ASEAN Journal for Science Education

Journal homepage: https://ejournal.bumipublikasinusantara.id/index.php/ajsed

Development and Validation of CalTech (Calculator Techniques) Exercises Manual

*Welard Jay C. Vicera**

Sultan Kudarat State University, Philippines

*Correspondence: E-mail: welardjayvicera@sksu.edu.ph

ABSTRACT

The paramount focus of the research study was to examine the effectiveness of the developed CAI-mediated CalTech (Calculator Techniques) Exercises Manual as an Intervention in Teaching Basic Calculus. The developed exercises manual was validated by experts in the field of mathematics and mathematics education who served as well as the study's respondents with the adopted instrument for validation. As results were obtained, the developed exercises manual was found perfectly acceptable and was suited to improve the learning competence of the STEM students in learning Basic Calculus. The results were perfectly acceptable in all its components for validation: objectives, content, presentation, usability, and consistency. The content was relevant, the presentation was clear and easy to understand, the manual was user-friendly, and the overall consistency was maintained. In conclusion, the developed CAI-mediated CalTech (Calculator Techniques) Exercises Manual as an Intervention in Teaching Basic Calculus was a valuable resource for STEM students and was deemed entirely suitable and appropriate to improve and enhance their learning performance.

ARTICLE INFO

Article History:
Submitted/Received 12 Oct 2024
First Revised 16 Nov 2024
Accepted 01 Jan 2025
First Available online 02 Jan 2025
Publication Date 01 Sep 2025

Keyword:
Computer-assisted instruction (CAI),
Calculator techniques (CalTech),
Supplemental instruction (SI).

1. INTRODUCTION

With the advent of technology, education is one of the sectors that has been revolutionized, offering innovative tools and approaches to enhance learning. Such advancement includes Computer-Assisted Instruction (CAI), which provides interactive and personalized learning experiences and scientific calculators (Verma, 2016; Anchor & Ukwuru, 2014). In mathematics, scientific calculators aided students in learning different mathematical concepts and teachers played a pivotal role in the discovery of this technology. This helped students better understand the concepts being taught in mathematics or any mathematics-related disciplines. Teachers were responsible for preparing students for the increasing technological global economy, such as using scientific calculators (Ok *et al.,* 2020). Also, in a study conducted by the National Council of Teachers of Mathematics in 2020, the effective use of scientific calculators developed the students' comprehension of operations and numbers promptly.

In today's 21st century education, teachers are currently encouraged to use different innovative strategies, such as integrating calculator technology to meet the student's learning needs. Teachers favor using scientific calculators to understand mathematics concepts (Cuncaga *et al*., 2019). However, some teachers were not into this innovation because teachers had a fear that this would weaken the students' hands. Teachers had yet to discover the potential of maximizing the use of scientific calculators in mathematics education, for it had been seen to be promising in teaching and the student's learning process, especially the integration of calculator techniques.

Calculator Techniques (CalTech) is the application of mathematical theories and engineering concepts that use extensively all the functions of the calculator. It is not just about performing the use of the calculator; it can be more of a tool for learning mathematics in a meaningful way (Li *et al*., 2004; Chang *et al*., 2021). Many studies have been pursued on the role of calculators in students' academic achievement and their importance, as these give direct access to representations of mathematical ideas that are conceptually significant and valuable in students' academic learning (Mainali, 2021). However, no studies have been conducted yet as to the integration of calculator techniques in Basic Calculus. As such, the study was formulated, CAI-mediated CalTech (Calculator Techniques) Exercises Manual as validated by experts in the field of mathematics and mathematics education to improve and enhance the learning performance of STEM students in learning Basic Calculus.

2. METHODS

In pursuit of aiding students in learning Basic Calculus, a thorough needs assessment was conducted to identify problems, specific needs, and goals of the study. Initially, the researcher went to the division office of Sultan Kudarat in the province of Sultan Kudarat to identify learning competencies in Basic Calculus identified as weak or low. As a result, the study was formulated to aid students in learning the discipline. More so, it identified the existing calculator proficiency of STEM students and identified areas where additional support was required in helping STEM students improve their academic performance.

The development of the CAI-mediated CalTech (Calculator Techniques) Exercises Manual aligned to the needs assessment conducted by the researcher. As a result, the researcher developed the exercise manual as a supplemental learning material to aid students in learning Basic Calculus. The topics included in the exercise's manual were Implicit Differentiation, Integration or Antidifferentiation, and the Formal Definition of Definite Integral. These topics

DOI:
p- ISSN 2828-3287 e- ISSN 2828-3295

are identified as weak in terms of learning competencies and so the developed exercises manual was initiated to aid students. Exercises were designed to cover a wide range of calculator techniques, from basic operations to advanced function.

2.1. Computer-Assisted Instruction (CAI) Tool Selection

After careful consideration, the researcher chose CAI as the platform to integrate the exercises. This was selected due to its features, compatibility, and ease of use for the students. More so, the most impressive feature of the CAI platform was its ability to adapt to each student's learning style and pace. It could track students' progress and adjust the difficulty level of the lessons accordingly. This meant that students who struggled with a particular topic could receive extra support, while those who excelled could be challenged with more advanced material.

2.2. Exercise Integration

Exercises were integrated using the CAI platform due to its dynamic and engaging learning experience. Also, the researcher chose this platform since students were more active with the use of technology in today's world. With each click and keystroke, students were actively involved in their learning journey as the platform brought the subject matter to life, making it more relatable and easier to understand for the students.

2.3. Validation and Refinement

The moment when the developed CAI-mediated CalTech (Calculator Techniques) was crafted, experts validated the developed manual for further improvement of the exercise's manual. For it to be not biased, the researcher selected validators from different institutions namely: Mindanao State University – General Santos City, Notre Dame of Marbel University, Sultan Kudarat State University, and Department of Education City Schools Division of General Santos. Based on the results obtained from the different validators, necessary adjustments were made to content, exercises, and the overall design of the developed exercises manual.

3. RESULTS AND DISCUSSION

3.1. Acceptability of CAI-mediated CalTech (Calculator Techniques) Exercises Manual

This study evaluated how well a newly created computer-assisted learning tool, called the CAI-mediated CalTech (Calculator Techniques) Exercises Manual, could improve the learning performance of STEM students. As seen in the table below, results show that the developed manual was found to be perfectly acceptable as evaluated by experts in mathematics and mathematics education. In **Table 1**, results show that the developed CAI-mediated CalTech (Calculator Techniques) Exercises Manual as an intervention in teaching Basic Calculus had a mean of 4.61 which was verbally described as perfectly acceptable and had a standard deviation of 0.57.

This result suggests that the developed manual was found to be an effective supplemental learning material for STEM students in aiding their weak learning competencies in the discipline. These findings conformed to the other studies (Rathmell, 2018) that the integration of computer-assisted instruction served as additional material or supplementary material providing concept practice that complements in-class lessons or student-level topics.

In terms of Objectives, the CAI-mediated CalTech Exercises Manual was found to be highly acceptable by students, with a mean of 4.60 (considered "perfectly acceptable"). The

DOI:
p- ISSN 2828-3287 e- ISSN 2828-3295

standard deviation of 0.57 indicates a relatively low spread in scores, suggesting that most students had a similar positive opinion of the manual.

Table 1. Acceptability of the developed CAI-mediated CalTech (calculator techniques) exercises manual

	Mean (M)	Standard Deviation (SD)	Verbal Description (VB)
Objectives	4.60	0.57	Perfectly acceptable
Content	4.60	0.57	Perfectly acceptable
Presentation	4.63	0.53	Perfectly acceptable
Usability	4.68	0.58	Perfectly acceptable
Consistency	4.56	0.61	Perfectly acceptable
Overall	4.61	0.57	Perfectly acceptable

Based on these findings, the CAI-mediated CalTech Exercises Manual appears to be a promising tool for teaching basic calculus. Its high level of acceptability suggests that students found it engaging, effective, and supportive of their learning. Moreover, in terms of Content, the developed manual had a mean of 4.60 verbally described as perfectly acceptable, maintaining a standard deviation that is relatively like objectives. This suggests that the developed manual effectively covered the relevant topics and objectives for teaching Basic Calculus identified as weak in terms of learning competencies (Cañeda *et al*., 2024).

In terms of its Presentation, results tell us that it was highly rated by the validators, with a mean of 4.63 and a standard deviation of 0.53. As such, this indicates that the manual was well-organized, easy to understand, and visually appealing. On the other hand, in terms of its Usability, the developed exercises manual obtained a mean score of 4.68 and a standard deviation of 0.58 suggesting that the manual was easy to use, navigate, and understand by the STEM students.

Lastly, in terms of Consistency, the consistency of the developed exercises manual was rated slightly lower than its presentation and usability, with a mean score of 4.56 and a standard deviation of 0.61. This indicates that while the manual was generally consistent, there may have been some minor inconsistencies or variations in its content, format, or style.

Overall, the developed exercises manual was found to be an effective and efficient supplemental learning material in learning Basic Calculus aiding STEM students with their difficulty in the discipline. These results were supported by other studies (Paloyo *et al.*, 2016; Madrazo & Dio, 2020) that supplemental instruction had a significant effect on the learning performance of the students and greatly improved their academic performance.

Further research and implementation in various educational settings are warranted to explore its full potential and impact on student outcomes

4. CONCLUSION

The developed CAI-mediated Calculator Techniques (CalTech) indicates that the manual effectively met the intended learning goals, provided relevant and clear content, was well-organized and easy to understand, was user-friendly, and maintained a consistent format. The high ratings by the validators for the developed manual suggest that it is a valuable resource for STEM students seeking to improve their academic performance in Basic Calculus. The interactive nature of the CAI-mediated approach likely contributed to the positive evaluation, as it may have made the learning process more engaging and effective.

In conclusion, the developed CAI-mediated CalTech (Calculator Techniques) Exercises Manual is a promising tool for enhancing STEM education. The positive evaluation of the

DOI:
p- ISSN 2828-3287 e- ISSN 2828-3295

manual suggests that it can be a valuable resource for students seeking to improve their calculator skills and achieve success in STEM-related fields.

5. ACKNOWLEDGMENT

The researcher expressed his gratefulness to Almighty God for sustaining confidence, courage, and enlightenment that exceedingly contributed to the success of this research study. To all who contributed significantly to this scholarly undertaking, no words could adequately express the researcher's gratitude.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Achor, E. E., and Ukwuru, J. (2014). An Examination of the facilitative effect of the Computer Assisted Instruction (CAI) in Students' achievement in Chemical reaction and equilibrium. *Education*, *4*(1), 7-11.

Cañeda, M. E., Logroño, J. J. F., and Culibra, C. D. (2024). Test questionnaire development on selected topics in calculus 1. *Ignatian International Journal for Multidisciplinary Research*, *2*(8), 1363-1376.

Chang, F., Yu, C., Li, D., Ji, Y., and Dong, Z. (2021). An Accurate doppler parameters calculation method of geosynchronous SAR considering real-time zero-doppler centroid control. *Remote Sensing*, *13*(20), 1-10.

Guncaga, J., Korenova, L., and Hvorecky, J. (2019). Calculators as facilitators of understanding computational and mathematical contexts. *Open Education Studies*, *1*(1), 177-183.

Li, W., Fan, J., Xu, H., Zhao, W., Meng, Q., and Su, Y. (2024). Optimal transport meshless method based fatigue life calculation method for hydraulic pipelines under combined excitation. *Applied Sciences*, *14*(6), 1-22.

Madrazo, A. L., and Dio, R. V. (2020). Contextualized learning modules in bridging students' learning gaps in calculus with analytic geometry through independent learning. *Journal on Mathematics Education*, *11*(3), 457-476.

Mainali, B. (2021). Representation in teaching and learning mathematics. *International Journal of Education in Mathematics, Science and Technology*, *9*(1), 1-21.

Ok, M. W., Bryant, D. P., and Bryant, B. R. (2020). Effects of computer-assisted instruction on the mathematics performance of students with learning disabilities: A synthesis of the research. *Exceptionality*, *28*(1), 30-44.

Paloyo, A. R., Rogan, S., abd Siminski, P. (2016). The effect of supplemental instruction on academic performance: An encouragement design experiment. *Economics of Education Review*, *55*, 57-69.

Verma, R. (2016). Computer Assisted Instruction (CAI): An Innovative Approach for Individualized Education. *International Journal of Research in Social Sciences*, *6*(12), 136-146.

DOI:
p- ISSN 2828-3287 e- ISSN 2828-3295