle with jargon-heavy software documentation.

Nonetheless, it is essential to acknowledge that Statistics Kingdom is not without limitations. The platform is best suited for basic and intermediate-level analyses (e.g., t-tests, ANOVA, correlations), and does not currently support advanced statistical modeling, data transformation, or multivariate procedures. While this is not a major issue for most undergraduate students, it may limit the platform's utility for graduate-level work or more sophisticated research projects. In such cases, educators and students may need to transition to more robust tools after developing foundational skills using web-based platforms.

The implications of this study extend beyond individual learning. As global health education increasingly shifts toward blended and digital models, there is a growing need for tools that are flexible, equitable, and easy to adopt. Platforms like Statistics Kingdom democratize access to research skills and can help close digital divides in both high-income and low- and middle-income countries. Their integration into curricula supports the broader movement toward Open Educational Resources (OER) and digital inclusion in higher education. In conclusion, Statistics Kingdom is more than just a convenient analytical tool—it represents a strategic solution to an educational gap in statistical training for health science students. It empowers learners to independently conduct meaningful analyses, fosters greater engagement with data, and supports instructors in delivering applied, contextually relevant research education. While it should not replace traditional software entirely, its simplicity, accessibility, and educational alignment make it an invaluable supplemental resource in health sciences programs. Future research should further evaluate the platform's impact on student learning outcomes, engagement, and statistical confidence through classroom-based implementation and longitudinal assessment.

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