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Research Article

STAWhiz: Discovering Statistics through Interactive Exploration

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Abstract: *Students often find it challenging to understand statistical formulas, perform calculations, and interpret results, while traditional slides offer limited guidance and feedback to support their learning. STAWhiz addresses this with an automated calculator embedded in lecture slides and web applications that run on smartphones and laptops, online or offline. Grounded in Cognitive Load Theory, it shows full working tables and step-by-step solutions, not just final answers, for ungrouped data, ungrouped data presented in the frequency tables and grouped data. The first version covers descriptive Statistics; measures of central tendency, dispersion, position and skewness of the distribution. STAWhiz combines classroom demonstrations, instant answer checking, and independent practice to help students improve their accuracy, deepen their understanding, and become more confident and independent learners.*

1. INTRODUCTION

Statistics is a core subject in business, accountancy, management and other quantitative programmes, yet many students struggle with it. They find the formulas hard to follow, make errors in long calculations and are unsure how to interpret the results. Statistics anxiety makes this worse. It is associated with lower self-efficacy and poorer mathematical competence (Alladin et al., 2026; Hernández de la Hera et al., 2023) and continues to be recognised as one of the most widely studied challenges in mathematics education (Özdemir & Yildirim, 2026).

Traditional teaching materials have some limitations in helping students learn statistics. Slides usually contain only a few examples, and students still need to work through calculations manually.

When completing tutorial exercises, they may have to wait until the next class to check their answers. As a result, mistakes may go unnoticed, and students may continue to misunderstand certain statistical concepts.

STAWhiz: Discovering Statistics through Interactive Exploration was developed to help students overcome some of the difficulties they face when learning statistics. Students can use STAWhiz to carry out calculations, see how each solution is obtained and check whether their answers are correct without having to wait for feedback from their lecturer. This also gives them the opportunity to practise on their own and review the steps whenever they need to. At this stage, STAWhiz covers Descriptive Statistics which includes four subtopics, namely Measures of Central Tendency, Measures of Dispersion, Measures of Position and Measures of Skewness. This paper describes the problems that led to the development of STAWhiz, the theories used as its foundation, its functions and how it may help students in learning statistics.

2. LITERATURE REVIEW

2.1 Difficulties in Learning Statistics

Students' difficulties with statistics are well documented. In a recent course-level study, statistics anxiety fell over a semester, but it stayed higher among students with lower self-efficacy and weaker perceived mathematics competence (Alladin et al., 2026). Calculation errors can make the situation worse, as even a small arithmetic mistake may cause students to lose confidence in the entire calculation process.

2.2 Feedback and Technology in Statistics Learning

The feedback given to students is also important in helping them learn. A network meta-analysis of 77 studies found that elaborated feedback, which explains why an answer is right or wrong, was the most effective. Simply telling students whether an answer is correct was the least effective (Mertens et al., 2022). However, most calculators and statistical software only show the final answer without explaining how it was calculated.

Technology for statistics teaching is growing. Web-based applets now support simulations and randomised practice datasets (Lu, 2023), mobile learning gives students flexible access beyond the classroom (Rangel-de Lázaro & Duart, 2023), and active learning in its many forms generally benefits statistics students (Dickson et al., 2026). However, interactivity alone does not guarantee learning. Students preferred interactive R Shiny visualisations to static pictures, but they did not perform better with them (Zhao et al., 2023). What matters is how a tool is designed.

2.3 Theoretical Framework: Cognitive Load Theory

STAWhiz is based on Cognitive Load Theory (CLT), which holds that working memory is limited and that instruction should not waste it (Sweller, 2023). A novice facing an unfamiliar statistics problem must search for a method while juggling many numbers, and this overloads working memory. The worked-example effect offers a way out: novices learn more by studying complete solutions than by solving problems unaided, and a recent meta-analysis confirmed this effect in mathematics (Barbieri et al., 2023).

STAWhiz puts this principle into practice. Its working tables and step-by-step solutions are worked examples that students can generate for any dataset. Instant checking provides elaborated

feedback (Mertens et al., 2022). Regular self-checking outside class also builds self-regulated learning, which has a moderate positive effect on achievement in online and blended settings (Xu et al., 2023).

3. METHODOLOGY

STAWhiz was developed using a design and development approach based on the principles discussed earlier. The development process began by looking at the common problems students faced during lectures and tutorials, particularly in selecting the correct formula, performing calculations accurately and interpreting statistical results. These problems were then considered when deciding which features to include in STAWhiz:

(a) Slide-embedded calculator. An automated calculator is included at the end of each subtopic's slides. Lecturers can use it to perform calculations using different datasets during lectures and tutorials.

(b) Interactive web applications. Students can access the applications using their smartphones or laptops. Once downloaded, the applications can be used with or without an internet connection.

(c) Three data categories. Each application allows students to work with three types of data: ungrouped data, ungrouped data presented in frequency tables, and grouped data. This helps students understand how the same statistical measure is calculated when data are presented in different forms.

(d) Working tables and step-by-step solutions. The system shows a working table with each calculation step so that students can see how the final answer is obtained.

The first version of STAWhiz focuses on Descriptive Statistics. These topics were selected as students frequently make errors in calculations involving multiple steps. For all three types of data, the results obtained from STAWhiz were compared with those calculated manually to check their accuracy.

4. FINDINGS

The result is a working platform in which one calculation engine serves three learning contexts (Figure 1).

4.1 Classroom Demonstration

Lecturers can change the data on the final slide and show the full solution at once. They no longer need to prepare several manual examples, and they can answer questions on the spot with new datasets.

4.2 Immediate Answer Verification

After completing a tutorial exercise, students can enter the same data into STAWhiz and check their calculations against the solution provided. The working table allows them to identify mistakes at each step rather than simply knowing that their final answer is incorrect.

4.3 Independent Learning beyond the Classroom

Students can use their own datasets to practise calculations on their devices at any time. The offline version also allows students to continue practising without an internet connection.

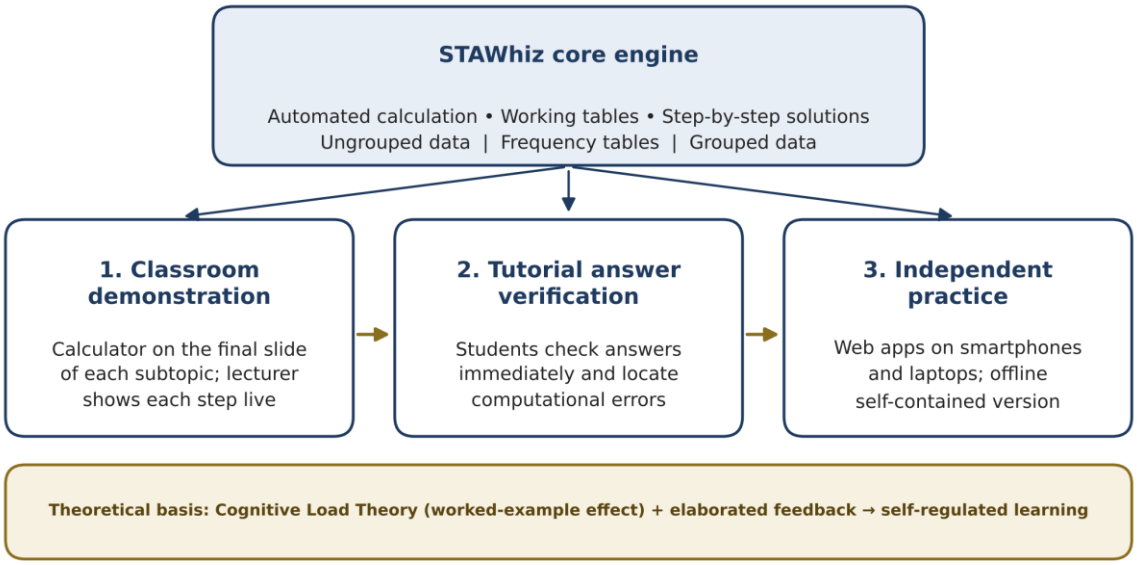


Figure 1. Conceptual framework of STAWhiz.

5. DISCUSSION

Unlike general statistical software, STAWhiz presents the steps involved in each calculation rather than only the final answer. Table 1 compares STAWhiz with conventional learning materials and explains the theoretical basis for each feature.

Table 1. Comparison of conventional materials and STAWhiz.

Learning context	Conventional approach	STAWhiz approach	Theoretical link
Lecture demonstration	Static slides with fixed, pre-worked examples	Live calculation with any dataset on the final slide	Worked-example effect (Barbieri et al., 2023)
Tutorial checking	Answers checked in the next class or by the lecturer	Instant, step-level answer verification	Elaborated feedback (Mertens et al., 2022)
Independent practice	Textbook exercises with final answers only	Web apps showing full working, online and offline	Self-regulated learning (Xu et al., 2023)
Data representation	Usually one data type per example	Ungrouped data, ungrouped data presented in a frequency-table and grouped data	Managing cognitive load (Sweller, 2023)

STAWhiz allows students to use any dataset to learn how calculations are carried out step by step, reducing the need to focus too much on numerical calculations (Sweller, 2023). Students can also check their answers immediately and identify mistakes through the feedback provided (Mertens et al.,

2022). With regular practice, students may become more confident in checking their own work and rely less on their lecturers.

The design of STAWhiz also considers the findings of Zhao et al. (2023), who highlighted that interactivity alone may not improve learning. Although STAWhiz is interactive, its main benefit lies in providing worked examples and feedback to help students understand the calculations.

The limitation is students may rely on the calculator without attempting the questions on their own. To avoid this, lecturers should encourage students to complete the calculations first before using STAWhiz to check their answers.

6. CONCLUSION

STAWhiz: Discovering Statistics through Interactive Exploration was developed to support students in learning statistics through a more interactive and flexible approach. It focuses on three common difficulties faced by students: understanding calculation steps, performing calculations accurately and checking their own answers.

Its contribution can be divided into three parts. First, a calculator is included on the final slide of each subtopic, allowing lecturers to demonstrate calculations during lessons while giving students a convenient way to check their answers during tutorials. Online and offline web applications extend practice to smartphones and laptops, anytime and anywhere. Complete working tables and step-by-step solutions for ungrouped data, ungrouped data presented in a frequency table and grouped data push students towards understanding and accuracy, not just final answers.

The initial development of STAWhiz demonstrates how classroom demonstrations, immediate answer checking and independent learning can be brought together within a single platform. However, its effectiveness in improving student learning has yet to be evaluated. Further assessment through student performance and feedback is therefore needed to determine its impact. Future development will also focus on extending the platform to cover statistical topics beyond Descriptive Statistics. Its modular design provides opportunities for wider use, collaboration with other institutions and potential commercialisation. Overall, STAWhiz offers a practical approach to supporting lecturers in delivering more interactive lessons while encouraging students to take a more active role in their learning.

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