INTERNATIONAL EXHIBITION & SYMPOSIUM ON PRODUCTIVITY, INNOVATION, KNOWLEDGE & EDUCATION

E-PROCEEDING

EXTENDED ABSTRACT

UiTM di hatiku

اوسها تقوى مولايا

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Welcome Message

RECTOR, UITM KEDAH BRANCH

Assalamualaikum warahmatullahi wabarakatuh,

First and foremost, I would like to extend my deepest appreciation to the organising committee of i-SPiKE 2025 for their steadfast dedication and commitment in making this prestigious event a reality. My heartfelt congratulations to the committee for their tireless efforts in ensuring that i-SPiKE continues to grow as a meaningful and impactful platform for academics, researchers, students, and industry players worldwide.

The theme for this year, "Empowering Minds: Bridging Innovation, Knowledge and Education for a Sustainable Future," is both timely and significant. It reflects our shared responsibility to not only embrace creativity and technological advancement, but also to ensure that innovation directly contributes to sustainable development, equitable education, and the well-being of future generations.

i-SPiKE 2025 provides a dynamic platform for showcasing innovations that address real-world challenges while opening new avenues for collaboration, engagement, and inclusivity. By bridging knowledge, innovation, and education, this symposium strengthens our collective capacity to design solutions that empower communities and inspire positive change.
I am truly impressed by the diversity and calibre of participants in this year's event. The projects and ideas presented highlight the extraordinary creativity and determination of our innovators. I am confident that the insights and solutions shared here will pave the way for continuous advancement in teaching, learning, and innovation.

It is my sincere hope that you will find i-SPiKE 2025 an enriching experience, one that sparks new ideas, builds lasting collaborations, and strengthens our shared vision for a sustainable future. To all participants, I wish you every success, and to the winners, my warmest congratulations.
Once again, I thank the organising committee, partners, and contributors for their invaluable support. May i-SPiKE 2025 continue to inspire and empower minds for many years to come.

Professor Dr. Roshima Haji Said
Acting Rector
Universiti Teknologi MARA (UiTM) Kedah Branch

Welcome Message
(i-SPiKE 2025 CHAIR)

It is my great pleasure to welcome you to the 4th International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2025 (i-SPiKE 2025). This year's theme, "Empowering Minds: Bridging Innovation, Knowledge, and Education for a Sustainable Future," reflects our collective commitment to advancing innovation and fostering meaningful collaboration across academia, industry, and communities.

i-SPiKE 2025 provides a platform for scholars, researchers, students, and practitioners from diverse fields to showcase their ideas, share knowledge, and inspire new solutions to global challenges. We extend our sincere appreciation to all participants and contributors whose efforts and dedication have made this symposium possible.
We hope that this e-proceedings serves not only as a record of the innovations presented but also as a valuable resource that continues to inspire long after the event.

Thank you.

Dr Junaida Ismail
Chair
4th International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2025 (i-SPiKE 2025)

PREFACE

The 4th International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education (i-SPiKE 2025) marks yet another milestone in our ongoing commitment to fostering innovation, creativity, and collaboration across disciplines. Guided by this year's theme, "Empowering Minds: Bridging Innovation, Knowledge and Education for a Sustainable Future," the event provides a dynamic platform for students, educators, researchers, and professionals to share their ideas, showcase their innovations, and engage in meaningful knowledge exchange.

This year, we are pleased to report that i-SPiKE 2025 received approximately 50 initial submissions, with more than 35 projects successfully advancing to final presentation and exhibition. These projects reflect a rich diversity of innovation, ranging from educational technologies, digital applications, and gamified learning tools to sustainable materials, cultural heritage preservation, and community-focused solutions. Collectively, they embody the spirit of bridging innovation and education to address pressing societal and global challenges.

We sincerely thank all participants, reviewers, and committee members for their invaluable contributions in making i-SPiKE 2025 a success. It is our hope that this e-proceedings will not only serve as a record of the ideas and innovations presented, but also as an inspiration for future collaborations and advancements in the pursuit of sustainable knowledge and innovation.

Assoc. Prof. Dr. Azlyn Ahmad Zawawi
Editor-in-Chief, i-SPiKE 2025 Proceedings

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CATEGORY 1

S&T (ACADEMIC)

ENHANCING CONCEPTUAL UNDERSTANDING IN DIFFERENTIAL CALCULUS THROUGH EASYDIFF

Jong Li Ling
Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA
Email address
jongll@uitm.edu.my

Noriham Bujang
Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA
Email address
noriham258@uitm.edu.my

Aimi Nuraida Ali Hassan
Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA
Email address
aiminuraida@uitm.edu.my

ABSTRACT

Basic differential calculus is a core mathematical competency required for science, technology, engineering, and mathematics (STEM) students. However, students often struggle to recall basic differentiation formulas and apply them correctly across different function types, including polynomial, natural logarithmic, exponential, and trigonometric functions. To address these challenges, EasyDiff was developed, which combines formula recall, hands-on practice, and a feedback mechanism that checks answers through digital codes, facilitating continuous improvement. The platform not only helps students memorize essential differentiation techniques but also enhances their problem-solving skills through interactive exercises. By providing instant feedback, EasyDiff empowers learners to identify their mistakes and build confidence in their calculus abilities. Instant scoring features are also provided to enhance student engagement and motivate frequent practice. Moreover, the platform includes various difficulty levels, allowing students to progress at their pace. This adaptability ensures that learners of all backgrounds can obtain the support they need to master differentiation concepts effectively. This study sought to evaluate EasyDiff's effect on problem-solving accuracy, learning engagement, and long-term conceptual understanding related to differential calculus. The study participants comprised students taking Calculus I from October 2024 to February 2025. The study adopted a one-group pretest-posttest quasi-experimental design, where the investigators used a paired t-test to determine significant differences in students' conceptual understanding of differential calculus. The study reveals a significant improvement in students' conceptual understanding following the use of EasyDiff. Students' feedback also provided further validation for EasyDiff's effectiveness, where the tool was rated highly positive in terms of facilitating conceptual understanding in differential calculus. The results point to the encouraging potential of gamified approaches such as EasyDiff for higher education mathematics teaching and suggest wider applicability and scalability to the educational technology community.

Keywords: differential calculus, conceptual understanding, game, performance

INTRODUCTION

The challenges that students face in differential calculus are well-documented, particularly as they move between different types of functions such as polynomial, logarithmic, exponential, and trigonometric (Aydogan-Yenmez & Özgeldi, 2019). These challenges typically stem from difficulties in recalling key differentiation formulas and limited practice with varied question types, which often result in repeated mistakes and diminished confidence in problem-solving. Despite the key role played by differential calculus in success in STEM fields like mathematics, engineering, and computer science, many undergraduates still experience challenges related to both the retention and application of formulas. Traditional instructional approaches often focus on procedural teaching while providing few opportunities for interactive practice or constructive feedback, with these ultimately working against students' long-term retention and their capacity to apply knowledge in new contexts.

Many undergraduates struggle with correctly applying derivatives, largely due to insufficient opportunities for meaningful practice and the lack of timely, corrective feedback. Modern educational approaches, including gamification, interactive visualization, collaborative problem-solving, and the utilization of technology, have demonstrated potential in reducing these difficulties by improving student motivation, fostering a more nuanced understanding of concepts, and facilitating continued engagement (Freeman et al., 2014; Hamzah et al., 2015; Özhan & Kocadere, 2020). Gamified learning environments can provide immediate feedback, adaptive complexity, and progress monitoring, all of which are conducive to reinforcing mastery through repeated and active participation. Despite these heartening developments, there is a considerable gap in empirical research exploring the synergistic impact of gamification, structured practice, and automated feedback within an integrated platform for calculus instruction. This gap underscores the need for further targeted research in this area.

The incorporation of technology in teaching mathematics has moved well ahead of traditional methods. The modern tools allow for the instantaneous detection of mistakes and offer immediate support, thus greatly enhancing the learning process (Kochmar et al., 2020). Blending these digital tools with explanatory examples and conceptual prompts makes it possible for learners to attain higher levels of procedural accuracy and more profound understanding of concepts in challenging topics like calculus (Sweller et al., 2019).

Extending the insights from the literature review, this study created EasyDiff as a unique integrated platform for teaching and learning differential calculus. It integrates gamified features, real-time feedback, and formula recall exercises in a structured manner. With interactive exercises, automated checking of responses, and real-time scoring, EasyDiff is intended to enable students to achieve higher accuracy in solving derivatives for a variety of problem types. Concurrently, the platform aims to boost motivation and engagement by providing a more interactive and sustained practice experience compared to conventional methods.

This study explores EasyDiff's potential as a learning tool for undergraduates' basic concepts in differential calculus, specifically in the computation of derivatives for different types of functions. The study seeks to determine if EasyDiff improves students' capacities to correctly calculate derivatives and analyze its effect on overall academic performance in differential calculus. Additionally, the study will assess student engagement and satisfaction with the platform, which will reveal how interactive learning tools can enhance understanding and retention of complex mathematical concepts. The findings are expected to provide valuable insights into the effectiveness of semi-digital learning resources in mathematics education. This could lead to recommendations for integrating similar tools into curricula to foster deeper comprehension and improve student outcomes in higher-level mathematics courses. By comparing test scores and survey responses, the study aims to highlight the effectiveness of EasyDiff in promoting a deeper comprehension of differential calculus.

METHODOLOGY

This study utilized a quasi-experimental design, employing both pre- and post-tests to evaluate students' understanding of fundamental differential calculus concepts before and after engaging with the EasyDiff game. Additionally, researchers administered a simple Likert-scale questionnaire to gauge participants' perceptions and attitudes regarding their experience. Both the pre-test and post-test consisted of 10 questions that covered basic derivatives of a single variable for polynomial functions (poly), exponential functions (exp), natural logarithmic functions (ln), and trigonometric functions (trigo). Additionally, a 5-point Likert scale questionnaire was administered shortly after the EasyDiff gameplay to capture students' perceptions of the game's effectiveness, enjoyment, and engagement in relation to their learning experience.

The experimental group consisted of 38 students enrolled in Calculus I between October 2024 and February 2025. Regarding their academic backgrounds, 5% were specializing in Technology Chemical Industry, 47% were pursuing studies in Science, 18% were enrolled in Computer Science, and 30% were part of the Civil Engineering program.

The Design of EasyDiff

Figure 1. The Design of EasyDiff

Figure 1 illustrates the design of EasyDiff. EasyDiff is a semi-digital board game developed to enhance students' performance in the basic concept of differential calculus. The game is didactically focused on getting the right derivatives from different functions. The game comprises 43 function tiles, 43 derivative tiles that pair with the function tiles, 43 score tiles at 1 and 2, and 4 display game boards. The game board has 5 rows and 3 columns. The 43 function tiles are comprised of polynomial functions (poly), exponential functions (exp), logarithmic functions (ln) and trigonometric functions (trigo). To enhance gameplay fluidity, all tiles are colour-coded according to their four categories, namely functions, derivatives, right derivatives, and scores. Tiles containing functions are distinguishable by a pink hue, those with derivatives are adorned with a yellow decoration, tiles with scores are marked in green colour, and those with right derivatives are encased in an orange hue. The right derivatives are digitazed in QR (quick response) format and affixed to the reverse side of function tiles. This visual differentiation is intended not only to enhance the game's aesthetic qualities but also to facilitate more efficient decision-making as players determine their pairings. EasyDiff can accommodate up to eight players.

Implementation

Students were given 20 minutes to complete the pre-test and received an explanation about the rules of the game, EasyDiff, 15 minutes prior to the activity beginning. The learning activity was conducted twofold within 2 hours. Students could do personalized practice exercises and peer collaborative learning. Students would be provided with a set of tiles that comprise 43 functions,

explicitly indicate the reasoning underlying the tile pairings, to be placed on the displayed gameboard. Upon completion of forming the pairing, students could verify the correct derivatives by scanning the QR code on the reverse side of the function tiles. If students formed the correct pairing, they receive a score based on the score tile. The highest of the grand scores based on the total of five rows is declared the winner of the game. Ultimately, the one who scores lowest loses the game. After two hours of practice, students were asked to complete the post-test within 20 minutes, followed by a further 15 minutes to finish the questionnaire.

RESULTS

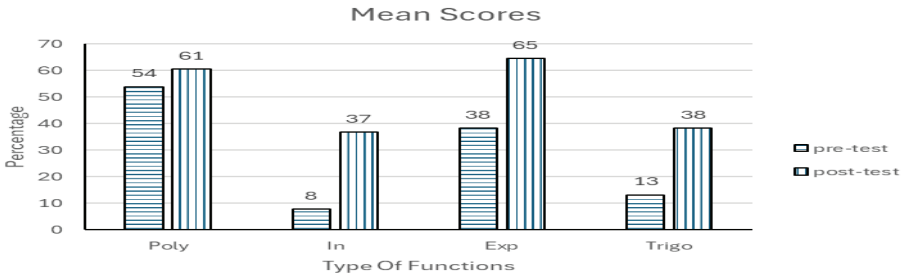

Figure 2. Pre- And Post-Test Performance for Four Types of Functions.

Figure 2 shows a 7% increase in mean scores for polynomial functions, a 29% increase for natural logarithmic functions, a 27% increase for exponential functions, and a 25% increase for trigonometric functions. The mean scores from pre-test to post-test showed an overall performance 37.4%. The difference in mean scores was analyzed by using a paired t-test. The results showed that mean scores for the post-test were significantly higher ($t(38) = 9.4$, $p = 0.001$) than mean scores for the pre-test. Students performed significantly higher mean scores for correct derivatives in the post-test ($M = 62.3$, $SD = 24.8$) than the pre-test ($M = 24.9$, $SD = 22.5$). These results showed that there was a significant difference in mean scores before and after using EasyDiff with the Cohen's effect size, $d = 1.5$, and test power of 0.8605.

In the summary of students' perceptions of the game's effectiveness, enjoyment, and engagement in relation to their basic concept of differential calculus learning experience, it was found that all dimensions obtained a very good rating. The effectiveness of knowledge acquisition attained the highest weighted mean of 4.53 with a standard deviation of 0.96, followed by engagement's weighted mean of 4.41 with a standard deviation of 0.98 and enjoyment in learning with a weighted mean of 4.32 and a standard deviation of 0.84. This indicates that the students concurred that the use of EasyDiff had enhanced their basic knowledge of differential calculus.

CONCLUSION

The findings indicate a clear and significant improvement in students' conceptual understanding following the use of EasyDiff compared to their initial performance. The difference between their pre- and post-implementation knowledge was significant, indicating that EasyDiff had a notable positive impact in line with the literature review (Freeman et al., 2014; Hamzah et al., 2015; Özhan & Kocadere, 2020). This finding highlights the efficacy of the EasyDiff in enhancing students' understanding of basic differential calculus concepts. EasyDiff promotes 21st-century learning by enhancing critical thinking, encouraging active participation, and facilitating self-

reflecting their agreement with the effectiveness of EasyDiff in enhancing conceptual knowledge of basic differential calculus. In conclusion, EasyDiff employs a hybrid gamified design that integrates formula recall, interactive activities, and instant feedback. This approach not only enhances educational outcomes but also demonstrates scalable potential for broader adoption, offering accessible, engaging, and collaborative learning opportunities.

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