UNIVERSITI TEKNOLOGI MARA

Pusat Asasi

ASiD COLLOQUIUM SERIES 2025

EXTENDED ABSTRACT BOOK

CENTRE OF FOUNDATION STUDIES
UNIVERSITI TEKNOLOGI MARA
CAWANGAN SELANGOR KAMPUS DENGKIL

ASiD COLLOQUIUM SERIES 2025

EXTENDED ABSTRACT BOOK

Editors
Siti Salwana Mamat (Dr.)
Dr Fadiatul Hasinah Muhammad (Dr.)
Ezathul Zerafena Mohd Ris
Nor Syarmila Shuib
Norashikin Kaharudin
Nurkhaizan Zulkepli (Dr.)

Published by:
Centre of Foundation Studies, Universiti Teknologi MARA Cawangan Selangor,
Kampus Dengkil, 43800 Dengkil, Selangor
2025

ASiD COLLOQUIUM SERIES 2025
EXTENDED ABSTRACT BOOK
Editors Siti Salwana Mamat/ Fadiatul Hasinah Muhammad/ Ezathul Zerafena Mohd Ris/ Nor Syarmila Shuib/ Norashikin Kaharudin/ Nurkhaizan Zulkepli

Published by:
Centre of Foundation Studies, Universiti Teknologi MARA Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor.

Preface

Assalamualaikum warahmatullahi wabarakatuh and greetings,

It is with profound honour and delight that I welcome you to the **ASiD Colloquium 2025**, an occasion dedicated to celebrating the research excellence of our esteemed lecturers. The scholarly works presented here embody not only intellectual curiosity and academic rigour but also the unwavering dedication that drives meaningful contributions across diverse fields of inquiry.

By sharing these findings, we do more than strengthen the fabric of our academic community - we also inspire one another to pursue new frontiers of knowledge and innovation. This exchange of ideas paves the way for interdisciplinary collaboration and collective advancement, reinforcing the role of research as a true catalyst for progress.

I wish to extend my deepest appreciation to the organising committee for their tireless commitment in making this colloquium a success, as well as to all the lecturers whose contributions enrich this platform. Your efforts are invaluable, and we eagerly anticipate the engaging discussions and fruitful exchanges that will follow.

May this colloquium serve as a source of inspiration, fostering fresh perspectives, innovative ideas, and lasting partnerships for the future.

Warm regards,

Dr. Fadiatul Hasinah Muhammad
Chairperson
ASiD Colloquium 2025

Foreword

Assalamu'alaikum warahmatullahi wabarakatuh and greetings,

It is with great honour that the Centre of Foundation Studies, Universiti Teknologi MARA (UiTM) Cawangan Selangor, Kampus Dengkil presents the inaugural collection of extended abstracts from the ASiD Colloquium Series 2025. We are privileged to feature contributions from distinguished scholars representing diverse disciplines, whose perspectives exemplify the collaborative spirit required to address the multifaceted challenges confronting education today. The research showcased herein reflects both expertise and meaningful steps towards advancing a sustainable future in education.

In an era defined by rapid transformation, the intersection of technology and education offers unprecedented opportunities for educators, researchers, and institutions to reconceptualise teaching and learning while shaping their contributions to a sustainable future. However, genuine innovation in education entails more than the integration of new technologies; it calls for interdisciplinary engagement, creative problem-solving, and critical awareness of social, economic, and environmental contexts. This compilation serves as a testament to the unwavering commitment of scholars who not only interrogate such challenges but also propose constructive pathways towards resilience and sustainability.

We extend our heartfelt appreciation to the contributors, editors, and reviewers whose dedication and scholarly rigour have made this publication possible. Their commitment to advancing knowledge and reshaping educational landscapes is deeply commendable. It is our hope that the insights contained within these pages will inspire readers to reflect critically and act purposefully in steering the future of education for generations to come.

Thank you.

Professor Dr. Haji Zulkhairi Haji Amom
Director
Centre of Foundation Studies
Universiti Teknologi MARA (UiTM)
Cawangan Selangor
Kampus Dengkil

Table of Contents

	Page
Preface	ii
Foreword	iii
Limiting Prime Minister Tenure in Malaysia Parliamentary System of Government: From a Legal Point of View	1
Zinc Oxide-Based Photocatalysts for Wastewater Remediation: Recent Advances and Perspectives	4
ESL Pre-University Students' Perceptions of the Generic Rubric Used to Assess Problem-Solution Essay – A Preliminary Study	7
Comparative Stability Analysis of the Extended Singly Diagonally Implicit Block Backward Differentiation Formulas Family	10
Empowering All Abilities: Innovation in Inclusive Remote Education	13
Aplikasi Model A.D.A.B dalam Kaedah Penerapan Nilai Murni bagi Kursus Matapelajaran Pengajian Umum (MPU) di UiTM	16
Tuning the Electronic and Optical Properties of ZnO by Ag Doping: A DFT+*U* Investigation	22
The Phonological Features of Malaysian English (MAE) 2.0	25
Operational Framework for an Independent ICH Commission in Malaysia	28
Comparative Analysis of Supplier Selection using Analytic Hierarchy Process and Potential Method	31
Examining the Issues and Challenges Encountered by Mathematics' Trainee Teachers	35
A Review on Synthesis of Silver Oxide Nanoparticles	38
Zinc Oxide Nanocomposite and Photocatalyst Applications as Antimicrobial: A Review	42
Improving Primary School Students' Understanding in Unit Conversion Using the 1,2,3 BOX Method	47
Review of Biodegradation of Carbofuran: Microbial Degradation and Enzymatic Mechanisms	50
The Effect of Aluminium Oxide Nanofillers on Electrochemical Properties of Cornstarch/NaI Biopolymer Electrolytes	55

Limiting Prime Minister Tenure in Malaysia Parliamentary System of Government: From a Legal Point of View

Abang Ikhbal Abang Bolhil*, Mohd Safri Mohammed Na'aim

Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*abg.ikhbal@uitm.edu.my

ABSTRACT

Malaysia Parliamentary system of government have practiced democratic governance since its first session in 1957. The Yang Di Pertuan Agong (YDPA) as the Head of State is empower by the Federal Constitution to appoint any members from Dewan Rakyat who in His Majesty judgement is likely to command the confidence of the majority members of Dewan Rakyat. Only 9 members of Dewan Rakyat have ever appointed to the position of Prime Minister since 1957 after 15 General election. Unlike Presidential system of government, which normally limit the tenure of a President to two terms of four years each, there is no limit on the tenure of any Prime Minister as long the appointment is according to the provision stipulated within Article 43 of Federal Constitution of Malaysia. The Constitution of Malaysia emphasize only two main priorities in the appointment of Prime Minister which can be summarize as the prerogative power of YDPA and the members of Parliament must hold the majority confidence of Dewan Rakyat. This practice has ensured democratic governance as its core function and confirming majority rule in Dewan Rakyat that become the main voice of people representatives. However, this practice may create another dilemma of bureaucratic polemic since it could allow any members of Parliament to clinch the power in such substantial tenure as long the members hold the confidence of the house of representative. Executive power can project immense power and the cloth of administration will enable unrelenting advantageous towards the people that wield it. This research intends to explore further the notion of limiting Prime Minister tenure in Malaysia system of government by reviewing its legality, practicality and rational. Doctrinal analysis from secondary sources is used in this research. This research found that limiting Prime Minister tenure acquire certain modification in our law and the initiative of political party. Research recommends further discussion on the tenure of Prime Minister in order to guide the law makers and public at larger of the importance of such notion.

Keywords: Federal Constitution, limitation, tenure, Prime Minister.

1. INTRODUCTION

Malaysia has established democratic rule since the first general election held in 1955, The Alliance party spectacular win by capturing 51 out of 52 Federal legislative seat beckoning the new era of independence for Malayan people. Tunku Abdul Rahman Putra Al Haj become the first Chief Minister of Malaya and the first cabinet members were appointed as minister for the new government begin their official duty to administer the nation. Dictate by the utmost responsibility towards the nation and the people of Malaya, our executive become the main pillar in exercising their solemn oath as dual executive which transcend into the echo of time balancing the need of people choice for their representative to govern them and royal institution

becoming the symbol of unity as the head of state. Parliamentary democracies system allowed the people of a nation to choose their representative or leader thru democratic free and fair election. After 5 years, the Prime Minister will seek an audience with the Yang Di Pertuan Agong of Malaysia requesting the dissolution of parliament in order to conduct new general election to choose the new government. This practice can be done much earlier than 5 year allocation of limit since there is no fix tenure for any government under the parliamentary system of government. The YDPA as head of State will act in his majesty discretion upon the request for the dissolution of Parliament but his majesty may accept or reject the request by the Prime Minister. After the dissolution of parliament, fresh general election will be held for federal parliamentary seat and qualified citizens will be allowed to become the candidate and electoral voters. Once the result is announced any political parties or coalition will have the opportunity to become the next government if they already captured at least a simple majority from 222 seats of Dewan Rakyat. However, the biggest question still remained unsolved since the position of Prime Minister is appointed not elected. His majesty the YDPA of Malaysia have the final say in appointing any member from Dewan Rakyat that in his majesty opinion have the confidence and support of Dewan Rakyat. Since there is no direct election, any members of Parliament as long they have enough support from the floor is eligible to become the next Prime Minister. This eventually led to this research which in essence focus on limiting the tenure of any prime minister in Malaysia democratic system of government. Objectively the research will review the legality of the position of prime minister, the rationality of limiting the term for any member of Dewan Rakyat to hold the position as prime minister and eventually evaluate the rationality to limit the term in more constructive understanding.

2. METHODOLOGY

Doctrinal analysis from secondary sources is used in this research. It is a qualitative work that relies largely on information that is readily available to the public, such as reports, research, publications, case studies, and legal reports. Each source that was received was subjected to in-depth analysis to provide an authentic and accurate evaluation, which was necessary to achieve the goal of the research.

3. RESULTS AND DISCUSSION

Malaysia establish parliamentary democratic rule since independence in 1957. This will ensure eligible citizen the right to vote their representative for parliamentary seat according to the respective constituent. Currently the Malaysian House of Representative also known as Dewan Rakyat comprise of 222 members from 13 states and federal territories. Any member of Dewan Rakyat pursuant to Article 43(2) (a) who likely in command of the majority confidence of Dewan Rakyat can be appointed as Prime Minister to preside over the Cabinet by his majesty the Yang Di Pertuan Agong of Malaysia. This lead to the notion that the position of Prime Minister is by appointment of Yang Di Pertuan Agong and not through election furthermore Article 40 (2) (a) empower the Yang Di Pertuan Agong alone to act in his discretion to appoint any member of Dewan Rakyat to the position of Prime Minister and this function is exclusively practice by his majesty alone without any interference from any branches and even the judiciary would not intervene in this matter since the court will not have any *Locus Standi* regarding this particular matter of appointment. The federal constitution only mentions one particular pre condition under Article 43(7) which limit any person who is a citizen by naturalization or registration under Article 17 of federal constitution shall not be appointed as Prime Minister of Malaysia. Federal constitution obviously delegates the power of appointment to the Yang Di Pertuan Agong, this is consistent with basic parliamentary concept that ensure check and

balance within executive branch that empower the head of state (YDPA) to appoint head of government (PM). However, it should be highly noted that his majesty must not involve directly in politics and serve only as neutral person in accepting or rejecting potential candidate who wish to become the Prime Minister. Any potential candidate must convince his majesty that he or she have the confidence the majority members of Dewan Rakyat, there is no specific method mention in the federal constitution however since the formation of the first cabinet in 1955 the political parties who won the biggest seat in parliament or any coalition that support any member of Dewan Rakyat will have the biggest chance to become the next Prime Minister.

Limiting Prime Minister Term

The basis of any limitation transpired thru any law that specifically limit or prohibit such measure. There is no specific provision in the federal constitution that mention such limitation. Federal constitution of Malaysia quiet explicit in term of the appointment and removal of Prime Minister however no specific provision appears regarding limitation. Furthermore, Members of Parliament (Remuneration) Act 1980, Houses of Parliament (Privileges and Powers) Act 1952 two most significant federal legislation regarding the members of parliament does not limit any term for members of parliament in office, with the exception of members of Dewan Negara that only have 6 year term. Consequently, Prime Minister is not a public servant by virtue of Article 132 that list down public services for the federation, which relate to the limitation as a public servant for mandatory retirement according to Pension Act 1980. Based on the basis of legality there is no law that limit the Prime Minister tenure in office; therefore it can be limited according to certain mechanism.

4. CONCLUSION AND RECOMMENDATION

Recommend further discussion on the tenure of Prime Minister in order to guide the law makers and public at larger of the importance. The Major concern on concentration of power which may lead to abuse of power must become the focal point discussion. Political harmony and stability will ensure growth in economic and social stability.

ACKNOWLEDGEMENT

The author is extremely grateful with the support and contribution from fellow author and express the highest appreciation to Centre of Foundation Studies UiTM Dengkil, research committee for the opportunity.

REFERENCES

Federal Constitution of Malaysia
Members of Parliament (Remuneration) Act 1980
Houses of Parliament (Privileges and Powers) Act 1952
Pension Act 1980

Shad Saleem Faruqi (2008). Document of Destiny, *The Constitution of the Federation of Malaysia:* Star Publication (Malaysia) Bhd

Zinc Oxide-Based Photocatalysts for Wastewater Remediation: Recent Advances and Perspectives

Hartini Ahmad Rafaie*

Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*hartinirafaie@uitm.edu.my

ABSTRACT

Zinc oxide (ZnO) is a cost-effective, non-toxic semiconductor with strong potential for photocatalytic degradation of persistent pollutants in wastewater. However, its wide bandgap (~3.37 eV) and rapid electron–hole recombination limit efficiency under solar light. This mini review summarizes the fundamentals of ZnO photocatalysis, identifies intrinsic limitations, and discusses recent advances in doping, heterojunction engineering, and green synthesis. Modified ZnO systems now demonstrate enhanced visible-light absorption, improved charge separation, and recyclability, with applications in dye, pharmaceutical, and heavy metal removal. Future work should address scalability, real wastewater testing, and sustainability assessment to bridge laboratory success with practical deployment.

Keywords: ZnO photocatalysis, wastewater treatment, doping, heterojunction, green synthesis

1. INTRODUCTION

Global water contamination from dyes, pharmaceuticals, and heavy metals is a growing environmental concern. Many of these pollutants are chemically stable, toxic, and resistant to conventional treatments (Mousa et al., 2024). Semiconductor photocatalysis, an advanced oxidation process (AOP), degrades organic contaminants into CO_2 and H_2O using light-activated reactive oxygen species (ROS) such as hydroxyl radicals (•OH) and superoxide anions (O_2^{-}•) (Ramírez et al., 2021). ZnO has emerged as a promising photocatalyst due to its direct bandgap (~3.37 eV), high exciton binding energy, non-toxicity, and low cost (Zhu & Wang, 2025). It can degrade dyes like methylene blue and rhodamine B, pharmaceuticals such as tetracycline, and toxic metals like Cr(VI) through photoreduction. However, its activation is limited to the UV region (~5% of the solar spectrum), coupled with rapid electron–hole recombination and vulnerability to photocorrosion, which collectively restrict its potential for large-scale applications (Ghamarpoor et al., 2024).

2. FUNDAMENTALS OF ZnO PHOTOCATALYSIS

Upon UV illumination, ZnO generates electron–hole pairs: electrons in the conduction band (CB) reduce oxygen to O_2^{-}•, and holes in the valence band (VB) oxidize water to •OH. These ROS mineralize pollutants into harmless products. Nanostructured ZnO such as nanorods, nanosheets, flowers enhance performance by increasing active surface area and tuning defect states for better carrier lifetimes (Güell et al., 2023). Characterization techniques such as UV–Vis diffuse reflectance spectroscopy (DRS) and photoluminescence (PL) reveal bandgap shifts and recombination dynamics. Lower PL intensity in modified ZnO typically indicates suppressed recombination and improved photocatalytic potential (Aftab et al., 2022).

3. LIMITATION OF PURE ZnO

Pure ZnO suffers from several intrinsic drawbacks that limit its large-scale photocatalytic applicability. Its wide bandgap (~3.37 eV) confines photoactivation to the ultraviolet region, which accounts for only about 5% of the solar spectrum, thereby restricting solar energy utilization. Moreover, photogenerated electrons and holes in ZnO tend to recombine rapidly, resulting in short carrier lifetimes and reduced yields of reactive oxygen species (ROS). Prolonged operation under irradiation can also induce photocorrosion, in which surface Zn^{2+} ions are leached into solution, degrading the catalyst's structural integrity and potentially introducing secondary contamination (Ramírez et al., 2021). In addition, ZnO's performance in real wastewater systems is often markedly lower than in laboratory dye tests due to the presence of natural organic matter, ionic strength variations, and pH-dependent surface charge effects that compete for ROS and inhibit target pollutant degradation (Nazim et al., 2023).

4. RECENT ADVANCES

Recent developments have focused on overcoming ZnO's intrinsic limitations through doping, heterojunction construction, and green synthesis approaches. Doping with transition metals such as Ag, Ni, Fe, and Ru, as well as non-metals including N, C, and S, has proven effective in narrowing ZnO's bandgap, thereby extending light absorption into the visible range and suppressing electron–hole recombination. For example, AgCl/ZnO/g-C_3N_4 composites demonstrated over 90% tetracycline degradation under visible light, highlighting the synergistic role of plasmonic silver species and g-C_3N_4 in enhancing charge transfer (Ding et al., 2023). Heterojunctions between ZnO and semiconductors such as g-C_3N_4, CuO, or TiO_2 create built-in electric fields at the interface, which promote efficient spatial separation of photoexcited carriers. A Ru–ZnO@g-C_3N_4 composite achieved rapid methylene blue degradation due to the Z-scheme charge transfer pathway, which preserved strong redox ability while minimizing recombination (Albadri et al., 2023). Green synthesis routes using plant-based precursors, such as lychee peel extract or marine algae (Padina pavonica), have gained attention for producing ZnO nanoparticles with high crystallinity, small particle sizes, and abundant surface functional groups. These bio-inspired nanoparticles have achieved dye removal efficiencies exceeding 98%, offering an eco-friendly alternative to conventional chemical synthesis while reducing production costs and environmental footprint (Alprol et al., 2024; Mousa et al., 2024).

5. CONCLUSION

Recent advances in doping, heterojunction engineering, and green synthesis have upgraded ZnO from a UV-only photocatalyst to a visible-light-active material with better charge separation, stability, and reusability. These strategies address its narrow light absorption, rapid recombination, and photocorrosion while promoting eco-friendly production. However, large-scale application remains limited, as most studies use model pollutants under controlled conditions. Future work should prioritize pilot-scale tests in real wastewater, long-term stability, scalable green synthesis, and integration with solar-driven systems. Meeting these challenges could enable ZnO-based photocatalysts to transition from laboratory research to practical, sustainable wastewater treatment solutions.

ACKNOWLEDGEMENT

The author gratefully acknowledges the Centre of Foundation Studies, Universiti Teknologi

MARA, for the continuous support and encouragement in carrying out this work.

REFERENCES

Albadri, A. E. A. E., Aissa, M. A. B., Modwi, A., & Saleh, S. M. (2023). Synthesis of mesoporous Ru–ZnO@g-C_3N_4 nanoparticles and their photocatalytic activity for methylene blue degradation. *Water*, 15(3), 481.

Alprol, A. E., Eleryan, A., Abouelwafa, A., Gad, A. M., & Hamad, T. M. (2024). Green synthesis of zinc oxide nanoparticles using Padina pavonica extract for efficient photocatalytic removal of methylene blue. *Scientific Reports*, 14, 32160.

Aftab, S., Shabir, T., Shah, A., et al. (2022). Highly efficient visible light active doped ZnO photocatalysts for the treatment of wastewater contaminated with dyes and pathogens of emerging concern. *Nanomaterials*, 12(3), 486.

Ding, C. M., Zhu, Q. R., Yang, B., Petropoulos, E., Xue, L. H., Feng, Y. F., He, S. Y., & Yang, L. Z. (2023). Efficient photocatalysis of tetracycline hydrochloride from pharmaceutical wastewater using AgCl/ZnO/g-C_3N_4 composite under visible light. *Journal of Environmental Sciences*, 126, 249–262.

Ghamarpoor, R., Fallah, A., Jamshidi, M. A., et al. (2024). A review of synthesis methods, modifications, and mechanisms of ZnO/TiO_2-based photocatalysts for photodegradation of contaminants. *ACS Omega*, 9(24), 25457–25492.

Güell, F., Galdámez-Martínez, A., Martínez-Alanis, P. R., Catto, A. C., da Silva, L. F., Mastelaro, V. R., Santana, G., & Dutt, A. (2023). ZnO-based nanomaterials approach for photocatalytic and sensing applications: Recent progress and trends. *Materials Advances*, 4(3), 967–993.

Mousa, S. A., Wissa, D. A., Hassan, H. H., Ebnalwaled, A. A., & Khairy, S. A. (2024). Enhanced photocatalytic activity of green synthesized zinc oxide nanoparticles using low-cost plant extracts. *Scientific Reports*, 14, 16713.

Nazim, V. S., El-Sayed, G. M., Amer, S. M., Nadim, A. H., et al. (2023). Optimization of metal dopant effect on ZnO nanoparticles for enhanced visible LED photocatalytic degradation of citalopram. *Sustainable Environment Research*, 33, 39.

Ramírez, A. E., Montero-Muñoz, M., López, L. L., Ramos-Ibarra, J. E., Coaquira, J. A. H., Heinrichs, B., & Páez, C. A. (2021). Significantly enhancement of sunlight photocatalytic performance of ZnO by doping with transition metal oxides. Scientific Reports, 11, 2804.

Zhu, C., & Wang, X. (2025). Nanomaterial ZnO synthesis and its photocatalytic applications: A review. *Nanomaterials*, 15(9), 682.

ESL Pre-University Students' Perceptions of the Generic Rubric Used to Assess Problem-Solution Essay – A Preliminary Study

Nur Hani Laily Ramli*

Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, Dengkil 43800, Selangor, Malaysia

*nurha056@uitm.edu.my

ABSTRACT

Rubrics are widely used in writing assessment to guide students' performance and support educators in providing structured feedback. This preliminary study explores ESL pre-university students' perceptions of a generic scoring rubric used to assess their problem-solution essays. Twenty-three students from a Malaysian foundation programme participated by responding to an adapted questionnaire based on Gutiérrez (2017), which examined the rubric's goals, structure, and usefulness. Descriptive statistics revealed that while students generally found the rubric helpful in guiding their essay writing, they perceived its criteria as too broad to effectively support the development of specific writing skills required for problem-solving tasks. Although students acknowledged the rubric's value as a basic guide, findings suggest that a more detailed and targeted rubric is needed to better facilitate learning outcomes and improve writing proficiency. This study underscores the importance of refining assessment tools to enhance their pedagogical impact on ESL learners' academic writing and to further enhance problem-solving skills.

Keywords: writing assessment, ESL learners, scoring rubric, problem-solution essay, pre-university students.

1. INTRODUCTION

In English language education, particularly writing instruction, assessment rubrics are vital tools that guide learners toward academic expectations and provide transparent criteria for evaluation. Among ESL (English as a Second Language) learners, especially at the pre-university level, writing remains a challenging skill due to difficulties in idea organisation, language proficiency, and understanding task requirements (Ramli et al, 2024). Rubrics can mitigate these challenges by clarifying performance expectations and supporting students' self-regulation in writing. However, the effectiveness of generic rubrics, those designed to assess writing broadly across genres, has been questioned, particularly for complex essay types (Ragupathi & Lee, 2020) such as problem-solution essays. Hence, this preliminary study investigates ESL pre-university students' perceptions of a generic scoring rubric used to assess their problem-solution writing, determining its clarity, organisation, and usefulness.

2. METHODOLOGY

A quantitative research design was employed using an adapted questionnaire from Gutiérrez (2017). The instrument was modified to focus on three key constructs relevant to the rubric: (1) goals and objectives, (2) components and organisation, and (3) overall usefulness. The study

involved 23 ESL pre-university students from a Malaysian foundation programme who had been previously taught how to write problem-solution essays. The students responded to the questionnaire via an online platform. The questionnaire consisted of 13 items rated on a 5-point Likert scale. The internal consistency of the instrument, as measured by Cronbach's Alpha, was high ($\alpha = 0.96$). Descriptive statistics, including mean and standard deviation, were analysed using SPSS (Version 29).

3. RESULTS AND DISCUSSION

Table 1. *ESL Pre-University Students' Perceptions of the Generic Scoring Rubric*

Rubric Element	Aspect Evaluated	Mean (M)
Goals and Objectives	Clarity of rubric's purpose as a writing guide	4.22
	Detail in explaining criteria	3.57
	Overall perception	**Moderate**
Components and Organisation	Clarity of language used in rubric	4.00
	Sufficiency and relevance of assessment criteria	3.65
	Overall perception	**Moderate**
Usefulness	Helpful as a reference tool	4.04
	Contribution to improving writing performance	3.78
	Overall perception	**Moderate**

The findings showed that the students' overall perception of the generic rubric was moderate. For the *goals and objectives* section, the highest-rated item was the clarity of the rubric's purpose as a writing guide (M = 4.22), while the lowest was the level of detail in explaining criteria (M = 3.57). This indicates that while the rubric served as a general guide, its vague descriptors made it less effective for supporting specific skills in problem-solving writing. A good rubric should be clear to assist students in fulfilling the requirements of an essay (Arindra & Ardi, 2020).

In the *components and organisation* category, students appreciated the clarity of language used (M = 4.00), yet raised concerns about the sufficiency and relevance of assessment criteria (M = 3.65). These results suggest that while students could understand the rubric's structure, its limited scope did not adequately cover key problem-solution elements such as thesis statements, cause-effect logic, or coherence in argument development. Detailed descriptions of components being assessed in a rubric are essential. This is because they outline the specific skills and knowledge students must demonstrate to achieve the intended learning outcomes (Chowdhury, 2018).

As for *usefulness*, students agreed that the rubric was helpful as a reference tool (M = 4.04), though its contribution to improving actual writing performance received only moderate ratings (M = 3.78). The results point to a misalignment between rubric design and the instructional needs of ESL students who require more scaffolded support in genre-specific writing tasks. Therefore, designing a rubric is crucial, as it guides students in developing and refining the targeted writing skills. Regularly reviewing and adjusting rubrics is essential to maintain their reliability, validity, and overall usability (Banerjee et al., 2015).

These findings align with previous literature that emphasises the importance of detailed, genre-aligned rubrics in writing instruction (Chowdhury, 2018; Ragupathi & Lee, 2020). A generic rubric, although beneficial for general guidance, may not sufficiently foster the critical writing skills necessary for mastering complex essay types among ESL learners.

4. CONCLUSION

This preliminary study highlights that while a generic scoring rubric is moderately useful as a basic guide for ESL pre-university students writing problem-solution essays, it lacks the specificity required to enhance writing skills effectively. The students' feedback underscores the need for rubric revision, particularly in terms of incorporating more detailed descriptors and genre-specific expectations. Educators and curriculum designers are encouraged to develop and implement analytic rubrics tailored to specific writing genres to better support learner development. Future studies should expand the sample size and explore comparative analyses across different essay types and institutional contexts to validate and enrich the findings.

ACKNOWLEDGEMENT

The researcher would like to express heartfelt thanks to the ESL pre-university students from a Malaysian foundation programme who participated in this preliminary study. Their valuable input and willingness to share their perceptions contributed meaningfully to the exploration of rubric use in writing assessment. Sincere appreciation is also extended to those who supported the research process, directly or indirectly, making this study possible.

REFERENCES

Arindra, M. Y., & Ardi, P. (2020). The correlation between students' writing anxiety and the use of writing assessment rubrics. *LEARN Journal: Language Education and Acquisition Research Network Journal, 13*(1), 76–93. https://eric.ed.gov/?id=EJ1242955

Banerjee, J., Yan, X., Chapman, M., & Elliott, H. (2015). Keeping up with the times: Revising and refreshing a rating scale. Assessing Writing, 26, 5-19. https://doi.org/10.1016/j.asw.2015.07.001

Chowdhury, F. (2018). Application of rubrics in the classroom: A vital tool for improvement in assessment, feedback and learning. *International Education Studies, 12*(1), 61–68. https://doi.org/10.5539/ies.v12n1p61

Gutiérrez, R. (2017). Political conocimiento for teaching mathematics: Why teachers need it and how to develop it. In S. E. Kastberg, A. M. Tyminski, A. E. Lischka, & W. B. Sanchez (Eds.), *Building support for scholarly practices in mathematics methods* (pp. 11–38). Information Age Publishing.

Ragupathi, K., & Lee, A. (2020). Beyond fairness and consistency in grading: The role of rubrics in higher education. In C. S. Sanger & N. W. Gleason (Eds.), *Diversity and inclusion in global higher education* (pp. 59–73). Palgrave Macmillan. https://doi.org/10.1007/978-981-15-1628-3_3

Ramli, N. H. L., Abdul Kadar, N. S., & Rafek, M. (2024). ESL foundation learners' difficulties and strategies applied in writing argumentative essay online. *ESTEEM Journal of Social Sciences and Humanities, 8*(1), 1–13. https://ejssh.uitm.edu.my

Comparative Stability Analysis of the Extended Singly Diagonally Implicit Block Backward Differentiation Formulas Family

Zharif Aliff Shah Norzam Hazli[1], Muhammad Hanif Abdul Razak[2], Saufianim Jana Aksah[3]*

[1,2]Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Seremban, 70300 Seremban, Negeri Sembilan, Malaysia
[3]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*saufianim@uitm.edu.my

ABSTRACT

Stiff ordinary differential equations (ODEs) are common in real-world applications. This study compares the stability of methods within the Extended Singly Diagonally Implicit Block Backward Differentiation Formulas (ESDIBBDF) family by analyzing their stability regions using Maple software. The methods are evaluated based on A, $A(\alpha)$, and stiff stability. Results show that structural modifications significantly affect stability, as reflected by the stiffness abscissa D and α. The findings confirm the suitability of ESDIBBDF methods for solving stiff ODEs.

Keywords: Stiff Ordinary Differential Equations, Stability Analysis for Stiff ODEs, $A-$Stability, $A(\alpha)-$Stability, Stiffly Stable

1. INTRODUCTION

Stiff ordinary differential equations (ODEs) frequently arise in real-world applications such as chemical kinetics, epidemiological modeling, electrical circuits, mechanical systems, control and robotic systems, and environmental or climate models involving multiple time scales. These problems typically involve both fast and slow dynamics, and solving them accurately requires numerical methods with strong stability properties. Without appropriate stability, even small step sizes can lead to numerical oscillations or divergence, making the solution unreliable or unusable. The most desirable and widely accepted type of stability for stiff solvers is $A-$stability defined by Lambert (1991) as follows:

Definition 1: *A numerical method is said to be $A-$stable if its region of absolute stability contains the whole left-hand half-plane*, $Re(h) < 0$.

In cases where full $A-$stability is not achievable, $A(\alpha)-$stability or stiffly stable may still be sufficient, as these properties effectively damp the fast components of stiff systems while preserving accuracy. For the $A(\alpha)$ and stiffly stable, the following definitions by Butcher (2008) will be considered.

Definition 2: *A method is stiffly stable with stiffness abscissa D if the stability region includes all complex numbers, z, such that* $Re(z) \leq -D$.

Definition 3: *A numerical algorithm is said to be* $A(\alpha)$ *−stable for some* $\alpha \in \left[0, \frac{\pi}{2}\right]$ *if the region of absolute stability includes the infinite wedge* $S_\alpha = \{H: |Arg(-H)| < \alpha, H \neq 0\}$.

Implicit methods like Backward Differentiation Formulas (BDF) are well-known for their stability advantages. İbrahim et al. (2019) emphasized that expanding the stability region of the Block BDF (BBDF) method is critical for solving stiff problems, as broader stability regions allow for fewer step-size restrictions. BBDF methods have been shown to cover the left half of the complex plane, ideal for stiff problems (Aksah et al., 2019; Zawawi, 2020). Aksah et al. (2019) also found that among BBDF variants, the Singly Diagonally Implicit BBDF (SDIBBDF) method offers the largest stability region due to step-size considerations. Expanding on this, Jusoh et al. (2023) proposed the Extended SDIBBDF (ESDIBBDF) method, ESDI3BBDF(3), which demonstrated $A(\alpha)$ −stability and stiffly stable. Azizan (2025) later extended it to a four-point version, ESDI4BBDF(3), which showed further changes in stability behavior.

This research aims to conduct a comparative stability analysis of methods within the ESDIBBDF family, specifically comparing the BBDF method by İbrahim et al. (2019), the ESDI2BBDF(2) method by Aksah et al. (2019), the ESDI3BBDF(3) method by Jusoh et al. (2023), and the ESDI4BBDF(3) method by Azizan (2025).

2. METHODOLOGY

First, we will review the construction of the stability graph for the ESDI4BBDF(3) method, which is plotted using Maple software. The stability analysis is carried out after confirming that the method satisfies consistency and zero-stability, thereby proving its convergence. The graph is generated by substituting $t = e^{i\theta}$, with $\theta \in [0, 2\pi]$ into the stability polynomial of the method, $R(H)$, as presented in Azizan (2025), as shown.

$$R(H) = \frac{94}{14641}tH + \frac{5865}{14641}t^2 + \frac{960}{1331}t^2H + \frac{2448}{14641}t^2H^2 - \frac{12312}{14641}t^3H - \frac{27864}{14641}t^3H^2 + \frac{5184}{14641}t^3H^3 - \frac{24}{11}t^4H + \frac{216}{121}t^4H^2 - \frac{864}{1331}t^4H^3 + \frac{1296}{14641}t^4H^4 - \frac{20694}{14641}t^3 + t^4 + \frac{188}{14641}t$$

The stability graph of the ESDI4BBDF(3) method, along with selected methods from the ESDIBBDF family, is presented in Figure 1.

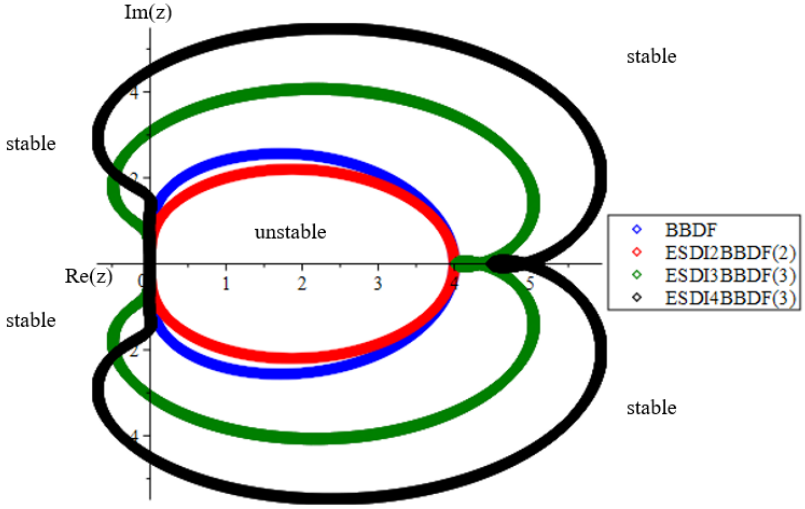


Figure 1. Stability Graph of ESDIBBDF Methods

3. RESULTS AND DISCUSSION

As shown in Figure 1, the stability region decreases as the graph size increases. The ESDI4BBDF(3) method has the smallest stability region, followed by ESDI3BBDF(3), ESDI2BBDF(2), and BBDF. Based on Definition 1, BBDF and ESDI2BBDF(2) satisfy $A-$stability, while ESDI3BBDF(3) and ESDI4BBDF(3) exhibit stiff and $A(\alpha)-$stability as defined in Definitions 2 and 3. The corresponding values of D and α , which justify the $A(\alpha)$ and stiff stability properties, are summarized below.

Table 1. Boundary of the Unstable Region, Value of D and α

METHODS	UNSTABLE REGION	D	α
BBDF	[0.009, 3.99]	-	-
ESDI2BBDF(2)	[0.0, 4.0]	-	-
ESDI3BBDF(3)	[0.0, 4.03]	0.56	65°
ESDI4BBDF(3)	[0.009, 4.441]	0.56	68°

4. CONCLUSION

The objective of this study was successfully achieved. The findings show that extensive modifications to the method significantly affect its stability characteristics. While $A-$stability was initially observed, changes in the method's dimensional structure resulted in a loss of full $A-$stability, with the methods instead exhibiting $A(\alpha)-$stable and stiffly stable. These changes influence step size selection when solving highly stiff problems, as reduced stability regions require more cautious integration strategies.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Universiti Teknologi MARA (UiTM). The authors extend their heartfelt gratitude to the reviewers for their invaluable and insightful suggestions.

REFERENCES

Aksah, S. J., Ibrahim, Z. B., & Mohd Zawawi, I. S. (2019). Stability analysis of singly diagonally implicit block backward differentiation formulas for stiff ordinary differential equations. *Mathematics*, 7(2), 211. https://doi.org/10.3390/math7020211

Azizan, R. Z. S. R. (2025). *Formulation of 4-Points Extended Singly Diagonally Implicit Block Multistep Method for Ordinary Differential Equations with Stiffness*. FYP Thesis, Universiti Teknologi MARA.

Butcher, J. C. (2008). Numerical Methods for Ordinary Differential Equations 2nd ed. John Wiley & Sons Ltd.

Ibrahim, Z., Noor, N., & Othman, K. (2019). Fixed coefficient A(α)-stable block backward differentiation formulas for stiff ordinary differential equations. *Symmetry,* 11(7): 846. https://doi.org/10.3390/sym11070846

Jusoh, R., Aksah, S. J., Zainuddin, N., & Ibrahim, Z.B. (2023). Numerical solver of A(alpha)-stable for stiff ordinary differential equations. *Engineering Letters*, 31(4): 1574-1583.

Lambert, J. D. (1991). *Numerical Methods for Ordinary Differential Systems: The Initial Value Problems*. John Wiley & Sons Ltd.

Zawawi, I. (2020). BBDF-α for solving stiff ordinary differential equations with oscillating solutions. *Tamkang Journal of Mathematics*, 51(2), 123-136.

Empowering All Abilities: Innovation in Inclusive Remote Education

Zazaleena Zakariah[1], Nawal Abdul Razak[2]*, Juhaida Ismail[3], Rozeleenda Abdul Rahman[4], Prasanna Ramakrishnan[5]

[1,2] Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia
[3,4] Fakulti Sains Komputer dan Matematik, Universiti Teknologi MARA, Cawangan Pahang, Kampus Raub, 27600 Raub, Pahang, Malaysia
[5] Fakulti Sains Komputer dan Matematik, Universiti Teknologi MARA Shah Alam, Selangor, Malaysia

*nawal@uitm.edu.my

ABSTRACT

This project seeks to transform the landscape of remote education by creating an inclusive digital learning environment that accommodates the diverse needs of students with disabilities. Its core objective is to improve accessibility, usability, and learner engagement through the implementation of assistive technologies and customizable tools. By addressing the unique challenges faced by students with visual, cognitive, physical, and learning disabilities, the initiative strives to deliver a more equitable and empowering educational experience. The platform incorporates inclusive features such as adjustable font sizes, text-to-speech capabilities, screen reader compatibility, and alternative input methods, allowing all learners to meaningfully engage with digital content. Additionally, interactive multimedia resources and adaptive learning pathways are designed to enhance motivation and support individualized learning. Beyond enhancing academic outcomes and boosting self-confidence, the project aims to eliminate physical and technological barriers that may limit participation in remote learning. It encourages learner independence and promotes the use of universal design principles within digital education systems. Setting a new standard for accessibility, this initiative also raises awareness about the importance of inclusive educational practices. In the future, the platform will be integrated into existing university learning management systems to ensure long-term usability, offering seamless access to inclusive tools and contributing to a more equitable learning ecosystem.

Keywords: Inclusive Remote Classrooms; Online Learning; E-learning; Learners with Disabilities; Special Need Learners

1. INTRODUCTION

The shift towards digital learning has underscored the urgent need for inclusive remote education platforms that accommodate learners of all abilities. Many conventional learning management systems lack usability and essential assistive tools, creating significant accessibility barriers for students with disabilities. To address these challenges, this initiative aims to revolutionize online education by integrating assistive technologies and applying universal design principles. Grounded in the Universal Design for Learning (UDL) framework (Al-Azawei et al, 2022) the platform offers features such as text-to-speech functionality, screen readers, and customizable interfaces to support learners with visual, physical, and cognitive impairments. Research highlights the positive impact of adaptive learning tools in increasing motivation and engagement among students with disabilities (Yang & Taele, 2025). The

platform also includes interactive multimedia elements and personalized learning paths to encourage active participation, aligning with learner-centered and technology-enabled educational models (Wells, 2024). By removing technological and educational barriers, this project seeks to enhance academic achievement, foster greater learner independence, and build self-confidence among students with diverse needs. Moreover, it promotes best practices in accessibility and sets a new standard for inclusivity in online education, contributing to a more equitable and supportive digital learning environment (Saborío-Taylor & Rojas-Ramírez, 2024).

2. METHODOLOGY

This study utilized a structured approach to design and evaluate inclusive features for remote learning platforms tailored to students with disabilities. It began with expert interviews involving specialists in pedagogy and educational technology, identifying key barriers faced by learners with visual, auditory, cognitive, and physical impairments. From these insights, nine enhancement features were proposed, including audio assistance, multimodal delivery, and structured content access. A prototype was developed and tested by 48 students with disabilities to assess usability and effectiveness. A ranking analysis identified the most impactful features. The study offers a practical, evidence-based framework to promote accessibility and equity in remote education.

3. RESULTS AND DISCUSSION

This study provides a detailed evaluation of an inclusive remote learning platform designed for students with disabilities. The research was conducted in three phases: descriptive, ranking, and thematic analysis, ensuring that the platform's features met the diverse needs of learners. In the descriptive analysis, feedback from 48 participants showed strong support (95-100%) for features like audio assistance, open access to materials, multimodal content delivery, micro submissions, and easy navigation links. These features significantly improved usability and accessibility, particularly for students with visual, cognitive, and physical impairments. The ranking analysis used the mean rank method to prioritize features based on user preferences, with the highest-ranked elements including direct links to organized content, online appointment scheduling with educators, and continuous access to learning resources. Thematic analysis identified four key themes: (1) improving accessibility and inclusivity through customizable tools and assistive technologies, (2) enhancing task management with progress tracking and structured submissions, (3) optimizing communication via timely notifications and appointment systems, and (4) refining user experience with a clean, professional interface. The findings led to the development of a model grounded in Universal Design for Learning (UDL) principles, promoting equitable access, engagement, and success for all learners by addressing diverse needs through flexible, inclusive

UDL PRINCIPLES	***ENHANCEMENT ELEMENTS IN INCLUSIVE REMOTE CLASSROOMS FOR LEARNERS WITH DISABILITIES***	***FEATURES BASED ON THE ENHANCEMENT ELEMENTS***
ENGAGEMENT: *The variety of ways learners are engaged or motivated to learn*	*Access to all learning materials should be kept available throughout the term*	• ***Open access*** *Open access to all learning materials (notes, teaching videos, assignments, quizzes, etc.)*
	Breaking assignments/projects up into smaller tasks with multiple deadlines (submission by chapter/topic)	• ***Micro submission*** *Submission by chapter/topic/segment for assignments/projects*
	Custom pacing guides for students who have fallen behind with work	• ***Feedback and discussion*** *Lecturers provide feedback for each chapter/topic/segment for assignments/project submission before giving marks/grades*
	Access to discussion room for lecturer-student and peer-peer discussion	• ***Discussion room*** *Lecturer-student and peer discussion like a chat room*
	Pre-arrange discussion session with lecturer (consultation/tutor)	• ***Online appointment booking*** *Pre-arrange discussion session with lecturer for consultation or tutor*
REPRESENTATION: *The variety of ways that learners perceive and comprehend content that is shared with them*	*Use of both visual and auditory forms of presenting information*	• ***Visual and auditory*** *Visual and auditory (can be clicked on when they need to listen) forms of presenting information*
	Direct link to a folder that contains learning materials based on chapter/topic	• ***Direct link*** *Direct link to a folder that contains all learning materials (notes, teaching videos, assignments, quizzes, etc.)*
ACTION AND EXPRESSION: *The variety of ways that learners can navigate the learning experience and share what they know*	*Allow verbal replies through online discussion or a forum*	• ***Verbal feedback/verbal chatroom*** *Verbal reply through online discussion or forum*

design as shown in Figure 1.

4. CONCLUSION

The findings from descriptive, ranking, and thematic analyses validate the effectiveness of an inclusive remote education model that supports learners of all abilities. Grounded in the Universal Design for Learning (UDL) framework, the model integrates essential features such as open content access, multimodal delivery, structured task management, and adaptive communication tools. These elements significantly improve accessibility, engagement, and learning personalization for students with diverse needs. The strong user consensus and prioritization of features highlights its practical value. Consistent with recent studies, this model promotes equitable, barrier-free digital learning environments and presents a scalable solution to enhance academic outcomes across varied educational settings. Looking ahead, the model is designed for seamless integration into existing university learning management systems, with the potential for AI-driven personalization, automated support tools, and intelligent content adaptation to further enhance the inclusivity and efficiency of remote education platforms.

ACKNOWLEDGEMENT

We sincerely thank Universiti Teknologi MARA (UiTM) Cawangan Selangor for supporting our research through the UCS Grant (DUCS) [File No: 600-UITMSEL (PI 5/4)(119/2022)]. Our deepest appreciation goes to UiTM for providing the platform to realize the full potential of this research.

REFERENCES

Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2022). Universal Design for Learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2020. *Journal of Computers in Education*, 9(1), 1–28. https://doi.org/10.1007/s40692-021-00189-w

Saborío-Taylor, S., & Rojas-Ramírez, F. (2024). Universal Design for Learning and artificial intelligence in the digital era: Fostering inclusion and autonomous learning. International *Journal of Professional Development, Learners and Learning*, 6(2), ep2408. https://doi.org/10.30935/ijpdll/14260

Wells, M. B. (2024). Enhancing accessibility and learning outcomes in higher education: The role of Universal Design for Learning in digital formats. *Journal Plus Education*, 36(1). https://doi.org/10.46788/jpe.2024.v36i1.01

Yang, C., & Taele, P. (2025). AI for accessible education: Personalized audio-based learning for blind students. ArXiv preprint, *ArXiv*:2504.17117. https://doi.org/10.48550/arXiv.2504.17117

Aplikasi Model A.D.A.B dalam Kaedah Penerapan Nilai Murni bagi Kursus Matapelajaran Pengajian Umum (MPU) di UiTM

Noor Syahida Md Soh[1*], Mohd Norazri Mohamad Zaini[2], Faridah Mohd Sairi[3], Mohd Annas Shafiq Ayob[4], Azhar Abdul Aziz[5]

[1,3,4,5]Pusat Asasi, Universiti Teknologi MARA Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia
[2]Akademi Pengajian Islam Kontemporari, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

*noors8233@uitm.edu.my

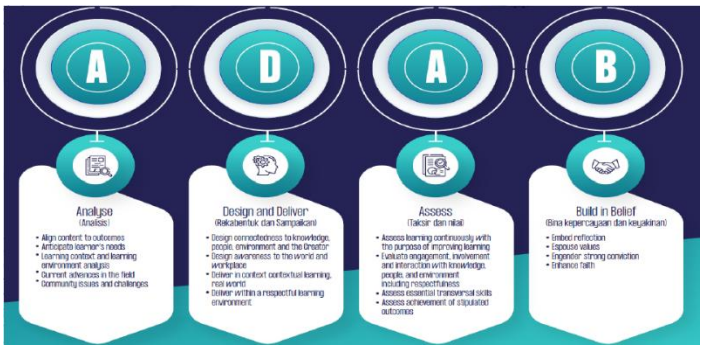
ABSTRAK

Konsep penerapan adab telah mendapat perhatian oleh pihak Universiti Teknologi MARA bagi merealisasikan pelaksanaan Pendidikan 5.0 di UiTM. Pengenalan kepada model A.D.A.B sebagai rekabentuk penyampaian pengajaran, diinspirasikan dari perkataan adab yang diaplikasi di dalam "B" (Built-in Belief) semasa pengajaran dan pembelajaran. Bertitik tolak dari amanat sulung dan ucapan Hari Akademia 2021 yang disampaikan oleh Naib Canselor UiTM, model A.D.A.B mula diperkenalkan untuk dibudayakan di dalam pelan ODL 4.0 di UiTM. Kajian lepas mendapati model A.D.A.B adalah lebih baik berbanding dengan model rekabentuk pengajaran yang lain. Justeru, kajian ini akan meneroka aplikasi model A.D.A.B dalam kaedah penerapan nilai murni bagi kursus Matapelajaran Pengajian Umum (MPU) di Universiti Teknologi MARA (UiTM). Kajian yang menggunakan pendekatan kualitatif melalui temubual dan pemerhatian telah dianalisis menggunakan perisian ATLAS.ti9 secara tematik. Dapatan menunjukkan aplikasi model A.D.A.B dalam kaedah penerapan nilai murni bagi kursus MPU di UiTM telah berlaku melalui tiga kaedah iaitu kaedah pelaksanaan, metodologi pengajaran, dan kaedah pentaksiran. Ketiga-tiga kaedah ini boleh menjadi rujukan para pensyarah dan pelajar UiTM dalam merealisasikan aplikasi A.D.A.B serta menerapkan nilai murni melalui proses pengajaran dan pembelajaran.

Kata kunci: Model A.D.A.B, Kursus MPU, Nilai Murni, Pendidikan 5.0

1. PENGENALAN

Berlandaskan aspirasi Pendidikan 5.0 UiTM, kajian ini meneliti aplikasi Model A.D.A.B sebagai kaedah penerapan nilai murni dalam kursus Mata Pelajaran Pengajian Umum (MPU). Model ini diadaptasi daripada kerangka reka bentuk instruksional ADDIE dengan penambahan komponen Built-in Belief yang menekankan penghayatan nilai, adab, dan akhlak. Latar belakang kajian disokong oleh pandangan sarjana Islam seperti Al-Ghazali, Syed Muhammad Naquib al-Attas, dan Asmawati Suhid, yang menegaskan pendidikan sebagai proses pembentukan akhlak melalui adab. Rajah 1 menunjukkan Model A.D.A.B yang mengandungi empat proses utama iaitu *Analyse, Design and Deliver, Assess, dan Built-in Belief*. Ia dilaksanakan secara berperingkat untuk memastikan nilai murni disepadukan dalam pengajaran.



Rajah 1. Model rekabentuk A.D.A.B bagi penyampaian pengajaran
Sumber: Norhapizah (2021)

Selain itu, tujuh elemen pelaksanaan seperti *situate, digest, synthesize, create, connect, reflect, dan value & extend* menjadi panduan pensyarah untuk membina pembelajaran reflektif dan penghayatan nilai secara berkesan.

Kajian ini menggunakan pendekatan kualitatif deskriptif melalui temu bual separa berstruktur dan pemerhatian terhadap pensyarah serta pelajar MPU. Analisis tematik menggunakan ATLAS.ti9 mengenal pasti tiga strategi utama penerapan nilai murni: (1) pelaksanaan pengajaran sebelum, semasa, dan selepas kuliah; (2) penggunaan kaedah pengajaran berpusatkan guru dan pelajar dengan integrasi teknologi tinggi dan rendah; dan (3) pentaksiran formatif dan sumatif yang menilai pengetahuan serta penghayatan nilai. Hasil kajian menunjukkan Model A.D.A.B mampu menghubungkan dimensi kognitif, afektif, dan psikomotor pelajar, sekali gus membentuk graduan holistik. Dapatan ini selari dengan penemuan Ahmad Zukarnain et al. (2022) yang membuktikan keberkesanan model ini berbanding kerangka instruksional konvensional, khususnya dalam pengajaran berasaskan teknologi.

2. METODOLOGI

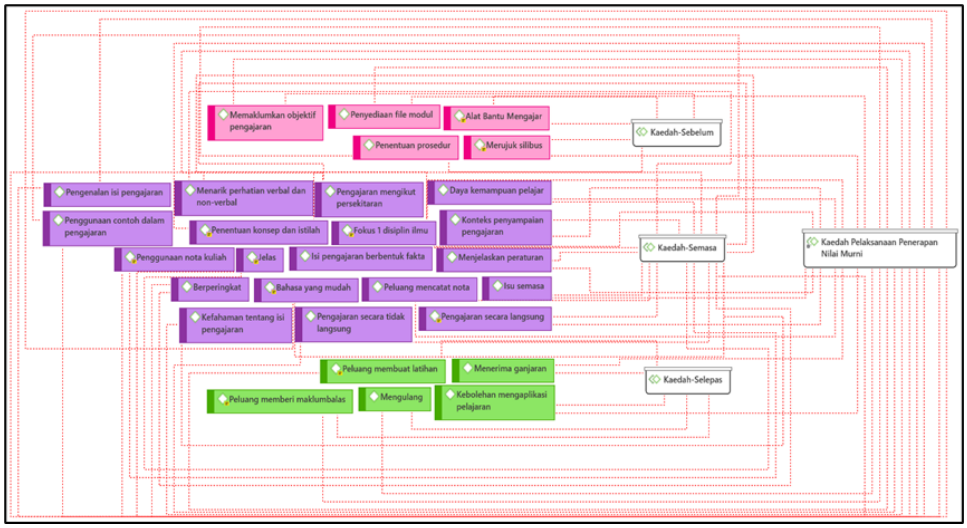
Kajian ini menggunakan reka bentuk kualitatif deskriptif untuk meneliti aplikasi Model A.D.A.B dalam penerapan nilai murni bagi pengajaran kursus MPU di UiTM, relevan dari sudut teori kerana mengukuhkan konsep pendidikan berteraskan adab dan signifikan dari sudut praktikal sebagai panduan pensyarah membentuk graduan holistik. Sampel terdiri daripada lima pensyarah tetap Akademi Pengajian Islam Kontemporari berpengalaman lebih lima tahun dan lima pelajar kursus MPU kelompok U1 di Selangor, dipilih melalui persampelan bertujuan (Bernard, 2011). Data dikumpul melalui temu bual tandem separa berstruktur dan pemerhatian, dianalisis secara tematik (Braun & Clarke, 2012) menggunakan ATLAS.ti9, serta dibandingkan dengan kerangka Model A.D.A.B. Kaedah ini sesuai kerana membolehkan analisis mendalam terhadap amalan penerapan nilai dan kesesuaiannya dengan model yang dikaji, dengan tema yang terhasil divisualkan bagi memudahkan interpretasi (Othman, 2019).

3. DAPATAN DAN PERBINCANGAN

Bahagian ini menerangkan dapatan dan perbincangan secara terperinci.

3.1 Kaedah Pelaksanaan

Dapatan kajian menunjukkan penerapan nilai murni melalui Model A.D.A.B dilaksanakan secara berperingkat meliputi sebelum, semasa, dan selepas kuliah. Pada peringkat awal, pensyarah memperkenalkan nilai yang ingin diterapkan, diikuti dengan pengukuhan semasa sesi pengajaran melalui aktiviti pembelajaran yang relevan, dan seterusnya peneguhan selepas kuliah melalui tugasan atau refleksi. Pendekatan berperingkat ini memastikan kesinambungan proses penghayatan nilai dalam kalangan pelajar.

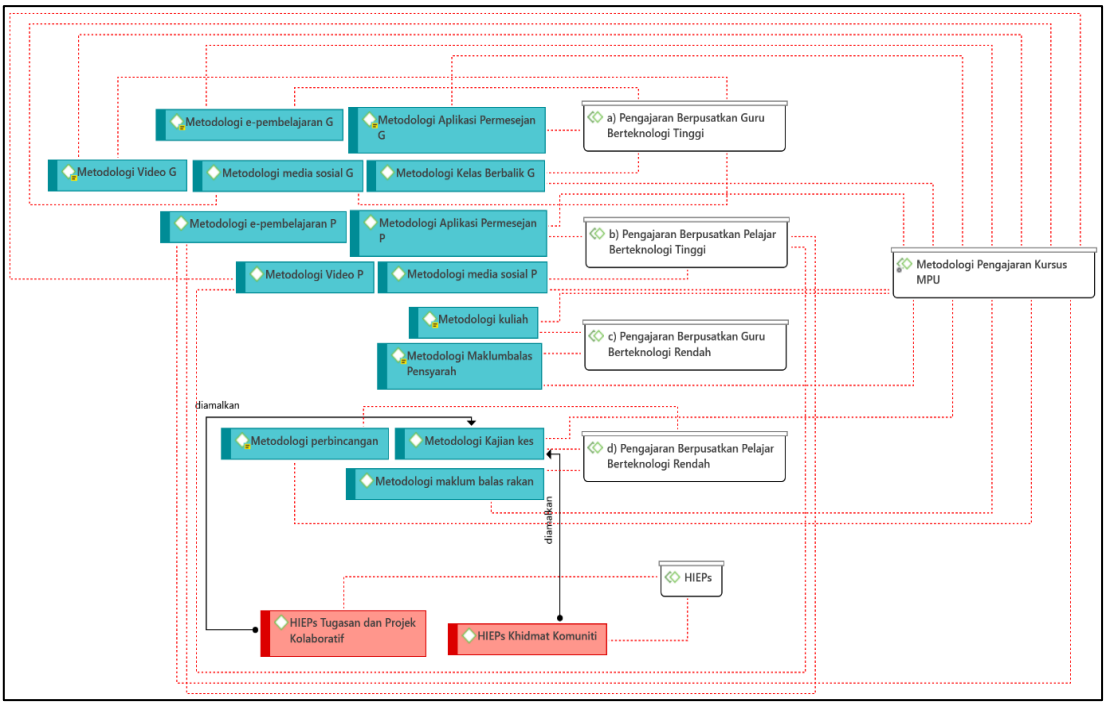


Rajah 2. Kaedah pelaksanaan penerapan nilai murni
Sumber: Penyelidik (2025)

Dapatan kajian menunjukkan pengamalan Model A.D.A.B dalam kursus MPU di UiTM berjaya diaplikasikan secara berkesan melalui tiga peringkat pelaksanaan iaitu sebelum, semasa, dan selepas kuliah. Pada peringkat sebelum, pensyarah menganalisis keperluan pelajar dan memastikan kesediaan mereka untuk memudahkan penerapan nilai. Semasa kuliah, penyampaian kandungan dikaitkan dengan isu semasa, menggunakan teknik menarik perhatian secara verbal dan non-verbal dalam suasana saling menghormati, sejajar dengan teori pembelajaran sosial Bandura dan pandangan tokoh pendidikan Islam. Selepas kuliah, pengukuhan nilai dilakukan melalui refleksi, latihan tambahan, tugasan, pengulangan topik, serta penggunaan platform digital seperti u-future. Kaedah ini meningkatkan keupayaan pelajar mengaitkan ilmu dengan konteks semasa, mencadangkan penyelesaian holistik, dan mengaplikasikan nilai murni dalam kehidupan, sekali gus menyokong keberkesanan Model A.D.A.B dalam membentuk graduan holistik sejajar aspirasi Pendidikan 5.0 UiTM.

3.2 Metodologi Pengajaran

Dari segi metodologi, pensyarah menggabungkan pendekatan berpusatkan guru dan pelajar dengan memanfaatkan teknologi tinggi seperti platform pembelajaran digital dan bahan multimedia, serta teknologi rendah seperti perbincangan bersemuka dan aktiviti kolaboratif. Kepelbagaian kaedah ini membolehkan pembelajaran lebih inklusif, interaktif, dan kontekstual, sekali gus meningkatkan keberkesanan penerapan nilai murni. Rajah 3 menunjukkan metodologi pengajaran yang digunakan bagi menerapkan nilai murni melalui kursus MPU.

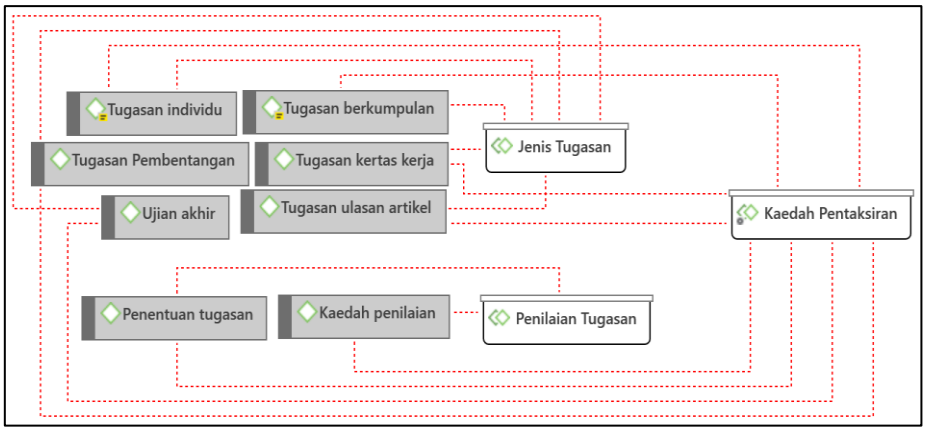


Rajah 3. Metodologi pengajaran kursus MPU
Sumber: Penyelidik (2025)

Dapatan kajian menunjukkan penerapan nilai murni dalam kursus MPU di UiTM sejajar dengan Model A.D.A.B dilaksanakan melalui gabungan metodologi pengajaran berteknologi tinggi seperti slaid, video, bahan pembelajaran kendiri, MOOC, aplikasi WhatsApp/Telegram, dan flipped classroom, serta metodologi berteknologi rendah seperti kuliah, perbincangan, maklum balas pensyarah dan rakan, kajian kes, dan tugasan kolaboratif. Walaupun pandemik Covid-19 membataskan pelaksanaan Amalan Pendidikan Berimpak Tinggi (HIEPs) seperti khidmat komuniti, pensyarah tetap menyesuaikan pendekatan bagi memastikan penyampaian nilai murni berkesan dalam talian. Penggunaan isu semasa, komunikasi interaktif, dan aktiviti lapangan terbukti meningkatkan kefahaman, penyertaan, dan penghayatan nilai murni dalam kalangan pelajar. Namun, kesedaran pensyarah terhadap pelaksanaan Pendidikan 5.0 dan aplikasi HIEPs masih rendah, memerlukan penekanan berterusan agar metodologi pengajaran dapat dilaksanakan secara konsisten mengikut norma baharu.

3.3 Kaedah Pentaksiran

Bagi pentaksiran, pensyarah menggunakan gabungan penilaian formatif dan sumatif untuk menilai bukan sahaja tahap penguasaan pengetahuan pelajar tetapi juga penghayatan nilai murni. Penilaian formatif memberi maklum balas berterusan sepanjang proses pembelajaran, manakala penilaian sumatif mengukur pencapaian akhir dan tahap internalisasi nilai. Gabungan ini membolehkan pentaksiran yang lebih menyeluruh merangkumi aspek kognitif, afektif, dan psikomotor, sejajar dengan objektif Model A.D.A.B dan aspirasi Pendidikan 5.0 UiTM seperti dalam Rajah 4.



Rajah 4. Kaedah pentaksiran dalam kursus MPU
Sumber: Penyelidik (2025)

4. KESIMPULAN

Kajian ini mendapati bahawa pengaplikasian model A.D.A.B dalam penerapan nilai murni khususnya dalam Matapelajaran Pengajian Umum (MPU) di UiTM adalah penting dalam merealisasikan Pendidikan 5.0 secara holistik. Malah model ini juga memiliki kemiripan yang sama daripada beberapa model yang lain berserta nilai tambah yang penting dalam pembentukan nilai murni terhadap para pelajar. Hasil kajian ini juga mendapati bahawa dengan ketiga-tiga tema yang diperolehi iaitu kaedah perlaksanaan penerapan nilai murni, metodologi pengajaran kursus MPU dan kaedah pentaksiran dalam kursus MPU telah membuktikan bahawa model A.D.A.B yang telah dilaksanakan oleh para pensyarah kursus MPU di UiTM dengan baik dalam merealisasikan Hasrat Kementerian Pengajian Tinggi khususnya terhadap Pendidikan 5.0. Kefahaman para pelajar terhadap nilai-nilai murni yang ingin digarapkan melalui model A.D.A.B melalui kursus MPU ini akan membentuk keberhasilan pendidikan abad ke-21 melalui metodologi pengajaran kursus dan kaedah pentaksiran yang tepat oleh para pensyarah MPU.

SUMBER RUJUKAN

Ahmad Zukarnain, Z., Abdul Rahman, N., Sudin, R., & Jamaludin, M. (2022). Implementation of a.D.a.B Model in Technology -Based Subjects. *International Journal of Education, Psychology and Counseling*, *7*(46), 561–570. https://doi.org/10.35631/ijepc.746042

Asmawati Suhid. (2006). Pengajaran adab & akhlak Islam dalam membangunkan modal insan. *Jurnal Pengajian Umum*, *8*, 167–178.

Bernard, H. R. (2011). *Research methods in anthropology: Qualitative and quantitative approaches*. Rowman Altamira

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological* (pp. 57–71). American Psychological Association. https://doi.org/10.1037/13620-004

Ibnu Khaldun & Franz Rosenthal. (1967), *The Muqaddimah: An Introduction to History*. Princeton, New Jersey: Princeton University Press.

Naquib al-Attas, S. M. (1980). The Concept of Education Islam. *The Keynote Address Delivered at the First World Conference on Muslim Education*, 16. https://doi.org/10.1007/s13398-014-0173-7.2

Norhapizah Mohd Burhan. (2021). *PELAKSANAAN MODEL A.D.A.B DALAM*

PENYAMPAIAN DAN PEMBELAJARAN KURSUS CTU KAEDAH BIASA DAN ODL (pp. 1–45). Center for Innovative Delivery and Learning Development.

Othman Talib. (2019). *Analisis Data Kualitatif dengan Atlas.ti8 Penerangan Lengkap Langkah Demi Langkah*. Serdang: Universiti Putra Malaysia, 21-45.

Tuning the Electronic and Optical Properties of ZnO by Ag Doping: A DFT+*U* Investigation

N.A. Johari[1], N. Hamzah[*1], A.F.A. Faizal[1], A.M.M. Ali[2,3], R. Zakaria[2,3], N.H.M. Zaki[2,3], O.H. Hassan[2,3], N.H. Hussin[5], M.Z.A. Yahya[6], M.F.M. Taib[2,3]

[1]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia
[2]Ionic Materials & Devices (iMADE) Research Laboratory, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
[3]Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
[4]Department of Industrial Ceramics, Faculty of Art & Design, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
[5]Faculty of Applied Sciences, Universiti Teknologi MARA, 26400 Jengka, Pahang, Malaysia.
[6]Faculty of Defence Sciences and Technology, Universiti Pertahanan Nasional Malaysia, 57000 Kuala Lumpur, Malaysia.

*norjuliyati@uitm.edu.my

ABSTRACT

The structural, electronic and optical properties of Ag-doped ZnO were examined using first-principles calculations. The density functional theory plus Hubbard *U* correction (DFT+*U*) was incorporated to ensure an accurate analysis of the electronic structure. The inclusion of Ag dopants was found to introduce new impurity levels that significantly reduce the ZnO bandgap from 3.362 eV to 2.810 eV. Consequently, absorption in the visible light spectrum is greatly enhanced, providing valuable theoretical guidance for the development of Ag-doped ZnO for solar energy applications.

Keywords: DFT+*U*, Ag-doped ZnO, Structural Properties, Electronic Properties, Optical Properties.

1. INTRODUCTION

Zinc oxide (ZnO) is a versatile II-VI semiconductor with a wide, direct bandgap of 3.37 eV, making it suitable for many applications (Sharma et al., 2022). However, this wide bandgap is also its primary limitation for solar energy conversion, as it restricts optical absorption almost exclusively to the UV portion of the solar spectrum, which accounts for only 4% of available energy (López-López et al., 2022). To enhance its efficiency, the electronic and optical properties of ZnO must be modified to utilize the more abundant visible light spectrum.

Doping with transition metals is a proven strategy to modifying the structural, electronic and optical properties of ZnO (Gopalakrishnan & Ashokkumar, 2024). Silver (Ag) is considered a particularly promising dopant because of its ability to modify the electronic structure of zinc oxide and enhance its luminescence properties. Density functional theory (DFT) is a powerful tool for studying such systems. However, standard DFT methods often fail to accurately predict the electronic properties of strongly correlated materials like ZnO. This study addresses this

gap by employing the DFT+*U* method to conduct a rigorous first-principles investigation into the effects of varying Ag concentrations (x = 0.0625, 0.125 and 0.1875) on the structural, electronic and optical properties of ZnO, providing a more accurate theoretical foundation for its practical application.

2. COMPUTATIONAL METHOD

First-principles calculations were performed using the Cambridge Serial Total Energy Package (CASTEP) code. A 2×2×2 wurtzite ZnO supercell, containing 16 Zn and 16 O atoms, served as the basis for the models. Ag-doped systems ($Zn_{1-x}Ag_xO$) were created by substitutionally replacing one, two and three Zn atoms with Ag atoms to achieve concentrations of x = 0.0625, 0.125 and 0.1875, respectively.

Structural optimizations were performed using the generalized gradient approximation of Perdew-Burke-Ernzerhof for solids (GGA-PBEsol) to treat the exchange-correlation functional. To correct for the underestimation of the bandgap inherent in standard DFT, the electronic and optical properties were calculated using the GGA-PBEsol+*U* method. Based on previous studies, the Hubbard *U* parameters were applied to account for strong on-site Coulomb interactions, with values set to U_d = 5 eV for Zn-3*d* states, U_p = 9 eV for O-2*p* states and U_d = 6 eV for Ag-4*d* states (Hamzah et al., 2023; Wang et al., 2020). A plane-wave cut-off energy of 340 eV and a 4×4×1 Monkhorst-Pack *k*-point mesh were used for all calculations.

3. RESULTS AND DISCUSSION

3.1 Structural Properties

Structural optimization revealed that the lattice parameters (*a*, *b*, *c*) and unit cell volume increase systematically with higher Ag concentrations. This expansion is attributed to the larger ionic radius of the substituting Ag^+ ion (1.15 Å) compared to the host Zn^{2+} ion (0.74 Å), which is consistent with experimental observations.

3.2 Electronic Properties

The GGA-PBEsol+*U* method proved essential for accuracy. While standard GGA-PBEsol severely underestimated the bandgap of pure ZnO at 0.620 eV, the Hubbard *U* correction yielded a bandgap of 3.362 eV, in excellent agreement with the experimental value of 3.37 eV (Harun et al., 2017). Upon doping, the bandgap of ZnO was significantly reduced. The calculated bandgaps for Ag concentrations x =0.0625, 0.125 and 0.1875 were 3.120 eV, 2.970 eV and 2.810 eV, respectively. At the highest concentration, this represents a 16.4% reduction from the calculated pure ZnO value.

Analysis of the density of states (DOS) reveals the mechanism behind this bandgap narrowing. The hybridization of Ag-4*d* and O-2*p* orbitals introduces new, occupied impurity states at the top of the valence band. This effectively raises the valence band maximum, thereby reducing the energy required to excite an electron to the conduction band.

3.3 Optical Properties

The engineered reduction in the electronic bandgap has a direct and beneficial impact on the optical properties. The optical absorption edge of Ag-doped ZnO exhibits a significant redshift

(a shift to longer wavelengths) compared to pure ZnO. The redshift pushes the absorption threshold from the UV region into the visible light spectrum (380-780 nm), especially at higher Ag concentrations (x = 0.125 and 0.1875). This enhanced absorption of lower-energy photons means that a greater portion of the solar spectrum can be utilized by the material.

4. CONCLUSION

This study used DFT+U calculations to show that doping ZnO with Ag can effectively improve its properties for solar energy use. Ag doping expands the crystal structure and significantly reduces the bandgap by introducing Ag-4d states that mix with O-2p states. As a result, the material shows a redshift in light absorption, allowing better use of visible light. These findings suggest that Ag-doped ZnO is a strong candidate for photocatalytic and photovoltaic applications, providing useful guidance for future experiments.

ACKNOWLEDGEMENT

Acknowledgment is extended to the Ministry of Higher Education (MOHE) Malaysia, the Ionic Materials & Devices (iMADE) Research Laboratory, Institute of Science (IOS), Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia and Universiti Teknologi MARA, Dengkil, Selangor, Malaysia.

REFERENCES

Gopalakrishnan, R., & Ashokkumar, M. (2024). Comparative assessment of transition metals doping effects on structural, optical, optical conductivity, and photocatalytic features of ZnO nanoparticles. *Journal of Materials Science: Materials in Electronics*, *35*(24), 1614. https://doi.org/10.1007/s10854-024-13395-6

Hamzah, N., Samat, M. H., Johari, N. A., Faizal, A. F. A., Hassan, O. H., Ali, A. M. M., Zakaria, R., Hussin, N. H., Yahya, M. Z. A., & Taib, M. F. M. (2023). A DFT+U study of structural, electronic and optical properties of Ag- and Cu-doped ZnO. *Microelectronics International*, *40*(1), 53–62. https://doi.org/10.1108/MI-05-2022-0088

Harun, K., Yaakob, M. K., Taib, M. F. M., Sahraoui, B., Ahmad, Z. A., & Mohamad, A. A. (2017). Efficient diagnostics of the electronic and optical properties of defective ZnO nanoparticles synthesized using the sol-gel method: Experimental and theoretical studies. *Materials Research Express*, *4*(8), 1–15. https://doi.org/10.1088/2053-1591/aa8151

López-López, J., Tejeda-Ochoa, A., López-Beltrán, A., Herrera-Ramírez, J., & Méndez-Herrera, P. (2022). Sunlight photocatalytic performance of zno nanoparticles synthesized by green chemistry using different botanical extracts and zinc acetate as a precursor. *Molecules*, *27*(1). https://doi.org/10.3390/molecules27010006

Sharma, D. K., Shukla, S., Sharma, K. K., & Kumar, V. (2022). A review on ZnO: Fundamental properties and applications. *Materials Today: Proceedings*, *49*, 3028–3035. https://doi.org/10.1016/j.matpr.2020.10.238

Wang, J., Shen, T., Feng, Y., & Liu, H. (2020). A GGA + U study of electronic structure and the optical properties of different concentrations Tb doped ZnO. *Physica B: Physics of Condensed Matter*, *576*(June 2019), 411720. https://doi.org/10.1016/j.physb.2019.411720

The Phonological Features of Malaysian English (MAE) 2.0

Nur Haziq Fikri Ahmad[1]*, Muhammad Haikal Shariff[2]

[1]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, Dengkil 43800, Selangor, Malaysia
[2]Faculty of Modern Languages and Communications, Universiti Putra Malaysia

*haziqfikri@uitm.edu.my

ABSTRACT

The study of Malaysian English (ME) has gained significant attention due to its emergence as a distinct variety within World Englishes. However, while its lexical, syntactical, and phonological features are well recognised, research on its phonological features remains under-explored. This study provides an in-depth analysis of the phonological features of ME, focusing on three main areas: vowels, consonants, and suprasegmentals. Additionally, the study explores the influence of Malaysia's multilingual context on the development of these phonological features. The research contributes to the ongoing standardisation of ME and its recognition as a unique variety of World English.

Keywords: Malaysian English, Phonological Features, Vowel Quality, Consonants, Suprasegmentals

1. INTRODUCTION

Malaysian English (ME) is recognised as a unique variety of English that has developed through the influence of Malaysia's multilingual environment. English, introduced by the British during colonisation, has since evolved into a variety distinct from other Englishes worldwide. The phonological features of ME, however, remain understudied in comparison to its lexical and syntactical features (Baskaran, 2005). Early studies by Platt and Weber (1980) classified ME speakers into two groups: those from English-medium schools (ME I) and those from Malay-medium schools (ME II). The development of ME's phonological system has been shaped by various social and linguistic factors, including the influence of the Malay, Chinese, and Indian languages spoken by the majority of Malaysia's population. This study examines the phonological features of ME, with a focus on vowels, consonants, and suprasegmental features, and considers how these features reflect the country's diverse ethnic background (Rajadurai, 2006; Yamaguchi, 2014).

2. METHODOLOGY

This study adopts a qualitative approach, using a library research design to analyse the phonological features of Malaysian English. The primary data sources include books, academic journals, and expert consultations. The study focuses on existing works, especially those by Baskaran (2005), Rajadurai (2006), and other researchers, to identify key phonological features of ME. These features are categorised into three major areas: vowels, consonants, and suprasegmentals. The data was collected from a range of sources that discuss the phonological characteristics of ME and how these features align with or differ from other varieties of English.

The methodology also involved a detailed review of phonological inventories and frameworks, such as those outlined by Baskaran (2005) and Phoon and Maclagan (2009), to provide a comprehensive understanding of ME's phonology.

3. RESULTS AND DISCUSSION

The findings from the research reveal that Malaysian English exhibits several distinct phonological features that set it apart from Received Pronunciation (RP).

Firstly, the vowels in ME show a pattern of centralisation and fronting. For example, the vowel /æ/ in the word "trap" is commonly realised as /ɛ/ (Baskaran, 2005). Other vowels such as /ʌ/ and /ɔ/ also exhibit fronting, which differs from RP pronunciation (Rajadurai, 2006). These changes are influenced by the local languages spoken by the Malaysian population, particularly Malay.

In addition to vowel quality, the length of vowels in ME varies. Long vowels are often shortened in unstressed syllables. For instance, the vowel /i:/ in "field" is pronounced as a shortened /i/ in ME, while vowels like /u/ may be lengthened in specific contexts (Baskaran, 2005; Rajadurai, 2006).

Consonant features in ME also reflect the influence of Malaysia's multilingual context. One of the most prominent features is consonant cluster reduction. For example, words like "hundred" and "syndrome" tend to lose the final consonant cluster, resulting in pronunciations like /hʌnrəd/ instead of the RP /hʌndrəd/ (Baskaran, 2005). Furthermore, ME displays significant instances of glottalisation, where final consonants like /g/ and /d/ are replaced with a glottal stop, especially in informal speech (Rajadurai, 2006).

The study also observed that fricatives in ME often undergo devoicing. For example, voiced fricatives such as /v/ and /z/ are frequently replaced with their voiceless counterparts /f/ and /s/, while dental fricatives like /θ/ and /ð/ are substituted with alveolar stops like /t/ and /d/ (Yamaguchi, 2014). These substitutions are a direct result of the phonological constraints of the speakers' native languages, mainly Malay, which lacks these fricative sounds.

Regarding suprasegmental features, ME follows a syllable-timed rhythm, unlike RP's stress-timed rhythm. In ME, all syllables, whether stressed or unstressed, are given approximately equal weight, which is more evident in casual speech (Rajadurai, 2006). Additionally, ME exhibits relatively flat intonation patterns compared to other varieties of English. Although pitch can shift to indicate questions or emotional emphasis, these intonation patterns are not as varied as those found in RP or different varieties of English (Yamaguchi, 2014).

4. CONCLUSION

This study highlights the distinctive phonological features of Malaysian English, demonstrating how ME deviates from Received Pronunciation in terms of vowel quality, consonant usage, and suprasegmental features. These differences reflect the influence of Malaysia's multilingual society, where the various ethnic groups within the country shape phonological features. The findings underscore the importance of recognising ME as a unique variety of World English. Further research is necessary to explore regional variations and the suprasegmental features of ME, which will contribute to the standardisation of its phonological system and reinforce its status as a distinct variety of English.

ACKNOWLEDGEMENT

We would like to express our gratitude to the linguistic experts and researchers whose works have been referenced in this study. We also appreciate the institutions supporting this research and the community of Malaysian English speakers for their valuable contributions.

REFERENCES

Baskaran, L. (2005). *A Malaysian English primer, aspects of Malaysian English features*. University of Malaya Press.

Phoon, H. S., & Maclagan, M. A. (2009). Chinese Malaysian English phonology. *Asian Englishes, 12*(1), 20-45.

Platt, J. T., & Weber, H. (1980). *English in Singapore and Malaysia: Status, features, functions*. Oxford University Press.

Rajadurai, J. (2006). Pronunciation issues in non-native contexts: A Malaysian case study. *Malaysian Journal of ELT Research, 2*, 42-59.

Yamaguchi, A. (2014). The phonological features of Malaysian English in the context of social linguistics. *World Englishes, 33*(2), 210-227.

Operational Framework for an Independent ICH Commission in Malaysia

Nurulhuda Adabiah Mustafa*

Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*adabiah@uitm.edu.my

ABSTRACT

This paper addresses the fragmented legal and jurisdictional landscape governing intangible cultural heritage (ICH) in Malaysia. While the *National Heritage Act 2005* (Act 645) serves as the primary federal legislation, its implementation is hindered by conflicts with state laws, constitutional divisions of power, and competing normative orders. This study proposes and operationalizes a new, independent statutory body: an Independent ICH Commission. Employing a doctrinal legal analysis and a comparative approach with nations like Indonesia and the Philippines, the research identifies shortcomings in existing governance structures and proposes a practical solution. The main findings detail a comprehensive operational framework for the commission, including a multi-stakeholder composition with representation from federal and state authorities, indigenous communities, and academic experts. The commission's key mandates would include acting as a neutral arbiter for federal-state disputes, harmonizing heritage policies through a "Model State Heritage Law," and institutionalizing mandatory Cultural Impact Assessments (CIAs). A core principle of the framework is a shift towards genuine community empowerment by providing legal aid and support for community-led nominations. The paper concludes that establishing this commission as a statutory body with legal enforcement authority is essential to creating a robust, inclusive, and forward-looking heritage governance system in Malaysia that reflects the nation's cultural pluralism and unlocks its economic potential.

Keywords: Intangible Cultural Heritage, Heritage Governance, Cultural Policy, Statutory Body, Malaysia

1. INTRODUCTION

The safeguarding of Malaysia's diverse intangible cultural heritage (ICH) is a complex challenge within a legal landscape characterized by fragmented laws and overlapping jurisdictions. The *National Heritage Act 2005* (Act 645) provides a federal framework, but its effectiveness is often hampered by conflicts with state laws, particularly those concerning religious and customary practices. The existing heritage governance bodies lack the autonomy and mandate to serve as neutral arbiters in these intricate disputes. This paper addresses this critical gap by proposing and detailing an operational framework for a new, independent body: the ICH Commission. The objective is to move beyond critiques of the current system and offer a practical, actionable model to create a more cohesive and pragmatic heritage governance system. This framework draws on a review of pertinent literature and an analysis of international conventions to address the problem of legal fragmentation and institutional weakness.

2. METHODOLOGY

The central research question is: How can a practical and effective operational framework for an Independent Intangible Cultural Heritage (ICH) Commission address Malaysia's fragmented legal and jurisdictional landscape? This question is highly relevant to both legal theory and practice, as it addresses a critical gap in Malaysia's heritage governance system. The study employs a doctrinal legal analysis as its primary research method, which involves a meticulous examination and critical evaluation of the existing legal framework, including the National Heritage Act 2005 (Act 645) and relevant state-level legislation. This method allows for a deep and systematic analysis of the statutes, case law, and legal principles that contribute to the jurisdictional conflicts. To supplement this, a comparative legal approach is utilized, drawing on case studies from other Southeast Asian nations such as Indonesia and the Philippines to inform the design of a new framework. The research framework is structured as a problem-solution analysis, identifying specific issues within the current system and then proposing a detailed, actionable model for a new commission.

3. RESULTS AND DISCUSSION

3.1 The operational framework for the Independent ICH Commission is designed to overcome the key challenges of legal fragmentation, institutional weakness, and political constraints.

3.2 A firm legal basis is essential, which is why it is proposed that the commission be established as a statutory body or a tribunal through an amendment to the National Heritage Act 2005. This would grant it the authority to enforce its decisions and recommendations, moving it beyond a purely advisory role.

3.3 The composition of the commission is critical for its impartiality and credibility. Membership would be multi-stakeholder, including representatives from federal and state bodies (e.g., Department of National Heritage, State Islamic religious councils), indigenous communities (e.g., Center for Orang Asli Concerns), and academic experts. This ensures all relevant voices are heard and incorporated into the decision-making process.

3.4 The commission would have three key mandates:

3.4.1 Dispute Resolution and Mediation: The commission would act as a neutral arbiter for federal-state and community-state conflicts, with a multi-tiered process for mediation and a final tribunal-like authority to issue legally binding rulings.

3.4.2 Policy Harmonization and Coordination: The commission would proactively work to align federal and state laws. A key tool for this would be the development of a "Model State Heritage Law" to be adopted voluntarily by states, ensuring a baseline of protection while respecting regional nuances. The commission would also be authorized to review and comment on all relevant proposed legislation.

3.4.3 Community Empowerment and Participation: A dedicated Community Liaison Office would provide legal aid, technical support, and capacity-building programs to local communities, empowering them to drive the safeguarding process and participate in community-led nominations.

3.5 To address the challenges to operationalization, the framework proposes securing strong

political will and clearly defining the commission's powers in the amended Act. To overcome funding constraints, the commission would be funded through a dedicated parliamentary allocation or a national heritage fund. Finally, granting the commission legal and enforcement authority is the cornerstone of its effectiveness.

4. CONCLUSION

This paper has outlined a comprehensive operational framework for an Independent ICH Commission in Malaysia. The success of this new body is predicated on its multi-stakeholder and independent structure, clear mandates for dispute resolution and policy harmonization, and a commitment to community empowerment. By establishing the commission as a statutory body or tribunal with the legal authority to enforce its decisions, Malaysia can overcome historical political, jurisdictional, and funding constraints. It is recommended that future work should focus on legislative drafting and a feasibility study for a national heritage fund. The establishment of this commission is a critical step towards creating a robust, inclusive, and economically valuable heritage governance system in Malaysia.

ACKNOWLEDGEMENT

The author would like to express sincere gratitude to the Centre of Foundation Studies, UiTM, for providing the platform (ASID Colloquium 2025) to present this idea and for their unwavering support.

REFERENCES

Harding, A. (2018). *The Constitution of Malaysia: A contextual analysis* (2nd ed.). Bloomsbury Publishing.

Idris, J. (2019). *Cultural heritage law in Malaysia: The challenges of federalism*. Kuala Lumpur: IIUM Press.

Logan, W. (2012). Cultural diversity, cultural heritage and human rights: Towards heritage management as human rights-based cultural practice. *International Journal of Heritage Studies*, 18(3), 231–244.

Mustafa, N. A., & Abdullah, N. C. (2022). Preservation of intangible cultural heritage under the National Heritage Act 2005 [Act 645] vs UNESCO Convention for the Safeguarding of Intangible Cultural Heritage (2003). *International Journal of Academic Research in Business and Social Sciences*, 12(11), 3299–3316.

Nicholas, C. (2020). *The recognition and protection of Orang Asli customary land rights in Peninsular Malaysia: Legal and policy challenges*. Suhakam Reports.

Mustafa, N. A., & Abdullah, N. C. (2022). Preservation of intangible cultural heritage under the National Heritage Act 2005 [Act 645] vs UNESCO Convention for the Safeguarding of Intangible Cultural Heritage (2003). *International Journal of Academic Research in Business and Social Sciences*, 12(11), 3299–3316.

Nicholas, C. (2020). *The recognition and protection of Orang Asli customary land rights in Peninsular Malaysia: Legal and policy challenges*. Suhakam Reports.

Republic of the Philippines. (1997). *Indigenous Peoples' Rights Act of 1997* (Republic Act No. 8371) (PH).

Sagong bin Tasi & Ors v Kerajaan Negeri Selangor & Ors [2002] 2 MLJ 591 (MY).

UNESCO. (2003). *Convention for the Safeguarding of the Intangible Cultural Heritage*. https://ich.unesco.org

Comparative Analysis of Supplier Selection using Analytic Hierarchy Process and Potential Method

Sarah Afrina Saidi[1], Wan Nur Haryani Wan Mohd Ariff Rashiddin[2], Siti Salwana Mamat[3]*

[1,2]Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Seremban, 70300 Seremban, Negeri Sembilan, Malaysia
[3]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*sitisalwana@uitm.edu.my

ABSTRACT

Comparing alternatives is the standard approach used to address problems through Multi-Criteria Decision Making (MCDM) methods. It involves evaluating multiple factors and calculating weighted outcomes for each alternative. Some of the well-known MCDM methods are the Analytic Hierarchy Process (AHP) and the Potential Method (PM). PM utilizes a directed graph based on pairwise comparisons to assign a value for each alternative. In this study, PM is applied to the supplier selection problem that has already been analyzed using AHP. The purpose is to demonstrate the application of PM in decision making. Furthermore, both methods rank the alternatives in a similar way, demonstrating that PM is equally competent as AHP in solving real-world complex problems with multiple criteria.

Keywords: Multi-Criteria Decision Making, Analytic Hierarchy Process, Potential Method, Supplier Selection

1. INTRODUCTION

In decision-making, it's important to find and select options based on the decision-maker preferences. Decision making process always require examining various options and choosing the one that best meets goals and values (Štirbanović et al., 2019). Multi-Criteria Decision Making (MCDM) is a method to help decision-makers handle complex situations involving multiple criteria. This study focuses on two main methods in MCDM which are The Analytic Hierarchy Process (AHP) and the Potential Method (PM). The AHP is widely used method for MCDM that was developed by Thomas L.Saaty during the 1970s. It helps decision makers compare factors in pairs and their relative importance to help enforce consistency in judgements (Huang, 2021; Schiavon et al, 2023). In contrast, the PM applies network analysis in analysing the relationship and relative preference between different alternatives to support decision making (Čaklović & Kurdija, 2017).

This study focuses on improving the analysis of AHP matrices by utilizing the PM in a supplier selection case study taken from Hruška et al. (2014). The aim is to evaluate the decision results of both techniques, especially regarding the resultant weights and rankings.

2. METHODOLOGY

The Potential Method is a decision-making approach that employs a graph called as a "preference graph to represent pairwise comparisons between alternatives (Čaklović and Kurdija, 2017). Definition 1 formally describe the preference graph while Figure 1 provides some examples of its various forms.

Definition 1 (Čaklović & Kurdija, 2017)

A preference graph is a triple $G=(V,A,F)$ where V is a set of $n\in$ vertices, $A\subseteq V\times V$ is a set of directed edges, and $F:A\to$ is a preference flow which maps each edge (u,v) to the corresponding intensity $F_{(u,v)}$.

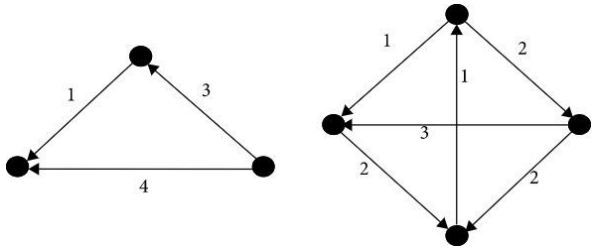


Figure 1. Some examples of preference graph

3. IMPLEMENTATION, RESULTS & DISCUSSION

Hruška et al. (2014) are needed to find the best supplier for a Czech manufacturing company. The company is seeking a new supplier for a particular item. There are 10 criteria to be evaluated to find the best suppliers. The company has three potential suppliers and is using a structured, multi-criteria decision-making approach to evaluate them.

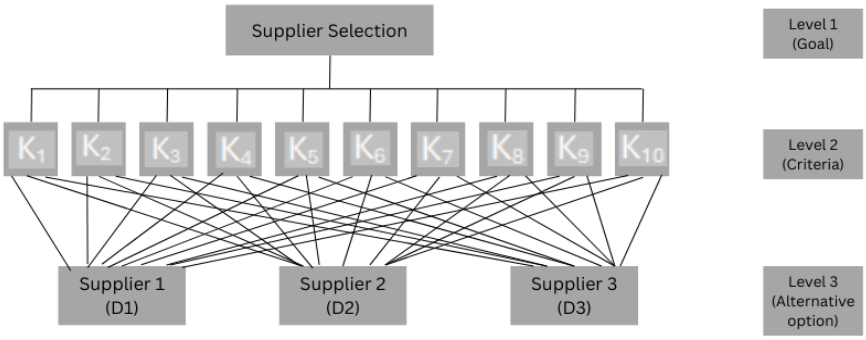


Figure 2. The hierarchy of problem (Hruška et al., 2014)

3.1 Weight Determination

The initial step in analyzing hierarchical decision problems is finding the weights of criteria. The preference graph with respect to criteria from supplier problem is illustrated in Figure 3.

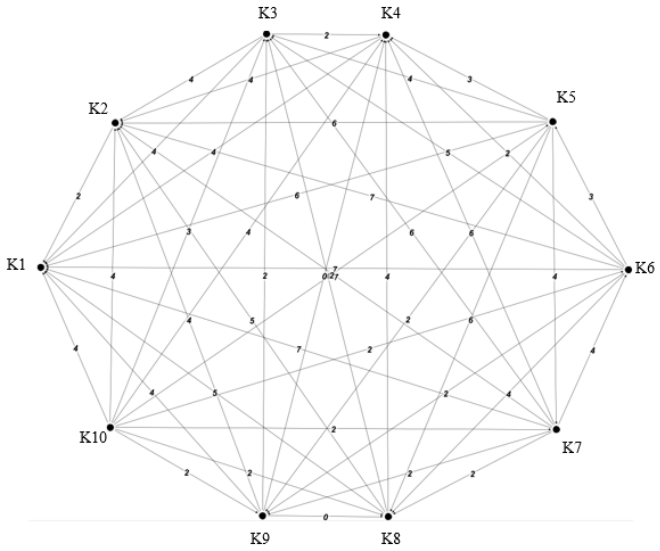


Figure 3. Preference graph for the criteria

Table 1 presents the global weights assigned to each criterion as determined by the PM, along with their rankings.

Table 1. Global weightage of suppliers

Suppliers / Criteria	D1	D2	D3
K1	0.0379	0.1517	0.0095
K2	0.1256	0.1256	0.0010
K3	0.0995	0.0078	0.0006
K4	0.0559	0.0559	0.0035
K5	0.0712	0.0035	0.0004
K6	0.0418	0.0041	0.0002
K7	0.0285	0.0002	0.0036
K8	0.0504	0.0100	0.0002
K9	0.0510	0.0032	0.0004
K10	0.0135	0.0430	0.0003
Global weight	0.5753	0.4050	0.0197
Final Ranking	1	2	3

Table 2 shows the final results for the PM and AHP. In the PM analysis, supplier D1 has the highest weight of 0.5753. The supplier D2 follows with 0.4050 and D3 has 0.0197. The AHP shows similar results where D1 has a weight of 0.4785, D2 has 0.4397 and D3 has 0.0816. Both methods rank the suppliers in the same order as D1 > D2 > D3.

Table 2. Comparison of weight and ranking for suppliers

Suppliers	AHP	Rank	PM	Rank
D1	0.4785	1	0.5753	1
D2	0.4397	2	0.4050	2
D3	0.0816	3	0.0197	3

4. CONCLUSION

The results of the Potential Method are similar to those of the AHP. This shows that PM is consistent and reliable for decision-making. Such consistency suggests that PM is not just good for choosing suppliers, it can also be useful in other multi-criteria decision-making situations. The PM is an organized framework that allows decision-makers to evaluate options effectively. This makes PM a valuable tool for tackling complex issues in different areas.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Universiti Teknologi MARA.

REFERENCES

Čaklović, L., & Kurdija, A. S. (2017). A universal voting system based on the Potential Method. *European Journal of Operational Research*, 259(2), 677-688

Hruška, R., Průša, P., & Babić, D. (2014). The use of AHP method for selection of supplier. *Transport*, 29(2), 195–203. https://doi.org/10.3846/16484142.2014.930928

Huang, J. J. (2021). Analytic Hierarchy Process with the Correlation Effect via Wordnet. Mathematics, 9(8). https://doi.org/10.3390/math9080872

Schiavon, L. L. P., Lima, P. A. B., Crepaldi, A. F., & Mariano, E. B. (2023). Use of the Analytic Hierarchy Process Method in the Variety Selection Process for Sugarcane Planting. *Eng*, 4(1), 602–614. https://doi.org/10.3390/eng4010036

Štirbanović, Z., Stanujkić, D., Miljanović, I., & Milanović, D. (2019). Application of MCDM Methods for Flotation Machine Selection. *Minerals Engineering*, 137, 140–146. https://doi.org/10.1016/j.mineng.2019.04.014

Examining the Issues and Challenges Encountered by Mathematics' Trainee Teachers

Nur Afiqah Abdul Malek[1], Siti Farhana Husin[2*]

[1]Faculty of Education, Universiti Teknologi MARA, Cawangan Selangor, Kampus Puncak Alam, Selangor, Malaysia
[2]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*sitifarhana@uitm.edu.my

ABSTRACT

This study examines the issues and challenges faced by mathematics trainee teachers during their practicum. Concentrating on teaching and instructional techniques, and classroom challenges, the study emphasizes how trainee teachers manage teaching mathematics in secondary schools. The objectives include identifying teaching approaches, understanding challenges faced, and exploring strategies used to enhance students' mathematical understanding. A quantitative research approach was employed with 49 respondents from a public university in Selangor. Data were collected using structured questionnaires and analyzed through descriptive and inferential statistics methods. The findings showed that teachers employ a mix of conventional and 21st-century teaching methods, yet many still depend significantly on traditional approaches due to limitations such as lack of resources, digital tools, and student behavior. Trainee teachers encountered challenges such as insufficient of ICT facilities, unmotivated students, oversized classes, and limited willingness to implement modern teaching methods. This study highlights the importance of enhanced teacher training and support systems to facilitate effective teaching methods.

Keywords: Mathematics Education, trainee teachers, teaching methods, classroom challenges, 21st-century teaching methods.

1. INTRODUCTION

Despite being a fundamental subject in Malaysia education, mathematics continually poses challenges for both students and educators (Davis, 2018). Even with extensive investments in ICT and pedagogical reforms, students frequently find it challenging to grasp mathematical concepts. The lack of knowledge regarding what and how trainee teachers deal with these challenges during their practicum is the focus of this study. It aims to explore the challenges faced, the methods used to enhance learning in the classroom, and the instructional techniques applied.

2. METHODOLOGY

2.1 Research Design

With the objective to investigate the teaching strategies, challenges, and methods employed by mathematics trainee teachers, this study employed a quantitative research approach. A descriptive survey method was chosen to gather information using a structured questionnaire,

to efficiently collect data from a specific group of trainee teachers.

2.2 Population and Sampling

49 mathematics trainee teachers from a public university in Selangor who were completing a practicum in a secondary school participated in the study. To ensure that every respondent had relevant teaching experience, a purposive sampling technique was employed. A minimum of 44 participants was considered sufficient, although a slightly greater number was acquired to increase dependability, in accordance with Krejcie and Morgan's (1970) sample table.

2.3 Research Instrument

Data were collected using a structured questionnaire divided into four main sections: (1) demographic profile, (2) teaching methods used, (3) problems encountered in the classroom, and (4) strategies used to improve student understanding. The questionnaire items were adapted from prior validated research instruments (Mohamed et al., 2023; Sullamo, 2023). A pilot study was conducted to refine the instrument, ensuring clarity and appropriateness.

2.4 Validity and Reliability

Pilot testing involved a small group of trainee teachers included in the main study. The results confirmed strong reliability, with Cronbach's alpha values above 0.7 for all three key sections: teaching methods, challenges, and strategies. The pilot also helped ensure content validity and improve item clarity based on expert feedback.

2.5 Data Collection and Analysis

Data were collected during the practicum period using both printed and online formats to accommodate participant availability. Responses were analyzed using SPSS software. Descriptive statistics (mean, standard deviation) were used to summarize responses, while inferential statistics included:

- Paired sample t-test to compare traditional vs. 21st-century methods.
- Independent sample t-test to compare gender differences.
- Pearson correlation analysis to examine relationships among teaching methods, challenges, and strategies.

3. RESULTS AND DISCUSSION

Findings show that most trainee teachers use a combination of traditional and 21st-century methods. Traditional approaches remain dominant due to resource limitations and lack of exposure to digital tools even these methods are no longer sufficient to meet the demands of modern education in the information age (Engelbrecht et al., 2020). A significant correlation was found between teaching methods and classroom problems, suggesting that flexible, student-centred approaches are more effective (Shen & Wu, 2021).

The findings revealed that mathematics trainee teachers predominantly used a combination of traditional and 21st-century teaching methods. However, teachers employ various strategies such as group work, tech-enhanced lessons, and real-world applications to address these challenges. Descriptive statistics showed that while traditional methods were still widely practiced, 21st-century approaches (e.g., collaborative and ICT-based learning) were

increasingly adopted to improve engagement and understanding. A paired sample t-test indicated a significant difference between the two approaches, with 21st-century methods rated more effective ($p < 0.05$). However, challenges such as limited classroom management, inadequate facilities, and unmotivated students were frequently stated. These issues persisted in both teaching philosophies and became worse by lack of resources in the classroom and inadequate digital infrastructure.

In response to these challenges, trainee teachers implemented several instructional strategies including group activities, real-life applications, and limited use of technology. The Pearson correlation analysis revealed a moderate positive relationship between teaching methods and challenges faced ($r = 0.481$, $p < 0.01$) as well as between challenges and the strategies employed ($r = 0.534$, $p < 0.01$). An independent sample t-test showed no significant difference in teaching methods used based on gender. These findings propose that while trainee teachers show strong initiative in adapting their teaching methods, there is a clear need for better support systems, training, and access to digital tools to overcome structural barriers and enhance classroom effectiveness.

4. CONCLUSION

This study provides insights into challenges faced by mathematics trainee teachers. Despite the intention to implement modern teaching strategies, underlying limitations and structural challenges often delay their application. Addressing these challenges requires improved training, digital infrastructure, and adaptive pedagogical. Future studies may examine long-term effects of trainee teacher strategies on student outcomes.

ACKNOWLEDGEMENT

The authors wish to express their heartfelt appreciation to the Centre of Foundation Studies, UiTM Cawangan Selangor, Kampus Dengkil for their generous financial support and unwavering encouragement.

REFERENCES

Davis, J. L. (2018). An examination of three Black African male mathematics teachers' teacher preparation and teaching experiences in Africa and the USA. *Journal for Multicultural Education*, *12*(2), 161–171. https://doi.org/10.1108/JME-04- 2017-0023.

Krejcie, R. V., & Morgan, D. W. (1970). Sample size determination table. *Educational and psychological Measurement*, *30*(3), 607-610.

Mohamed, R. H., Khalil, I. A., & Awaji, B. M. (2023). Mathematics teachers' awareness of effective teaching practices: A comparative study. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(2). https://doi.org/10.29333/ejmste/12962.

Sullamo, A. E., Mekonnen, E. A., & Mihirete, D. M. (2023). Teacher Educators' Views Vis-à-Vis Their Practices on Facilitating Learning to Teach. *Pedagogical Research*, *8*(4).

Engelbrecht, J., Llinares, S., & Borba, M. C. (2020). Transformation of the mathematics classroom with the internet. *ZDM - Mathematics Education, 52*(5), 825–841. https://doi.org/10.1007/s11858-020-01176-4

Shen, J., & Wu, Q. (2021). Research on the Application of Smart Classroom in Higher Mathematics Teaching. *IEEE 6th International Conference on Cloud 67 Computing and Big Data Analytics, ICCCBDA 2021*, 161-165.

A Review on Synthesis of Silver Oxide Nanoparticles

Nor Adrina Amira Hasan[1], Mohd Helmy Yusof[1,2]*

[1]Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Selangor 40450, Malaysia
[2]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*mohdhelmy_87@uitm.edu.my

ABSTRACT

This review discusses the synthesis, characterization and the antimicrobial properties of silver oxide nanoparticles (AgO NPs), including their importance for the growling dispute with antibiotic-resistant pathogens. The recent advancement in nanotechnology has established AgO NPs as one of the key interest areas because of their distinguished physicochemical characteristics such as high surface to volume ratios, and their exceptional antibacterial, antifungal and catalytic activities. These qualities render AgO NPs highly adaptable for use in medical, environmental and industrial sectors. The review points out existing gaps in knowledge regarding optimal synthesis techniques, the influence of nanoparticle size and shape on antimicrobial effectiveness, and the specific mechanisms by which AgO NPs exert their antimicrobial effects. AgO NPs are synthesized using chemical, physical and biological methods. To confirm that the nanoparticles are as per basic specifications of size, shape and stability, characterization techniques like dynamic light scattering (DLS), scanning electron microscopy (SEM) and X-ray diffraction (XRD) have been employed. These nanoparticles exhibit antimicrobial properties by disrupting microbial membranes, producing different reactive oxygen species (ROS), and interfering with the synthesis of DNA and proteins in microorganisms. Such multiple actions increase their efficacy against strains with multidrug resistance. This review aims at acquiring knowledge of the synthesis methods and expanding the understanding of the antimicrobial therapies in applications such as environmental remediation and targeted drug delivery.

Keywords: Silver Oxide Nanoparticles, Synthesis, Antimicrobial, Antibacterial, Reactive Oxygen Species.

1. INTRODUCTION

This review summarized the area of silver oxide nanoparticles (AgO NPs) with focus on their synthesis routes, physical and chemical properties, antimicrobial mechanisms, with particular emphasis on the ways to optimize them for biomedical and environmental applications. The main problem is set against the backdrop of the urgent need for new antimicrobial pathways as these pathogens are reaching levels of antibiotic resistance across the globe; purportedly, another aspect is that little is known about how synthesis parameters, morphology, and molecular pathways affect the antimicrobial performance of AgO NPs (Rodrigues et al,. 2024). The current literature points out three major routes of synthesis, i.e., chemical, physical, and biological (green) methods, all with its own

merits and demerits (Muhammad et al., 2023). Green synthesis harnesses the power of plant extracts or microbes and has turned popular due to its eco-friendly nature and the fact that it can boost biocompatibility (Fayyadh et al., 2021; Saka et al,. 2024). Smaller particles (<10 nm), perhaps coupled with non-spherical morphologies, tend to have higher antimicrobial activity due to enhanced surface reactivity and better interaction with microbes (Abbas et al., 2024; Aguilar-Garay et al., 2024). From a mechanistic standpoint, AgO NPs exert their action through multiple targets: membrane disruption, oxidative stress induction, stopping DNA or protein synthesis, and interference in signal transduction. Thus, these AgO NPs might act as a good option versus multidrug-resistant microorganisms (Kodintcev, 2022; Kamat & Kumari, 2023).

2. METHODOLOGY

The articles were searched in Scopus database search engine for the year 2015 and above. Any articles show the Silver Oxide Nanoparticles sytesization, characterization, antibacterial activity including membrane rupture, Ag^{+} ion release, and ROS formation (killing mechanism) were selected and examined in this review.

3. RESULTS AND DISCUSSION

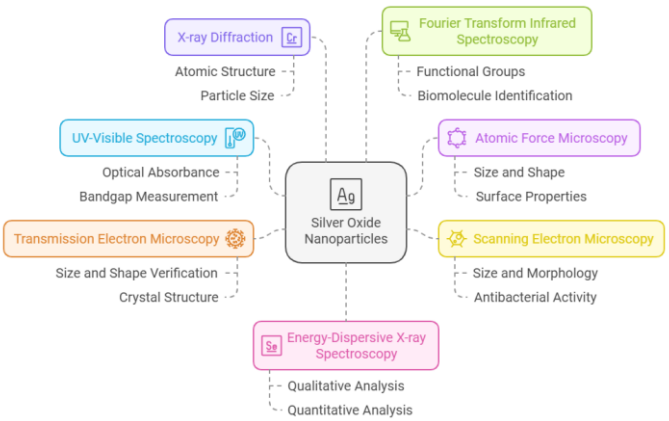


Figure 1. Various Characterization Technique

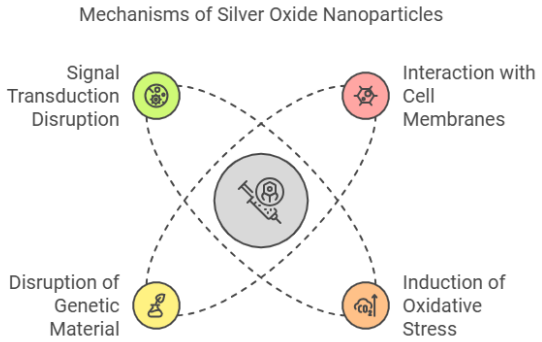


Figure 2. Mechanism in Silver Oxide Nanoparticles

Table 1. Key Feature Of Synthesis Method Of Silver Oxide Nanoparticles (Zhang et al., 2016)

Synthesis Method	Key Features	Limitation
Sol gel method	Controlled particle size and morphology	Time-consuming, potential toxicity from precursors
Micro-emulsion	Homogenous, well-characterized surface features	Requires surfactants, possible cytotoxicity
Electrochemical synthesis	High purity, no stabilizers required	Require precise reaction control
Microbial synthesis	Enzymatic reduction, sustainable	Slow process, requires controlled microbial growth
Evaporation-condesation	High purity, controlled environment	Energy-intensive specialized equipment needed
Laser ablation	No chemical contamination	Expensive laser equipment required
Sputtering	Produces uniform, high-purity nanoparticles	Costly vacuum systems needed

4. CONCLUSION

In conclusion, silver oxide nanoparticles (AgO NPs) synthesized via green methods such as those utilizing *Lawsonia inermis* extracts, are both eco-friendly and effective antimicrobial agents. The particle size and shape are critical determinants of their efficacy as smaller and well-defined nanoparticles demonstrate superior antimicrobial performance. AgO NPs exert their effects through multiple biological pathways, including membrane disruption, oxidative stress induction, interference with genetic material and inhibition of signal trasnduction. This multi-targeted action makes them highly potent against drug-resistant microorganis.

REFERENCES

Rodrigues, A. S., Batista, J. G. S., Rodrigues, M. Á. V., Thipe, V. C., Minarini, L. a. R., Lopes, P. S., & Lugão, A. B, Advances in silver nanoparticles: a comprehensive review on their potential as antimicrobial agents and their mechanisms of action elucidated by proteomics. *Frontiers in Microbiology*, 2024, vol 15.

Muhammad, S., Ali, A., Zahoor, S., Xie Xinghua, Shah, J., Hamza, M., Kashif, M., Khan, S., Khan Ajat Khel, B., & Iqbal, A, Synthesis of Silver Oxide Nanoparticles and its Antimicrobial, Anticancer, Anti-inflammatory, Wound Healing, and Immunomodulatory Activities -A Review. *In Acta Scientific Applied Physics,* 2023, (Vols. 3–7).

Fayyadh, A. A., & Muneer H. Jaduaa Alzubaidy, Green-synthesis of Ag2O nanoparticles for antimicrobial assays**. *Journal of the Mechanical Behavior of Materials*, 2021, vol 30(1),pp 228–236.

Saka, A., Dey, S. R., Jule, L. T., Ramaswamy Krishnaraj, Rengasamy Dhanabal, Mishra, N., & N. Nagaprasad, Investigating antibacterial activity of biosynthesized silver oxide nanoparticles using Phragmanthera Macrosolen L. leaf extract. *Scientific Reports*, 2024, pp 14(1).

Abbas, R., Luo, J., Qi, X., Naz, A., Khan, I. A., Liu, H., Yu, S., & Wei, J. Silver, Nanoparticles: Synthesis, Structure, Properties and Applications. *In Nanomaterials*, 2024.

Aguilar-Garay, R., Lara-Ortiz, L. F., Campos-López, M., Gonzalez-Rodriguez, D. E., Gamboa-Lugo, M. M., Mendoza-Pérez, J. A., Nicolás-Álvarez, D. E., A Comprehensive Review of

Silver and Gold Nanoparticles as Effective Antibacterial Agents. *Pharmaceuticals*, 2024 vol 17(9),pp 1134.

Kodintcev, A. N. Characterization and potential applications of silver nanoparticles: an insight on different mechanisms. *Chimica Techno Acta*, 2022, vol 9(4), pp 9402.

Kamat, S., & Kumari, M. Emergence of microbial resistance against nanoparticles: Mechanisms and strategies. *Frontiers in Microbiology,* 2023, pp 14.

Zhang, X., Liu, Z., Shen, W., & Gurunathan, S. Silver nanoparticles: synthesis, characterization, properties, applications, and therapeutic approaches. *International Journal of Molecular Sciences,* 2016, vol 17(9), pp 1534.

Zinc Oxide Nanocomposite and Photocatalyst Applications as Antimicrobial: A Review

Muhammad Uzair Bin Sulaiman[1], Mohd Helmy Yusof[1,2]*

[1]Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Selangor 40450, Malaysia
[2]*Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*mohdhelmy_87@uitm.edu.my

ABSTRACT

This review highlights the prospects of zinc oxide (ZnO) nanocomposites as photocatalysts and as antimicrobial agents with respect to their potential applications in environmental remediation and healthcare. High biocompatibility, surface area, and reactive for UV light possessed by this material in pathogen-deactivating activity through the generation of reactive oxygen species (ROS). However, having a large bandgap of about 3.37 eV means it will only be active in UV light. To deal with these problems, in this study the article that we found having approaches like doping of metals such as silver, copper, and more, axial blending with other materials, thereby effectively enables photocatalytic activity under visible light as an option. Apart from that, the modes of action of ZnO, which include the generation of ROS and the release of Zn^{2+} ions, have been proven efficient against resistant and antibiotic biofilms. It also intensifying the effect by combining it with other antibacterial agents. According to this review, ZnO nanocomposites should be used in a variety of scenarios for safer and more effective antibacterial treatments, especially in medicine and environmental applications.

Keywords: Zinc Oxide Nanoparticles, Antibacterial, Photocatalyst, Reactive Oxygen Species.

1. INTRODUCTION

Zinc oxide (ZnO) nanocomposites show strong potential as photocatalysts and antimicrobial agents due to their biocompatibility and ability to generate reactive oxygen species (ROS). Their main limitation is a wide bandgap (~3.37 eV), restricting activity to UV light and reducing efficiency under sunlight. This review examines their antibacterial mechanisms, modification strategies, and synergistic combinations to enhance visible-light performance and selectivity. Literature findings show that metal doping, hybridization, and bioconjugation significantly improve activity, making ZnO nanocomposites promising for safe, eco-friendly applications in healthcare, food packaging, and environmental disinfection.

2. METHODOLOGY

The articles were searched in Scopus database search engine (years 2015 and above). Any articles show the mechanisms of ZnO's antibacterial activity, including as membrane rupture, Zn^{2+} ion release, and ROS formation, are examined in this review. Metal doping (e.g., Ag, Cu), hybridisation with reduced graphene oxide (rGO), and formulation with natural antimicrobials were among the strategies to improve photocatalytic performance that were investigated. To

improve stability and efficiency, a number of composite combinations were investigated, including ZnO with MWCNTs, Au, or CMC/AAc hydrogels.

3. RESULTS AND DISCUSSION

ZnO's bandgap can be lowered through doping with Mn, Cu, or S, increasing its light absorption into the visible range. ZnO nanocomposites that were doped and hybridised shown improved photocatalytic and antibacterial properties against both Gram-positive and Gram-negative bacteria. Increasing exposure duration, mixing ZnO with other treatments, or employing structured carriers like hydrogels all decreased biofilm resistance. Moreover, biofunctionalized ZnO demonstrated preferential toxicity to microbial cells as opposed to human cells.

3.1 Figures and Images

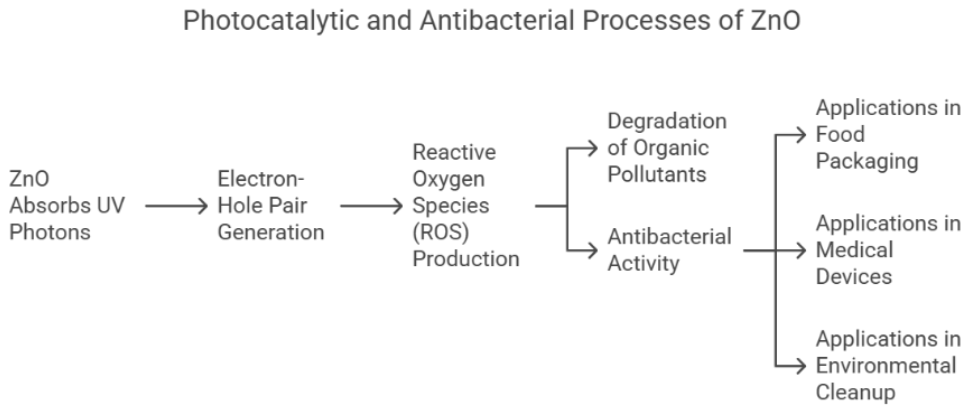


Figure 1. Photocatalytic and Antibacterial Processes of ZnO (Shen et al., 2016).

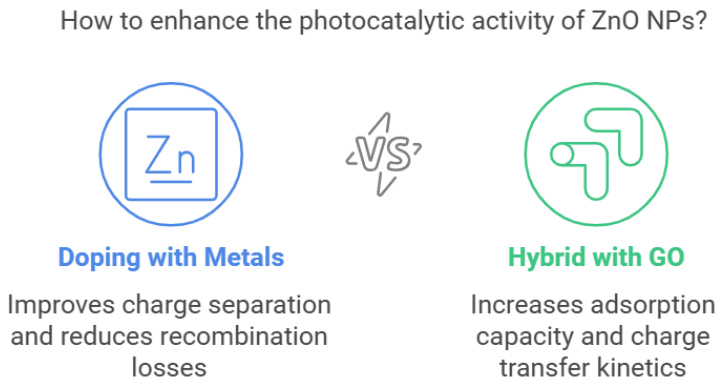


Figure 2. Enhancements of Photocatalytic Activity (Noman et al., 2021)

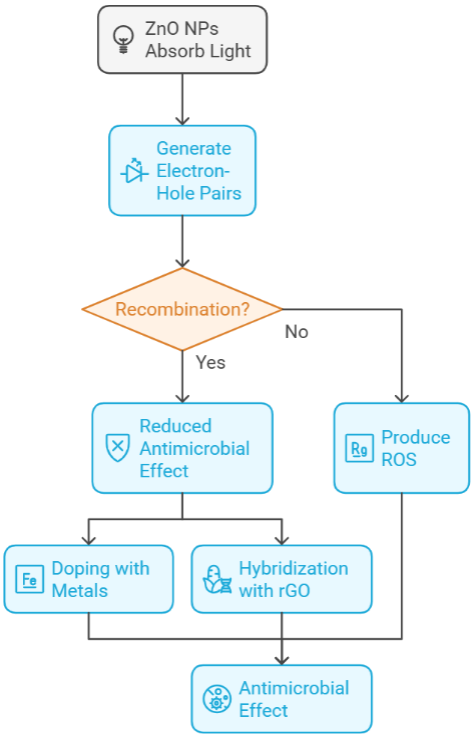


Figure 3. Ways for Recombination of Charge Carriers Works (Ben Dkhil et al., 2017)

3.2 Table

Table 1. Selective Antimicrobial Action of Biofunctionalized ZnO Nanocomposites (Reda et al., 2024)

Modification Approach	Effect	Target Specificity
Physiochemical modification	Enhance antimicrobial properties	General antimicrobial activity
Bioconjugation with ligands or biomolecules	Improve selective binding towards microbial cells	Pathogenic microbes over human or beneficial cells
Composite formation	Controlled delivery and reduced cytotoxicity	Balanced antimicrobial efficiency and safety

Table 2. Antibacterial Performance of CMC/AAc/ZnO Hydrogel Compared to ZnO-Free Hydrogel (Radmehr et al., 2025)

Material Types	ZnO Content	E. coli Viability Reduction (%)	Key Properties
CMC/AAc Hydrogel (Control)	None	0%	Standard hydrogel without antibacterial enhancement
CMC/AAc/ZnO Hydrogel	Embedded	61.8%	Controlled nanoparticle release, extended contact time

4. CONCLUSION

We discovered that ZnO nanocomposites have a lot of promise for antimicrobial uses, especially in wastewater treatment, food packaging, and medical equipment. Performance can be enhanced by reducing charge recombination and increasing visible light activation. For safe, effective, and useful use in real-world applications, future more research is compulsory.

ACKNOWLEDGEMENT

The authors thanks to Faculty of Applied Sciences, UiTM, for providing the facilities and resources needed.

REFERENCES

Ben Dkhil, S., Gaceur, M., Diallo, A. K., Didane, Y., Liu, X., Fahlman, M., Margeat, O., Ackermann, J., & Videlot-Ackermann, C. (2017a). Reduction of Charge-Carrier Recombination at ZnO-Polymer Blend Interfaces in PTB7-Based Bulk Heterojunction Solar Cells Using Regular Device Structure: Impact of ZnO Nanoparticle Size and Surfactant. ACS Applied Materials and Interfaces, 9, 17256–17264. https://doi.org/10.1021/acsami.7b01361

Noman, M. T., Amor, N., Petru, M., Mahmood, A., & Kejzlar, P. (2021a). Photocatalytic behaviour of zinc oxide nanostructures on surface activation of polymeric fibres. In Polymers (Vol. 13, Issue 8). MDPI AG. https://doi.org/10.3390/polym13081227

Radmehr, M., Poursattar Marjani, A., & Akhavan, A. (2025). Synthesis and characterization of antibacterial CMC/AAc/ZnO nanocomposite superabsorbent using gamma radiation. Scientific Reports, 15. https://doi.org/10.1038/s41598-025-93884-8

Reda, A. T., Park, J. Y., & Park, Y. T. (2024). Zinc Oxide-Based Nanomaterials for Microbiostatic Activities: A Review. Journal of Functional Biomaterials, 15. https://doi.org/10.3390/jfb15040103

Shen, Y., Li, L., Xiao, K., & Xi, J. (2016). Constructing Three-Dimensional Hierarchical Architectures by Integrating Carbon Nanofibers into Graphite Felts for Water Purification. ACS Sustainable Chemistry and Engineering, 4, 2351–2358. https://doi.org/10.1021/acssuschemeng.6b00030

Shin, J., Naskar, A., Ko, D., Kim, S., & Kim, K. S. (2022). Bioconjugated Thymol-Zinc Oxide Nanocomposite as a Selective and Biocompatible Antibacterial Agent against Staphylococcus Species. International Journal of Molecular Sciences, 23. https://doi.org/10.3390/ijms23126770

Singh, K., Nancy, Bhattu, M., Singh, G., Mubarak, N. M., & Singh, J. (2023). Light-absorption-driven photocatalysis and antimicrobial potential of PVP-capped zinc oxide nanoparticles. Scientific Reports, 13. https://doi.org/10.1038/s41598-023-41103-7

Sirelkhatim, A., Mahmud, S., Seeni, A., Kaus, N. H. M., Ann, L. C., Bakhori, S. K. M., Hasan, H., & Mohamad, D. (2015). Review on zinc oxide nanoparticles: Antibacterial activity and toxicity mechanism. In Nano-Micro Letters (Vol. 7, pp. 219–242). SpringerOpen. https://doi.org/10.1007/s40820-015-0040-x

Spirescu, V. A., Șuhan, R., Niculescu, A.-G., Grumezescu, V., Negut, I., Holban, A. M., Oprea, O.-C., Bîrcă, A. C., Vasile, B. Ștefan, Grumezescu, A. M., Bejenaru, L. E., Mogoşanu, G. D., Bejenaru, C., Balaure, P. C., Andronescu, E., & Mogoantă, L. (2021). Biofilm-Resistant Nanocoatings Based on ZnO Nanoparticles and Linalool. Nanomaterials (Basel, Switzerland), 11. https://doi.org/10.3390/nano11102564

Sun, Y., Zhang, W., Li, Q., Liu, H., & Wang, X. (2023). Preparations and applications of zinc

oxide based photocatalytic materials. Advanced Sensor and Energy Materials, 2(3), 100069. https://doi.org/10.1016/J.ASEMS.2023.100069

Improving Primary School Students' Understanding in Unit Conversion Using the 1,2,3 BOX Method

Hairul Rashit Ahmad[1], Siti Salwana Mamat[2] and Zarith Sofiah Othman[2*]

[1]Sekolah Kebangsaan (Felda) Keratong 6, 26700 Bandar Tun Abdul Razak, Rompin, Pahang, Malaysia
[2]Centre of Foundation Studies, Universiti Teknologi MARA Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*zarithsofiah@uitm.edu.my

ABSTRACT

Many primary school students struggle to master unit conversion, particularly in converting meters to centimetres and vice versa. This study presents an innovative approach using the 1,2,3 BOX method to improve students' understanding and retention of the conversion process. Conducted at primary school in Keratong, Pahang, this innovation involved 58 students from Year 4 and Year 5. A pre-test and post-test design was used to evaluate the method effectiveness. The results showed a significant improvement in students' performance after implementing the method. Observations and questionnaires indicated enhanced engagement, interest, and confidence among students. The 1,2,3 BOX method is an effective visual-based strategy that simplifies complex numerical processes and can be extended to other units such as mass, time, volume, and money.

Keywords: 1,2,3 BOX method, Innovative teaching, Mathematics education, Primary education, Unit Conversion

1. INTRODUCTION

Unit conversion is a critical skill taught at the primary level, yet many pupils find it challenging due to abstract mathematical operations and a lack of effective pedagogical strategies (Skemp, 1989). One of the recurring difficulties is the conversion of measurement units, particularly between metres and centimetres, which often results in low performance and disengagement in mathematics.

Several alternative approaches have been developed in response to these challenges. For example, Canto López et al. (2022) introduced the Algorithm Based on Numbers (ABN) method in Singapore to support mathematical learning in primary education. Their findings revealed that pupils who underwent the intervention demonstrated greater understanding of fractions and achieved significantly higher scores, showing that innovative teaching methods can facilitate concept assimilation. Similarly, Sadono et al. (2025) designed the "pouch of units" as a tool to improve pupils' ability to count units of weight. Their results indicated not only improved understanding of abstract concepts but also increased active participation in the learning process. In another study, Nguyen et al. (2023) examined strategies for solving two-dimensional measurement unit conversion problems. They found that targeted conceptual tasks enhanced students' problem-solving skills and positively impacted their levels of knowledge.

Despite these efforts, many pupils continue to struggle with mathematics due to conventional

teaching approaches that lack creativity and fail to sustain interest (Abdul Manap, 2001). To address this issue, the present study introduces the 1,2,3 BOX method, a simple and visual technique aimed at improving pupils' conceptual clarity and retention in unit conversion, particularly between metres and centimetres. The main objective of this study is to investigate the effectiveness of the 1,2,3 BOX method in enhancing students' performance, confidence, and interest in learning unit conversion.

2. METHODOLOGY

This study was conducted at SK LKTP Keratong 6 and involved 58 pupils from Year 4 and Year 5. The methodology followed five main steps.

The first step was identifying students' problems. Discussions with mathematics teachers revealed that pupils were generally weak in basic operations, problem solving, and particularly in unit conversion. Since unit conversion underpins several topics such as length, weight, time, money, and liquid volume, it was selected as the focus of this innovation project. The second step was data collection. Students' workbooks were examined to detect errors and misconceptions, and a written test was conducted to measure their understanding of unit conversion. Questionnaires were also distributed to all 58 pupils to capture their perceptions of mathematics, while classroom observations provided insights into their engagement and difficulties when answering conversion-related questions. The third step involved choosing the method. Findings confirmed that students had poor results in unit conversion, which justified the introduction of the 1,2,3 BOX method. This innovation employs a visual, diagram-based approach that simplifies the process and aids memory retention. As highlighted by Buzan (1976), the brain learns more effectively through images and associations. For this project, the scope was limited to metre–centimetre conversions, with the expectation that the method could later be applied to other units such as mass, time, money, and liquid volume. The fourth step was designing and implementing the innovation. A detailed plan was developed in consultation with the mentor, covering the project timeline, participants, teaching strategies, and required resources. Pupils were introduced to the 1,2,3 BOX method through structured lessons, followed by guided practice sessions to ensure mastery of the technique.

The final step was assessment and analysis. An evaluation test of ten questions was administered after the intervention. Results were analysed alongside data from the pre-test, post-test, questionnaires, and classroom observations. These instruments allowed the researchers to measure the effectiveness of the innovation, identify improvements needed, and evaluate the impact on students' performance, confidence, and interest in mathematics.

3. RESULTS AND DISCUSSION

Before the project, 79% of students showed no interest in counting, 93% did not know how to convert units, and non-completed questions on time. However, after completing the project, 100% of students were engaged, confident, and eager to participate.

Table 1. Questionnaire Results

Statement	Pre (%) Yes	Post (%) Yes
Interested in mathematics/conversion	37.5	100
Conversion is hard	100	-
Remember unit values	27.5	100
Method is easy and fun	-	100

Based on Table 1, the questionnaire results demonstrated a clear improvement in students' interest, confidence, and retention after the implementation of the 1,2,3 BOX method. Before the project, only 37.5% of students expressed interest in mathematics, and all students found unit conversion difficult. After the intervention, 100% of students reported interest, confidence, and enjoyment in learning unit conversion. Students went from scoring an average of 1.8/10 to 10/10, with all students showing perfect scores after using the method. This indicates a clear gain in skill acquisition and confidence in unit conversion.

4. CONCLUSION

The 1,2,3 BOX method proved to be a simple yet effective innovation in improving pupils' understanding of unit conversion. Findings from pre- and post-tests, observations, and questionnaires confirmed that students mastered the skills of converting metres to centimetres, showing significant improvement compared to before the project. The method reduced the learning duration from about two weeks (6 hours of instruction) to just two days (2 hours), while also boosting students' confidence, participation, and interest in mathematics. Through this innovative method, students can master the topic length, thereby increasing student achievement in examinations and providing motivation for pupils to be interested in mathematics. Beyond length measurement, the 1,2,3 BOX method can be adapted to other conversion topics such as weight, liquid volume, time, and money, making it a versatile and impactful teaching strategy.

ACKNOWLEDGEMENT

The authors extend their heartfelt gratitude to the reviewers for their invaluable and insightful suggestions.

REFERENCES

Abdul Manap, Y. (2001). Memartabatkan profesion keguruan tanggungjawab bersama. *Bestari Koleksi Guru Johor, JPN Johor*, 15-33.

Canto López, M. D. C., Manchado Porras, M., Piñero Charlo, J. C., Mera Cantillo, C., Delgado Casas, C., Aragón Mendizábal, E., & García Sedeño, M. A. (2022). Description of main innovative and alternative methodologies for mathematical learning of written algorithms in primary education. *Frontiers in Psychology*, *13*, 913536.

Nguyen, H., An, T., & Maher, E. M. (2023). Impact of Designed Task-Based Interventions on K-8 Preservice Teachers' Knowledge and Ability to Solve Measurement Unit Conversion Problems. *International Journal on Studies in Education (IJonSE)*, *5*(3).

Sadono, I., Riyadi, R., & Kurniawan, S. B. (2025). Analysis of the Impact of PBL Implementation Assisted by Pouch of Unit on the Ability to Count Units of Weight in Elementary School Learners. *Social, Humanities, and Educational Studies (SHES): Conference Series*, 8(1), pp. 382-391.

Skemp, R. R. (2002). *Mathematics in the primary school*. Routledge.

Review of Biodegradation of Carbofuran: Microbial Degradation and Enzymatic Mechanisms

Mohd Helmy Yusof[1,2]*

[1]Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Selangor 40450, Malaysia
[2]Centre of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*mohdhelmy_87@uitm.edu.my

ABSTRACT

Carbofuran, a highly toxic systematic carbamate pesticide, is widely used in agriculture but poses severe environmental and health risks due to its persistence and mobility in soil and water. Conventional chemical and physical remediation methods are costly and generate secondary pollutants, making microbial degradation an eco-friendly alternative. This review had found the articles (28 articles selected from Scopus database) that discovered various bacterial and fungal species, including *Sphingomonas*, *Pseudomonas*, *Enterobacter*, and *Rhodococcus*. All these bacterial have demonstrated carbofuran-degrading capabilities through enzymatic hydrolysis (e.g., CehA hydrolase) and oxidative pathways (e.g., CfdC monooxygenase). Despite improvement in research finding, a systematic understanding of microbial degradation efficiency, genetic regulation, and field applicability remains underexplored and require a lot of future research.

Keywords: Carbofuran; Carbamate pesticide; Microbial degradation; Bacterial; Enzyme biodegradation.

1. INTRODUCTION

Carbofuran is a highly toxic systematic carbamate pesticide. It is widely used in agriculture to control insect pests, nematodes, and mites (Fenoll et al., 2011). Despite its effectiveness as pesticide, carbofuran can cause environmental and health risks due to its lifespan in soil and water, high toxicity to non-target organisms, and likely to contaminate food chains (Kumar et al., 2018). Given its widespread use and environmental hazards, the degradation of carbofuran has become a serious research focus, with microbial offering excellent strategies.

Microbial degradation is a key mechanism for carbofuran removal in the environment. Various bacterial and fungal species, including *Sphingomonas, Pseudomonas, Methylobacterium*, and *Aspergillus*, have been reported to metabolize carbofuran into less toxic compounds (Gupta, 1994; Kim et al., 2015; Zhang et al., 2018). These microorganisms offered hydrolytic, catalytic and oxidative pathways to break down the carbofuran. Carbofuran degradation by microbe has been linked to specific catabolic genes, such as *cehA* and *mcd*, encoding carbofuran hydrolase and methylcarbamate hydrolase, respectively (Tomasek & Karns, 1989; Chaudhry & Ali, 1988; Hong et al., 2007). Understanding the microbial pathways particularly in enzymatic mechanisms play a pivotal role in carbofuran degradation for developing bioremediation techniques to lessen carbofuran contamination.
Enzyme such hydrolases, oxidoreductases, and ligninolytic enzymes contributing to the

breakdown Carbofuran and has been extensively studied for its ability to catalyze the hydrolysis of the carbamate linkage, yielding non-toxic metabolites (Yang et al., 2019). Additionally, oxidative enzymes such as monooxygenases and laccases have been implicated in the transformation of carbofuran into phenolic derivatives (Bano & Musarrat, 2003). Advances in enzyme engineering like enzyme immobilization techniques could enhanced the potential for large-scale pesticide degradation (Liu, 2020).

This review was made to discover current knowledge on microbial and enzymatic degradation of carbofuran, emphasizing the biochemical pathways and enzyme involvement. By elucidating all these data, this review work might to contribute to the development of efficient and eco-friendly strategies for carbofuran remediation.

2. METHODOLOGY

This review refers to the PRISMA review protocol. The articles were searched in Scopus database search engine (years 2014 and above) .The string search as following: TITLE-ABS-KEY (carbofuran biodegradation) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "article")) AND (LIMIT-TO (EXACTKEYWORD , "Carbofuran")) AND (LIMIT-TO (LANGUAGE , "English"). During this process,58 articles were discovered and only 15 articles were selected for the screening process that hit the criteria of “Carbofuran microbial degradation” and undergone review processed.

3. RESULT AND DISCUSSION

Table 1. Microbe and enzyme involve in carbofuran degradation.

No	Enzyme / Gene (Alias)	Host Organism	Genetic Context (plasmid/chromosome; cluster)	Citation
1	CehA (carbamate hydrolase)	*Sphingobium* sp. CFD-1	Mobile elements around cehA; conserved among CF degraders	Jiang et al. (2020)
2	CehA + cfdC ($FMNH_2$/$FADH_2$ monooxygenase)	*Sphingomonas* sp. CDS-1	cfd genes conserved vs. *Novosphingobium* KN65.2	Yan et al. (2018)
3	cfd cluster (cfdC/E/F) + cehA (comparative genomics)	*Sphingobium* spp. CFD-1/CFD-2; *Novosphingobium* KN65.2	cehA and cfd cluster on two plasmids; flanked by IS6100	Jiang et al. (2022)
4	IpcH (novel hydrolase)	*Rhodococcus* sp. D-6	Chromosomal; low identity (<27%) to known carbamate hydrolases	Zhu et al. (2024)

5	Extracellular transformation; metabolome shifts	*Chryseobacterium* sp. BSC2-3	Genes for IAA biosynthesis reported	Park et al. (2022)
6	EPS-linked catabolism & metabolites	*Cupriavidus* sp. ISTL7	n/a	Gupta et al. (2019)
7	Multi-enzyme system (Mcd; RamA)	*Enterobacter* sp. Z1	Multi-gene response (genomics/proteomics/qPCR)	Zhang et al. (2020)
8	Pathway prediction & substrate rules	*Novosphingobium* sp. KN65.2	Rieske dioxygenases & flavin monooxygenases emphasized	Schittich et al. (2024)
9	Substrate specificity (generalist vs specialist)	*Novosphingobium* sp. KN65.2 vs *P. fluorescens* P17	n/a	Schittich et al. (2022)

The biodegradation of carbofuran through microbial and enzymatic pathways presents a promising solution for mitigating their toxicity in environment. Microbial degradation, facilitated by diverse bacterial and fungal species, play significant role for bioremediation. Studies as shown in Table 1 have identified key microorganisms, such as *Sphingomonas* and *Pseudomonas*, capable of metabolizing carbofuran into less toxic intermediates. These findings align with earlier research as mentioned above that highlighting the role of carbofuran hydrolase (*cehA*) and methylcarbamate hydrolase (*mcd*) genes in beginning the process of degradation. Future studies should explore more on the discovering of microbial consortia to enhance degradation under several environmental situations.

Again, this review found that enzymatic mechanisms offer good approach for carbofuran breakdown, with hydrolases playing pivotal roles. Carbofuran hydrolase, for instance, catalyses the hydrolysis of the carbamate bond, yielding non-toxic compounds (Yang et al., 2019). Similarly, oxidative enzymes such as monooxygenases and laccases contribute to the transformation of carbofuran into phenolic derivatives (Bano & Musarrat, 2003). Despite this discovery, the practical application of free enzymes is limited by their instability and high production costs. Recent developments in enzyme immobilization and protein engineering present opportunities to overcome these limitations (Liu et al., 2020). For instance, immobilized enzymes exhibit enhanced stability and reusability, making them suitable for large-scale remediation. Further research should focus on improving the catalytic efficiency and scalability of these enzymatic systems.

4. CONCLUSION

In conclusion, while microbial and enzymatic degradation pathways offer effective means for carbofuran remediation, their success depends on addressing key challenges such as environmental variability, enzyme stability, and another factor such the production of intermediate toxicity. Future research should prioritize the development of robust, scalable, and

eco-friendly biodegradation systems to ensure sustainable environmental management.

ACKNOWLEDGEMENT

The authors extend their heartfelt gratitude to the reviewers for their invaluable and insightful suggestions.

REFERENCES

Fenoll, J., Hellín, P., Martínez, C. M., Flores, P., & Navarro, S. (2011). Determination of pesticide residues in fruit and vegetables. *Journal of Chromatography A*, 1218(42), 7395–7400.

Kumar, S., Kaushik, G., & Villarreal-Chiu, J. F. (2018). Scenario of organophosphate pollution and toxicity in India: A review. *Environmental Science and Pollution Research*, 25(10), 9480–9491.

Gupta, R. C. (1994). Carbofuran toxicity. *Journal of Toxicology and Environmental Health*, 43(4), 383–418.

Kim, Y.-H., Ahn, J.-Y., Moon, S.-H., & Lee, J. (2015). Biodegradation and detoxification of organophosphate insecticide, malathion by *Fusarium oxysporum* f. sp. *pisi* cutinase. *Chemosphere*, 60(10), 1349–1355.

Zhang, J.-J., Lu, X., Li, J.-J., & Zhang, J. (2018). Biodegradation of carbofuran by *Pichia anomala* strain HQ-C-01 and its application for bioremediation of contaminated soils. *Environmental Science and Pollution Research*, 25(18), 17654–17663.

Tomasek, P. H., & Karns, J. S. (1989). Cloning of a carbofuran hydrolase gene from *Achromobacter* sp. strain WM111 and its expression in gram-negative bacteria. *Journal of Bacteriology*, 171(7), 4038–4044.

Chaudhry, G. R., & Ali, A. N. (1988). Bacterial metabolism of carbofuran. *Applied and Environmental Microbiology*, 54(6), 1414–1419.

Hong, Q., Zhang, Z., Hong, Y., & Li, S. (2007). A microcosm study on bioremediation of fenitrothion-contaminated soil using *Burkholderia* sp. FDS-1. *International Biodeterioration & Biodegradation*, 59(1), 55–61.

Yang, C., Liu, N., Guo, X., & Qiao, C. (2019). Cloning of *mpd* gene from a carbofuran-degrading strain *Novosphingobium* sp. KN65.2 and its expression in *Escherichia coli*. *Journal of Hazardous Materials*, 169(1–3), 809–814.

Bano, N., & Musarrat, J. (2003). Isolation and characterization of phorate degrading soil bacteria of environmental and agronomic significance. *Letters in Applied Microbiology*, 36(6), 349–353.

Liu, Y., Li, S., Ni, Z., Qu, M., Zhong, D., & Ye, C. (2020). Pesticide degradation by immobilized enzymes: Approaches and challenges. *Environmental Science and Pollution Research*, 27(15), 17642–17653.

Jiang, J., Li, B., Zhang, Y., & Qiu, L. (2020). Mobile genetic elements around cehA and their conservation among carbofuran-degrading sphingomonads. *Ecotoxicology and Environmental Safety*, 201, 110852.

Yan, Y., Yang, H., Tang, L., Zhang, J., & Li, M. (2018). The cfd gene cluster in Sphingomonas sp. CDS-1: Comparative analysis with Novosphingobium KN65.2 reveals conserved carbofuran degradation mechanisms. *Applied and Environmental Microbiology*, 84(12), e00342-18.

Jiang, J., Zhang, Y., Li, B., & Qiu, L. (2022). Comparative genomics of *Sphingobium* spp. reveals plasmid-borne cehA and cfd gene clusters responsible for carbofuran degradation.

Applied and Environmental Microbiology, 88(4), e02217-21.

Zhu, Y., Wang, X., Chen, R., & Liu, K. (2024). IpcH: A novel carbamate hydrolase in Rhodococcus sp. D-6 with low sequence identity to known enzymes. *Journal of Hazardous Materials*, 465, 133212.

Park, S., Kim, J., Lee, D., & Choi, H. (2022). Metabolomic shifts and extracellular transformation pathways in *Chryseobacterium* sp. BSC2-3 during carbamate degradation. *Metabolites*, 12(5), 432.

Gupta, R., Kumar, S., Srivastava, A., & Sharma, P. (2019). Exopolysaccharide-mediated carbamate degradation in *Cupriavidus* sp. ISTL7: Metabolic and biotechnological implications. *Bioresource Technology*, 282, 156–164.

Zhang, H., Wei, L., Wang, Y., & Zhao, G. (2020). Multi-enzyme response in Enterobacter sp. Z1: Genomic, proteomic, and qPCR analysis of mcd and ramA genes in carbamate degradation. *Chemosphere,* 240, 124965.

Schittich, A. R., Wagner, M., Brüls, T., & Pieper, D. (2024). Substrate rules and pathway prediction for Rieske dioxygenase- and flavin monooxygenase-driven carbamate degradation in Novosphingobium sp. KN65.2. *Environmental Microbiology*, 26(2), e16542.

Schittich, A. R., Morin, K., Lewis, J. D., & Pieper, D. (2022). Generalist versus specialist: Substrate range analysis of Novosphingobium KN65.2 and Pseudomonas fluorescens P17 in carbamate degradation. *Environmental Science: Processes & Impacts*, 24(5), 782–793.

Yang, C., Liu, R., Yuan, Y., Liu, J., & Jiang, J. (2019). Purification and characterization of a novel carbofuran hydrolase from Novosphingobium sp. KN65.2. *Journal of Agricultural and Food Chemistry*, 67(4), 1128–1135.

Liu, Y., Li, W., Li, Y., Jiang, Y., & Li, H. (2020). Enzyme immobilization on amino-functionalized mesoporous silica for improved carbofuran degradation. *Chemical Engineering Journal*, 395, 125090.

The Effect of Aluminium Oxide Nanofillers on Electrochemical Properties of Cornstarch/NaI Biopolymer Electrolytes

A. N. Hamdan[1] & F. H. Muhammad[2*]

[1]Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
[2]Center of Foundation Studies, Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor, Malaysia

*fadiatul@uitm.edu.my

ABSTRACT

Solid polymer electrolytes (SPEs) represent an alternative to conventional liquid electrolytes due to their improved safety, thermal stability, and electrochemical compatibility. Cornstarch-based SPEs are particularly attractive because of their abundance, low cost, and biodegradability, yet they are hindered by poor ionic conductivity and weak mechanical stability. This study investigates the effect of aluminium oxide (Al_2O_3) nanofillers on the structural and electrochemical performance of cornstarch–sodium iodide (NaI) based electrolytes fabricated via solution casting. Electrochemical impedance spectroscopy (EIS) was employed to measure ionic conductivity. Results revealed that NaI doping enhanced conductivity up to 9.43×10^{-9} S/cm at 15 wt% loading, beyond which conductivity decreased due to ion agglomeration. Incorporation of Al_2O_3 nanofillers further improved conductivity, with an optimum performance at 4 wt% filler (4.02×10^{-9} S/cm). These findings suggest that the synergistic effect of salt and nanofillers improves ion transport, thereby enhancing the applicability of cornstarch-based electrolytes in sustainable energy storage devices.
Keywords: Solid polymer electrolyte, cornstarch, sodium iodide, aluminium oxide, ionic conductivity

1. INTRODUCTION

The demand for safe, lightweight, and sustainable electrolytes for rechargeable batteries has motivated the exploration of solid polymer electrolytes (SPEs) as replacements for volatile liquid systems (Abdullah et al., 2023). SPEs eliminate risks of leakage, corrosion, and flammability while offering mechanical flexibility and wide electrochemical stability. Biopolymers such as starch, chitosan, and cellulose have gained attention for their environmental benignity (Huang et al., 2017). Among these, cornstarch is a promising host matrix due to its biodegradability, renewability, and favorable adhesion and recrystallization properties. However, cornstarch-based SPEs are limited by low ionic conductivity and poor thermal stability (Liew et al., 2015). Several strategies, including salt doping, polymer blending, and nanofiller addition, have been investigated to enhance conductivity. Sodium iodide (NaI) provides mobile Na^+ carriers, while aluminium oxide (Al_2O_3) nanofillers reduce crystallinity and promote Lewis acid–base interactions, thereby increasing charge carrier dissociation and mobility. This study focuses on evaluating how NaI and Al_2O_3 additions influence the conductivity and structural behavior of cornstarch SPEs.

2. METHODOLOGY

Cornstarch, NaI, and Al_2O_3 were used as host polymer, dopant salt, and nanofiller, respectively. Biopolymer films were prepared via the solution casting method. Samples with varying NaI contents (5–20 wt%) and Al_2O_3 fillers (2–10 wt%) were fabricated. The ionic conductivity was determined using Electrochemical Impedance Spectroscopy (EIS) over the frequency range of 50 Hz–5 MHz at room temperature. The bulk resistance (R_b) was extracted from Cole–Cole plots and conductivity calculated using $\sigma = t / (R_b \times A)$, where t = thickness, A = surface area, and R_b = bulk resistance. FTIR spectra were recorded in the range 650–4000 cm^{-1} to identify functional groups and confirm interactions between polymer, salt, and filler.

3. RESULTS AND DISCUSSION

Ionic conductivity increased with NaI loading up to 15 wt% (9.43×10^{-9} S/cm), beyond which conductivity decreased due to ion aggregation. The optimum Al_2O_3 nanofiller content was 4 wt%, yielding conductivity of 4.02×10^{-9} S/cm. Excess filler (>6 wt%) led to reduced conductivity, attributed to ion-blocking effects and particle agglomeration. (Teoh et al., 2014).

Table 1. Ionic conductivity values of cornstarch–NaI electrolytes

Sample	NaI (wt%)	σ (S/cm)
CN-5	5	2.73×10^{-9}
CN-10	10	7.19×10^{-9}
CN-15	15	9.43×10^{-9}
CN-20	20	4.23×10^{-9}

4. CONCLUSION

This study demonstrates that cornstarch, a renewable and biodegradable material, can be developed into SPEs with improved ionic conductivity through NaI doping and Al_2O_3 nanofiller addition. Optimal performance was achieved at 15 wt% NaI and 4 wt% Al_2O_3, showing improved ion transport and polymer–filler interactions. The findings suggest strong potential for cornstarch-based electrolytes in sodium-ion batteries and other eco-friendly electrochemical devices. Future work should optimize salt–filler ratios and explore alternative nanofillers for further enhancement.

ACKNOWLEDGEMENT

The author acknowledges the support of Universiti Teknologi MARA (UiTM), Faculty of Applied Sciences, and the laboratory facilities provided for this project.

REFERENCES

Abdullah, A. G., S, C., Primadona, I., & Hanantyo, M. H. G. (2023). Physical and chemical properties of corn, cassava, and potato starches. IOP Conference Series: Earth and Environmental Science, 160, 012003.

Hwang, J. Y., Myung, S., & Sun, Y. (2017). Sodium-ion batteries: present and future. Chemical Society Reviews, 46(12), 3529–3614.

Liew, C. W., & Ramesh, K. (2015). Electrical, structural, thermal and electrochemical properties of corn starch-based biopolymer electrolytes. Carbohydrate Polymers, 124, 222–228.

Teoh, K. H., Lim, C. S., & Ramesh, K. (2014). Lithium ion conduction in corn starch-based solid polymer electrolytes. Measurement, 48, 87–95.

UNIVERSITI TEKNOLOGI MARA

Pusat Asasi

e ISBN 978-629-99129-5-8

PUBLISHED BY:

CENTRE OF FOUNDATION STUDIES

UNIVERSITI TEKNOLOGI MARA

CAWANGAN SELANGOR KAMPUS DENGKIL

43800 DENGKIL

SELANGOR, MALAYSIA