Volume 2, Issue 4

Innovation Series Quarterly

https://journal.academicapress.org/aps/index.php/isq

Research Article

ChemEase: Smart Solution Concentration Calculator

Diana Indim[1,*], and Roseline Michael[2]

[1] Faculty of Applied Sciences, Universiti Teknologi MARA Sabah Branch, Kota Kinabalu Campus, Sabah; diana908@uitm.edu.my

[2] Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Sabah Branch, Kota Kinabalu Campus, Sabah; roseline@uitm.edu.my

* Correspondence: diana908@uitm.edu.my; +60168787494.

Keywords:
Chemistry calculator
Solution concentration
Concentration units
Solution preparation

Abstract: *Accurate chemical calculations are essential but often confuse students and laboratory personnel. This study presents ChemEase: Smart Solution Concentration Calculator, an interactive web-based platform designed to simplify chemical calculations. ChemEase integrates nine calculation modes, including multiple solution expression calculations such as molarity, percent concentration, parts ratio, mole calculation, and dilution. The platform provides automatic unit conversion, formula guidance, and instant results. The key contribution of ChemEase is the integration of calculation functions and interactive learning activities, including quizzes, games, and worked examples, on a single platform. In conclusion, ChemEase shows potential as a multifunctional digital tool that supports chemistry education and enhances the efficiency of lab calculations.*

Copyright: © 2026 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. INTRODUCTION

Accurate chemical calculations are essential but often confuse students and laboratory personnel. This study presents ChemEase: Smart Solution Concentration Calculator, an interactive web-based platform designed to simplify chemical calculations. The calculator integrates core chemical computation principles with an interactive, user-friendly interface, allowing users to enter the values required for specific chemical calculations. For example, if users want to prepare a solution with a specific concentration and by using calculator, they will receive instant outputs for the corresponding mass or volume. The tool is optimized for both educational and professional use, providing real-time guidance and minimizing common calculation errors.

Initial prototype testing with UiTM Sabah's diploma-level science students demonstrated improved accuracy in prepared solutions compared to manual calculation methods. This innovation supports laboratory efficiency, enhances training outcomes, and ensures reproducibility in chemical analyses. Future development will explore mobile app integration, database storage for commonly used chemicals, and automated preparation checklists. By bridging the gap between theoretical knowledge and practical execution, ChemEase has the potential to become a standard digital aid in educational laboratories and research environments.

1.1 Problem Statement

In a scientific laboratory, proper preparation of chemical solutions is essential for accurate and reliable analytical results. Yet many students struggle with manual calculations of moles, solution concentrations, solute masses, and solution volumes needed for solution preparations and dilutions. Manual methods of calculation are prone to human error, time-consuming, and require good chemistry fundamentals. As a result, solutions with inaccurate concentrations would be prepared, thereby affecting the quality of the analytical data. Regardless of these challenges, there remains a lack of user-friendly, automated digital tools that provide guidance on the calculation steps for preparing solutions with specific concentrations. Apart from being a tool to handle accuracy issues in the lab, the availability of this tool is significantly needed as an effective teaching aid to help students understand the concepts of chemistry better, especially in schools, matriculation centres and universities. The absence of this support highlights the need for an innovative chemistry calculator that simplifies calculations, enhances learning, and improves the accuracy of solution preparation in laboratory settings. Therefore, the ChemEase Solution Concentration Calculator was developed to fill this gap.

1.2. Objectives

The objective of this innovation is to develop a user-friendly digital chemistry calculator that serves as an educational tool for students, researchers, educators, and lab personnel to accurately determine solute weights and solution volumes during solution preparation and to calculate solution concentrations in multiple expressions. This web-based calculator is especially important for students in their final year, when they need to complete a final-year lab project in which solution preparation is part of their routine. This calculator is also beneficial for postgraduate students, early-career researchers, and lab personnel, as it accurately determines the mass and volume required to prepare a solution.

2. LITERATURE REVIEW

Knowledge of mole calculations and accurate solution preparation are fundamental skills in chemistry research and laboratory practices. It plays a critical role in ensuring the precision, reliability, and reproducibility of analytical results (Practice & ASTM, 2013). Standard solutions, in particular, serve as reference materials for calibrating instruments, method validation, and the quantitative determination of analyte concentrations in diverse samples. Standard solutions are also useful for verification of the method of analysis, including electrochemical, titrimetric, turbidimetric, and other analytical methods (Staniskiene, B. & Sinkeviciene, I. 2012). To conduct research work properly in the laboratory, chemical solutions of certain concentrations are required. Without adequate knowledge of how to prepare solutions, it is difficult to conduct the research work properly (Zeynep & Aysen, 2013). Any errors in calculating the correct amount of substances, improper weighing techniques, dilution errors, or contamination during solution preparation can propagate through subsequent analyses, leading to significant deviations in measured data. Therefore, accurate preparation of solutions serves as one of the factors that ensures the accuracy of experimental outcomes and is a fundamental aspect of analytical chemistry and laboratory practice (Todorovsky et al., 1981).

However, final year project students, post-graduate students, and newly appointed laboratory personnel often face challenges in translating theoretical concentrations into precise measurements of mass and volume, especially when dealing with diverse units of concentration such as molarity (M), percent weight/weight (%w/w), percent weight/volume (%w/v), and parts per million (ppm) (Singleton, 2018; Pinarbasi & Canpolat, 2003). In solution concentration calculations, many students

struggle to understand the different concentration units. Students often relied on algorithmic approaches to solving concentration problems due to a lack of conceptual understanding (Chong, 2016; Jadhav et al., 2019; Raviolo et al., 2021; Shadreck & Enunuwe, 2018). For example, many students are not clear about the difference between molality, m, and molarity, M. Solving concentration problems using only algorithmic procedures can prevent students from developing the understanding needed to see beyond the numbers.

Therefore, this project introduces ChemEase, a web-based chemistry calculator, specifically designed to help science-based students and lab personnel with solution concentration calculation. ChemEase is a solution concentration calculator, a user-friendly digital tool that simplifies and standardizes solution preparation calculations across various concentration expressions.

3. DESCRIPTION OF CHEMEASE SOLUTION CALCULATOR

3.1 User Interface

Figure 1 illustrates the homepage of the ChemEase user interface. The homepage features an attractive, user-friendly interface and highlights key functionalities, including 9 calculation modes, automatic unit conversion, formula guidance, and instant results. The homepage also features a brief introduction explaining the purpose of ChemEase, along with a step-by-step user guide to help users navigate the calculator.



Figure 1. Homepage of ChemEase Solution Concentration Calculator

3.2 Interactive quizzes and games section

In addition to the solution concentration function, an interactive learning section is incorporated through quizzes, games, and learning practices to support chemistry learning according to user's level, as shown in Figure 2. The integration of these activities provides an additional educational component that complements the calculator's primary functions.

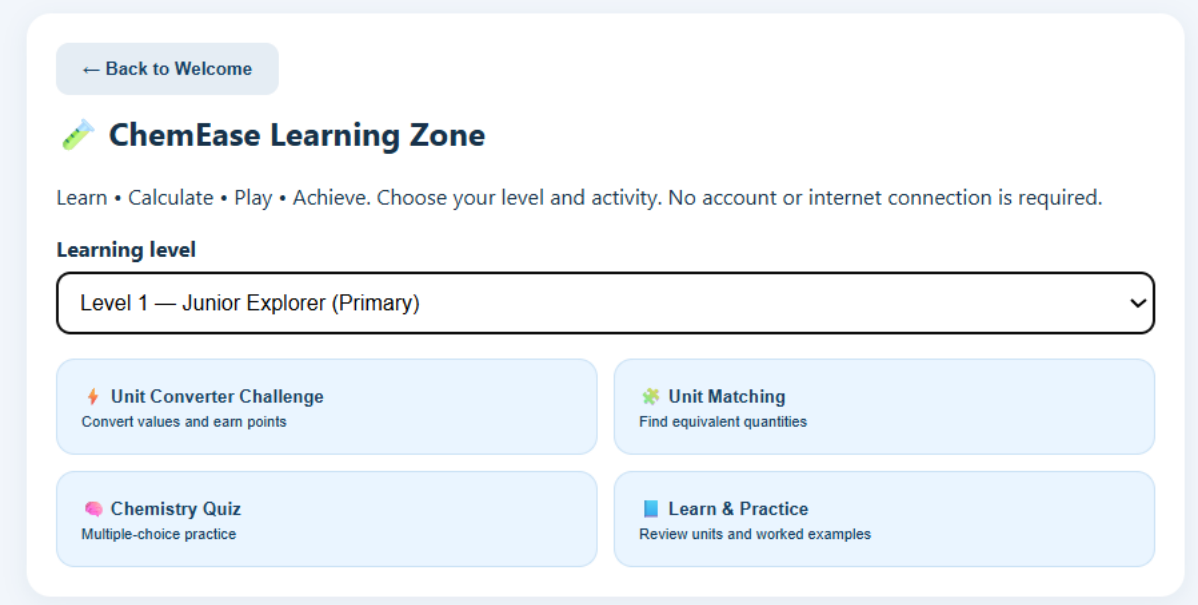


Figure 2. Interface of interactive quizzes and games section

3.3 Content page interface of ChemEase

Figure 3 illustrates the ChemEase calculator interface. The interface allows the user to select the desired calculation mode and the quantity to be determined through the drop-down menus. The required input fields are automatically displayed based on the selected calculation, allowing users to enter the required values. ChemEase automatically converts the input units to the units required by the formula, calculates the result, and finally the result is displayed. An example of how to use ChemEase is shown in Figure 3. The user wants to calculate the mass of sodium hydroxide (NaOH) needed to prepare a 250 mL solution with a concentration of 0.25 M. First, the calculation mode is set to Molarity, and the quantity to be calculated is the mass of solute through the drop-down menus. Then all the required values are entered, and the correct units are selected through the drop-down menus: molarity is 0.25 mol/L, the molar mass of NaOH is 40 g/mol, and the volume of the solution is 250 mL. Lastly, select the answer unit from the drop-down menu. The result (mass of NaOH) will be instantly displayed as 2.5 grams in the answer section.

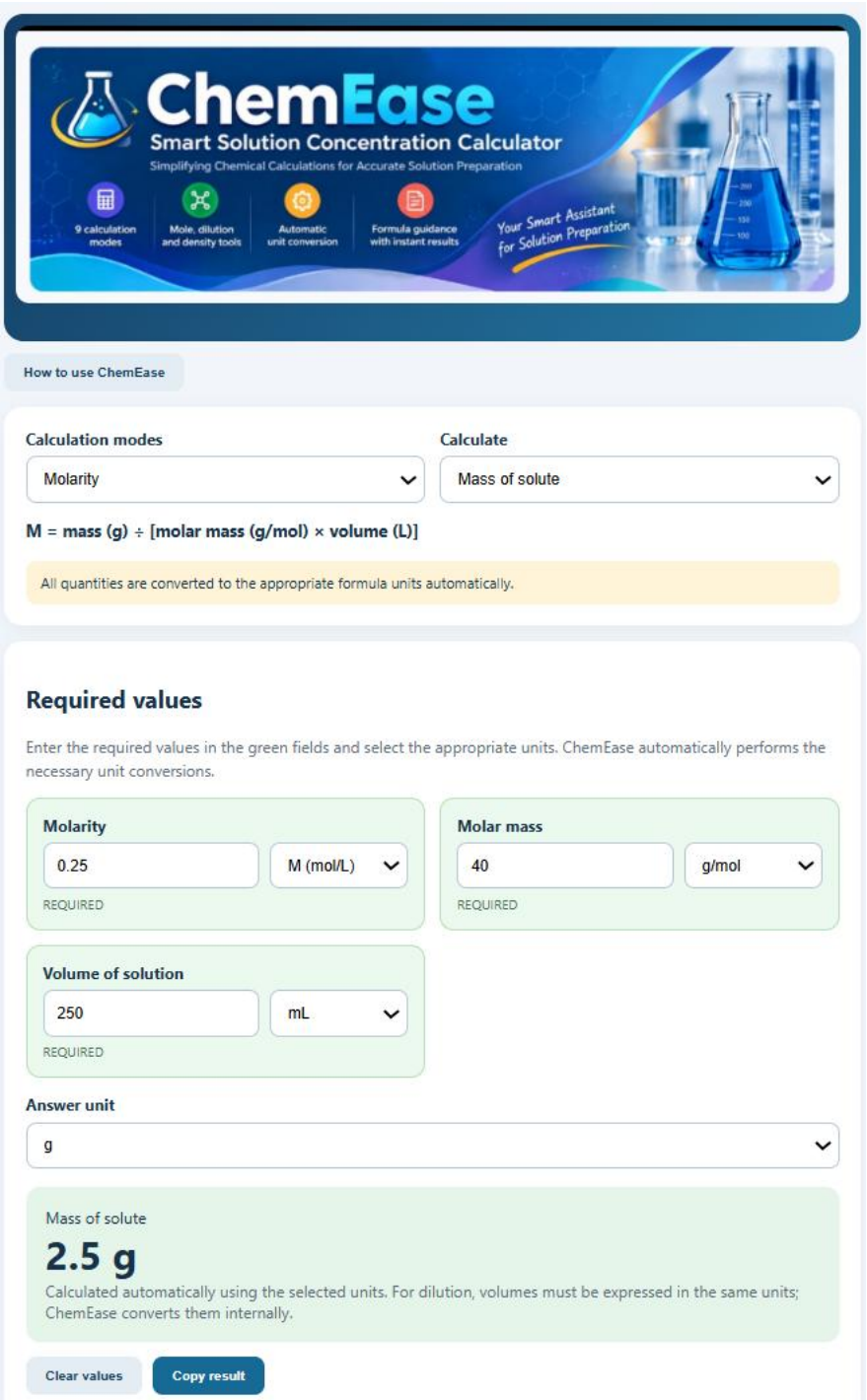


Figure 3. ChemEase calculator interface demonstrating solute mass calculation with automatic unit conversion and instant results.

4. FINDINGS

ChemEase is an interactive web application developed to help students and lab assistant with solution concentration calculations for laboratory solution preparation. As part of this, ChemEase calculator is also designed to enhance chemistry education and suitable to be used by educators as well. The novelty of ChemEase as an innovation lies in the integration of comprehensive chemical calculations and interactive learning features within a single web-based platform. Multiple calculation

modes such as mole determination, concentration of solution in various expression such as molarity, % w/w, % w/v, % v/v, ppb and ppt calculations, and dilution function are integrated in the calculator.

Another distinctive feature of ChemEase is the integration of the ChemEase Learning Zone, which offers interactive quizzes, unit conversion challenges, unit matching activities, and worked examples. These activities are designed to reinforce fundamental chemistry concepts and encourage independent learning. All this multifunctionality allows users to use the calculator for solute mass determination, solution volume calculations, concentration adjustments, dilution planning, and interactive learning activities in a single, unified, and user-friendly platform. By combining calculation assistance, formula guidance, automatic unit conversion, and interactive learning activities this innovation is tailored specifically for chemistry students, educators, researchers and laboratory personnel.

5. DISCUSSION

ChemEase, a web-based chemistry calculator, has strong commercialization potential due to its broad applicability across schools, matriculation centers, colleges, universities, and research laboratories as a user-friendly and affordable educational and research tool that supports teaching and research activities. It can reduce calculation errors and enhance students' confidence in preparing solutions and performing calculations; hence, their fundamental understanding of chemistry would increase. The product can be commercialized through institutional licensing, app-based distribution, and bundled packages for chemistry courses. The long-term impact includes improved laboratory accuracy, safer practices, enhanced learning outcomes, and a reduced workload for instructors, positioning the innovation as a valuable digital tool in modern chemistry education.

6. CONCLUSION

In conclusion, ChemEase, a web-based solution concentration calculator, has been successfully developed. This calculator has great potential as a learning tool, especially in chemistry education. The development of this chemistry solution-preparation calculator is also valuable for laboratory practice. By integrating essential chemistry calculations such as moles, mass, concentration, and dilution into a single, user-friendly digital tool, the innovation significantly reduces human error, enhances accuracy, and streamlines solution preparation for students, educators, researchers, and laboratory personnel. Additional function of quizzes and games section reinforce fundamental chemistry concepts and encourage independent learning. Therefore, its dual role as a practical lab aid and an effective teaching tool empowers learners to independently verify their calculations, reinforcing conceptual understanding and improving confidence in performing chemical tasks. With strong potential for adoption in schools, universities, and professional laboratories, this innovation stands to make a meaningful impact on teaching quality, laboratory efficiency, and the overall reliability of scientific work.

Acknowledgments: We would like to express our sincere gratitude to all those involved in the development of innovation, whether directly or indirectly.

References

Jadhav, V. R., Nair, S. G., More, B. A., & Author, C. (2019). Mathematical treatment to understanding the concentration terms. *International Journal of Research & Review (Www.Ijrrjournal.Com) Vol*, *6*(1).

Pinarbasi, T., & Canpolat, N. (2003). Students' understanding of solution chemistry concepts. *Journal of Chemical Education*, *80*(11), 1328. https://doi.org/10.1021/ed080p1328

Practice, S., & ASTM. (2013). Standard Practice for Preparation, Standardization, and Storage of Standard and Reagent Solutions for Chemical Analysis 1. In *Astm E15.01: Vol. 15.05* (Issue 2001).

Raviolo, A., Farré, A. S., & Schroh, N. T. (2021). Students' understanding of molar concentration. *Chemistry Education Research and Practice*, *22*(2). https://doi.org/10.1039/d0rp00344a

Shadreck, M., & Enunuwe, O. C. (2018). Recurrent Difficulties: Stoichiometry problem-solving. *African Journal of Educational Studies in Mathematics and Sciences*, *14*(SE-Articles), 25–31. https://doi.org/10.4314/ajesms.v14i0.

Sheau Huey Chong (2016). Wither the concepts of mole and concentration: Conceptual confusion in applying M1V1 = M2V2. *Universal Journal of Educational Research*, 4(5), 1158 - 1162. DOI: 10.13189/ujer.2016.040527.

Singleton, T. L. (2018). Preparation of solutions and reagents. In *Schizosaccharomyces pombe. Methods in Molecular Biology, vol 1721* (pp. 1–7). 2018 Springer Science+Business Media, LLC. https://doi.org/10.1007/978-1-4939-7546-4_1

Staniskiene, B., & Sinkeviciene, I. (2012). *Analytical Chemistry Lab Manual*. Lithuanian University Of Health Sciences.

Todorovsky, D., Kostadinov, K., & Djingova, R. (1981). Optimization of calculations for the preparation of standard solutions. *Analytica Chimica Acta*, *123*(C). https://doi.org/10.1016/S0003-2670(01)83184-6

Zeynep, E., & Aysen, T. (2013). Solution preparation and conductivity measurements: An experiment for introductory chemistry. *Journal of Chemical Education*, *90*(12), 1665–1667. https://doi.org/https://doi.org/10.1021/ed300593t