# BEYOND BOUNDARIES: THE MULTIDIMENSIONAL HORIZONS OF E-LEARNING

VOLUME 9, 2025
e-ISBN : 978-629-98755-5-0


SIG CS@e-Learning
Unit Penerbitan
Jabatan Sains Komputer & Matematik
Kolej Pengajian Pengkomputeran, Informatik & Matematik
Universiti Teknologi MARA Cawangan Pulau Pinang

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**Published by:**
**Unit Penerbitan Jabatan Sains Komputer & Matematik (JSKM)**
**Bahagian Hal Ehwal Akademik (BHEA)**
**Universiti Teknologi MARA**
**Cawangan Pulau Pinang**
**13500 Permatang Pauh**
**Pulau Pinang**
**Malaysia**

**e ISBN : 978-629-98755-5-0**

## PREFACE

The SIG CS@e-Learning committee sincerely appreciates the dedication and contributions of the educators from Jabatan Sains Komputer & Matematik (JSKM), UiTM Penang Branch, in bringing the 9th edition to fruition. This edition received 30 scholarly articles, all of which met the required criteria and were accepted. Authors are encouraged to further refine their research with additional insights and discussions for potential publication in high-impact journals indexed by SCOPUS, WOS, or ERA.

The theme for the ninth volume, "Beyond Boundaries: The Multidimensional Horizons of E-Learning," reflects the continuous evolution of digital learning. Over the past few decades, e-learning has proven to be a transformative force in education, demonstrating exceptional adaptability and effectiveness. The widespread use of mobile technology has expanded its reach, making e-learning an essential component not only in higher education and vocational training but also in primary and secondary education. Emerging trends such as artificial intelligence (AI), micro-credentials, big data, virtual and augmented reality, blended learning, cloud-based platforms, gamification, mobile learning, the Internet of Things (IoT), and online video are reshaping the digital learning landscape.

SIG CS@e-Learning remains dedicated to fostering academic excellence through impactful publications. With continuous commitment and innovation, we aspire for JSKM to attain recognition in esteemed academic journals, further advancing the frontiers of e-learning.

***Ts. Jamal Othman***
*Chief Editor*
*SIG CS@e-LEARNING*
*Beyond Boundaries : The Multidimensional Horizons of E-Learning*
***Vol. 9, 24 March 2025***

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*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# THE IMPACT OF AI TOOLS ON SOFTWARE DEVELOPMENT PRACTICES AND PROGRAMMER PRODUCTIVITY

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**ABSTRACT**

*The integration of Artificial Intelligence (AI) tools into software development has revolutionized traditional programming practices, significantly enhancing programmer productivity. This article explores the transformative impact of AI tools across various dimensions of software development, including code completion, bug detection and fixing, code refactoring, learning and adapting, automated testing, and natural language processing (NLP). AI-powered code completion tools like GitHub Copilot and PCR-Chain streamline coding by predicting and correcting code snippets, while bug detection systems like EBUG improve error resolution processes. Refactoring tools enhance software quality by automating repetitive tasks and providing optimization insights. AI's adaptive capabilities allow tools to learn user preferences, improving suggestion accuracy and usability. Additionally, automated testing frameworks leverage AI to optimize and expedite testing workflows, ensuring software reliability. The advancements in NLP have further enabled natural language-guided programming and documentation generation. Despite these advancements, challenges such as ethical concerns, reduced problem-solving skills, and usability issues persist, requiring balanced and responsible integration. Overall, AI programming assistants present immense potential to augment human capabilities and reshape the future of software development.*

***Keywords: AI tools, software development, code completion, bug detection, automated testing***

## Introduction

The integration of Artificial Intelligence (AI) into software development has transformed traditional programming paradigms. Historically, AI's role in software development has evolved from simple automation to sophisticated generative models capable of assisting in complex coding tasks. AI has become a significant part of our daily lives. From virtual assistants like Siri and Alexa to recommendation systems on Netflix and Amazon, AI is everywhere. One of the areas where AI is making a substantial impact is in the field of programming. The emergence of Large Language Models (LLMs) has significantly influenced computer science education, enhancing learning and curriculum development (Raihan et al., 2024)

The integration of AI in programming has transformed the landscape of software development. Recent advancements in conversational AI have enabled these tools to engage with developers in a

more interactive manner, thereby facilitating a collaborative coding environment. A study involving 42 software engineers demonstrated that conversational AI significantly improved code generation and overall software development tasks, with participants expressing newfound appreciation for the assistant's capabilities and productivity potential (Ross et al., 2023). AI tools are now being used to assist programmers in writing code, making the process faster, more efficient, and less prone to errors.

**AI Tools in Software Development**

This article explores the transformative impact of AI tools on various aspects of software development, including code completion, bug detection and fixing, code refactoring, learning and adapting, automated testing, and natural language processing as shown in Figure 1. As the software industry continues to evolve, AI technologies are becoming integral to enhancing productivity, improving code quality, and streamlining development processes.

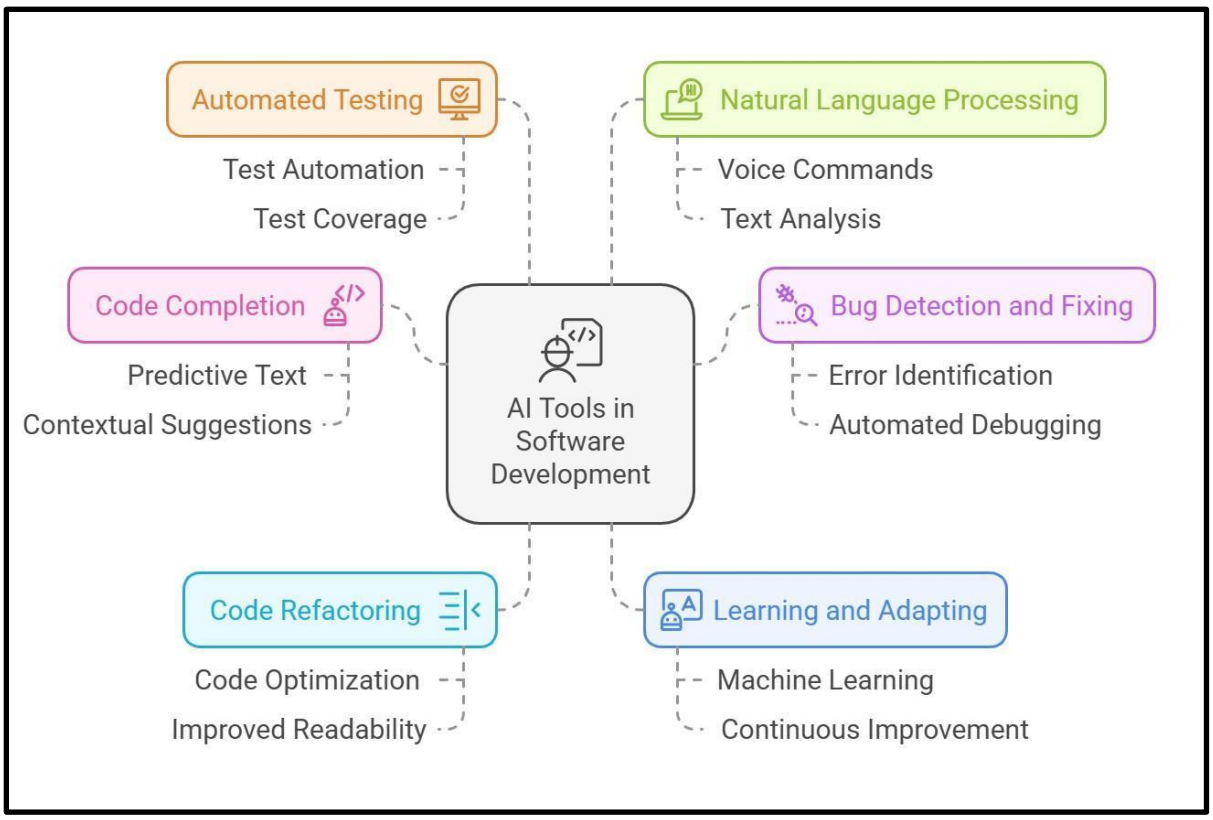


Figure 1: Impact of AI tools in various aspects of software development.

**Code Completion**

One of the most common ways AI aids in programming is through code completion tools. These tools use machine learning algorithms to predict what the programmer is going to type next. For example, GitHub Copilot, an AI-powered code completion tool, can suggest entire lines or blocks of code based on the context of what the programmer is writing. Research by Mozannar et al. (2023) indicates that tools like GitHub Copilot can potentially halve the time required to complete programming tasks. However, the study also highlights new inefficiencies arising from the need for prompt writing and suggestion verification, suggesting that while these tools are beneficial, they also introduce complexities that require further exploration (Mozannar et al., 2023).

AI-driven code completion tools utilize advanced algorithms to predict and suggest code snippets, thereby assisting programmers in writing code more efficiently. For instance, Huang et al. (2023) introduced PCR-Chain, an AI-based system that resolves fully qualified names (FQNs) and syntax errors in partial code, achieving an impressive accuracy of 80.5% in Java, which surpasses traditional methods focused solely on syntax errors (Huang et al., 2023). Additionally, Ciniselli et al. (2023) evaluated Transformer models, revealing that T5 excels in predicting masked tokens, although accuracy diminishes with increased complexity (Ciniselli et al., 2023).

**Bug Detection and Fixing**

Software reliability directly impacts user satisfaction and operational efficiency. As Lai et al. (2024) highlight, understanding the nuances of bug resolution in machine learning (ML) versus non-ML contexts is crucial for optimizing software performance. The study indicates that different categories of ML issues require tailored approaches for effective resolution, emphasizing the need for robust detection mechanisms.

AI techniques, particularly those utilizing machine learning, have shown potential in identifying bugs more efficiently than traditional methods. Jahan et al. (2024) discuss the prevalence of duplicate bug reports, which complicate maintenance efforts. Their findings suggest that existing detection techniques often fail to recognize textually dissimilar duplicates, underscoring the necessity for advanced AI-driven solutions that can better capture the complexities of software issues.

Traditional debugging can be a time-consuming process, but AI-powered tools can analyse the code and identify potential issues much faster. Tools like DeepCode and Codota use AI to scan the code for bugs and suggest fixes. This helps programmers to ensure that their code is more reliable and less prone to errors. Innovative systems like EBUG, as presented by Fazzini et al. (2022), demonstrate the effectiveness of AI in enhancing the quality of bug reports. EBUG's predictive models not only expedite report creation but also improve reproducibility, showcasing the tangible benefits of AI in streamlining the bug resolution process.

**Code Refactoring**

Refactoring is the process of restructuring existing code without changing its external behaviour. This process enhances maintainability, readability, and overall software quality. However, manual refactoring can be error-prone and time-consuming, necessitating the integration of advanced tools to streamline this process. AI can identify redundant code, suggest more efficient algorithms, and even reformat the code to make it more readable.

Refactoring is essential for adapting software to evolving requirements and improving performance. Pantiuchina et al. (2021) analyzed 287,813 refactoring operations across 150 open-source projects, revealing a strong correlation between specific metrics and refactoring activities. This study highlights the necessity of understanding developer motivations, which can inform better practices and tool development.

The implementation of AI tools in refactoring has shown promising results in improving software quality. AI tools have emerged as pivotal in enhancing refactoring practices. For instance, REFBUGFINDER, an Eclipse IDE plugin, effectively detects anomalies in manual refactoring processes. Nguyen et al. (2023) demonstrated that this tool significantly reduced manual effort and errors, thereby improving efficiency and reliability in software refactoring. Such tools not only automate repetitive tasks but also provide insights that guide developers in making informed decisions.

**Learning and Adapting**

Historically, programming tools have evolved from basic text editors to sophisticated AI-driven environments. Early tools lacked interactivity and real-time feedback, limiting their effectiveness. AI tools are not static; they learn and adapt over time. As programmers use these tools, they gather data on coding patterns and preferences. This allows the AI to provide more accurate and personalized suggestions. For instance, if a programmer frequently uses a particular coding style or library, the AI tool will learn this and tailor its suggestions accordingly. The focus on user-centric design is crucial for the future of AI programming tools. Developers express a need for improved interfaces that allow for better control over AI outputs, which is essential for fostering greater adoption and satisfaction.

Current trends indicate a growing reliance on live programming techniques, which facilitate the evaluation of AI-generated code suggestions. Ferdowsi et al. (2023) demonstrated that live programming not only aids in validating multiple suggestions but also enhances efficiency by providing immediate feedback. Despite these advancements, a survey by Liang et al. (2024) revealed that while AI programming assistants can boost productivity, usability issues persist, with low acceptance rates among developers.

**Automated Testing**

Testing is a crucial part of the software development process. Historically, software testing has evolved from manual processes to automated frameworks, driven by the need for faster and more reliable testing outcomes. Recent advancements in AI have further transformed this landscape, enabling more sophisticated testing methodologies. AI can automate various testing tasks, such as unit testing, integration testing, and performance testing. AI-powered testing tools can generate test cases, execute them, and analyse the results.

AI-driven testing tools have emerged as essential components in modern software development. These tools leverage various machine learning approaches, including supervised, unsupervised, and reinforcement learning, to enhance testing accuracy and efficiency. Notably, black-box testing has gained prominence, utilizing clustering and genetic algorithms to optimize regression testing processes (Lima et al., 2020). AI techniques, such as machine learning and neural networks, have been identified as pivotal in automating complex testing scenarios, thus reducing time and costs associated with software development (Job, 2021).

The integration of AI into software testing processes marks a significant evolution in the field of software development. As the demand for high-quality software increases, traditional testing methods often fall short in efficiency and effectiveness. AI technologies offer innovative solutions to enhance automation, thereby improving both the quality and speed of software testing.

**Natural Language Processing**

Natural Language Processing (NLP) is a branch of AI that deals with the interaction between computers and humans using natural language. NLP can be used to create tools that understand and generate human language. In programming, NLP can be used to create documentation, generate comments, and even translate code from one programming language to another. This makes it easier for programmers to understand and work with the code.

The current landscape of NLP in programming is characterized by significant advancements in techniques and applications. A comprehensive survey by Zhu et al. (2022) highlights the evolution of NLP4P, detailing the transition from early deductive models to contemporary competition-level frameworks. This survey emphasizes the existing gap between natural and programming languages, which presents both challenges and opportunities for future research (Zhu et al., 2022).

NLP applications in code generation are particularly noteworthy. Heyman et al. propose a natural language-guided programming approach that automates code completion through natural language descriptions. Initial experiments demonstrate the feasibility of this method, particularly in Python and data science libraries, suggesting a promising avenue for automating code adaptation from existing examples (Heyman et al., 2021). Furthermore, the enrichment of code completion with natural

language intent enhances the coding process, making it more efficient and user-friendly (Heyman et al., 2021).

**Conclusion**

The primary advantages of AI programming assistants include increased efficiency, reduced barriers to entry for novice programmers, and enhanced problem-solving capabilities. By automating routine coding tasks, these tools allow developers to focus on more complex challenges, thereby fostering innovation. Furthermore, responsible utilization of AI can mirror the positive impacts of previous technological advancements, such as search engines, which democratized access to information (Bull et al., 2023).

Despite their benefits, AI programming assistants face challenges, reduced problem-solving skills, reduced problem-solving skills, and ethical implications surrounding code originality. Addressing these issues requires a balanced approach that emphasizes responsible use while leveraging AI's potential to augment human capabilities.

In conclusion, AI programming assistants represent a significant advancement in software development, offering numerous benefits while also presenting challenges that necessitate careful consideration. The future of programming may well depend on how effectively these tools are integrated into the development process.

**References:**

Bull, C., & Kharrufa, A. (2023). Generative AI Assistants in Software Development Education: A vision for integrating Generative AI into educational practice, not instinctively defending against it. arXiv preprint arXiv:2303.13936.

Ciniselli, M., Cooper, N., Pascarella, L., Mastropaolo, A., Aghajani, E., Poshyvanyk, D., ... & Bavota, G. (2021). An empirical study on the usage of transformer models for code completion. IEEE Transactions on Software Engineering, 48(12), 4818-4837.

Fazzini, M., Moran, K., Bernal-Cardenas, C., Wendland, T., Orso, A., & Poshyvanyk, D. (2022). Enhancing mobile app bug reporting via real-time understanding of reproduction steps. *IEEE Transactions on Software Engineering*, *49*(3), 1246-1272.

Ferdowsi, K., James, M. B., Polikarpova, N., & Lerner, S. (2023). Live exploration of AI-generated programs. arXiv preprint arXiv:2306.09541.

Heyman, G., Huysegems, R., Justen, P., & Van Cutsem, T. (2021, October). Natural language-guided programming. In Proceedings of the 2021 ACM SIGPLAN International Symposium on New Ideas, New Paradigms, and Reflections on Pro*gramming and Software* (pp. 39-55).

Huang, Q., Zhu, J., Xing, Z., Jin, H., Wang, C., & Xu, X. (2023). A chain of ai-based solutions for resolving fqns and fixing syntax errors in partial code. arXiv preprint arXiv:2306.11981.

Jahan, S., Shah, M. B., & Rahman, M. M. (2024). Towards Understanding the Challenges of Bug Localization in Deep Learning Systems. arXiv preprint arXiv:2402.01021.

Job, M. A. (2021). Automating and optimizing software testing using artificial intelligence techniques. International Journal of Advanced Computer Science and Applications, 12(5).

Lai, T. D., Simmons, A., Barnett, S., Schneider, J. G., & Vasa, R. (2024). Comparative analysis of real issues in open-source machine learning projects. Empirical Software Engineering, 29(3), 60.

Liang, J. T., Yang, C., & Myers, B. A. (2024, February). A large-scale survey on the usability of ai programming assistants: Successes and challenges. In Proceedings of the 46th IEEE/ACM International Conference on Software Engineering (pp. 1-13).

Lima, R., da Cruz, A. M. R., & Ribeiro, J. (2020, June). Artificial intelligence applied to software testing: A literature review. In 2020 15th Iberian Conference on Information Systems and Technologies (CISTI) (pp. 1-6). IEEE.

Mozannar, H., Bansal, G., Fourney, A., & Horvitz, E. (2024, May). Reading between the lines: Modeling user behavior and costs in AI-assisted programming. In Proceedings of the CHI Conference on Human Factors in Computing Systems (pp. 1-16).

Nguyen-Duc, A., Cabrero-Daniel, B., Przybylek, A., Arora, C., Khanna, D., Herda, T., ... & Abrahamsson, P. (2023). Generative Artificial Intelligence for Software Engineering--A Research Agenda. arXiv preprint arXiv:2310.18648.

Pantiuchina, J., Lin, B., Zampetti, F., Di Penta, M., Lanza, M., & Bavota, G. (2021). Why Do Developers Reject Refactorings in Open-Source Projects?. ACM Transactions on Software Engineering and Methodology (TOSEM), 31(2), 1-23.

Raihan, N., Siddiq, M. L., Santos, J., & Zampieri, M. (2024). Large Language Models in Computer Science Education: A Systematic Literature Review. arXiv preprint arXiv:2410.16349.

Ross, S. I., Martinez, F., Houde, S., Muller, M., & Weisz, J. D. (2023, March). The programmer's assistant: Conversational interaction with a large language model for software development. In Proceedings of the 28th International Conference on Intelligent User Interfaces (pp. 491-514).

Zhu, Q., Luo, X., Liu, F., Gao, C., & Che, W. (2022). A Survey on Natural Language Processing for Programming. arXiv preprint arXiv:2212.05773.

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# ADVANCING AQUACULTURE AUTOMATION: THE ROLE OF AI AND IOT IN SUSTAINABLE SEAFOOD PRODUCTION AND ENVIRONMENT QUALITY

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**ABSTRACT**

*Aquaculture automation is one of the effective solutions to meet the growing global demand for seafood by improving efficiency and sustainability in the aquaculture industry. In this study, it can explore the abilities of advanced technologies such as robotics, artificial intelligence (AI) and the Internet of Things (IoT) to optimize operations in the field of aquaculture to be more advanced. Key innovations include robotic fish feeders, which can improve feeding accuracy based on fish behavior and environmental conditions, and automatic cleaning systems that maintain optimal water quality, reducing labor consumption and fish health will be more assured. These technologies collectively reduce operating costs, minimize indirect waste and can reduce environmental pollution. Despite challenges such as high start-up costs and technical complexity, aquaculture automation provides great opportunities in the production of a product. This research highlights how automation can revolutionize aquaculture practices, ensuring economic stability, increasing product quality and environmental balance that can guarantee global sustainability.*

***Keywords: Aquaculture Automation, Robotic Fish Feeders, Automated Cleaning Systems, Artificial Intelligence, Sustainable Aquaculture***

## Introduction of aquaculture automation

### *Overview of aquaculture automation*

Nowadays, the number of fish farmers is increasing day by day, whether for business or as a hobby. In 2019, Malaysia's fisheries industry accounted for 1.1 percent of the global total, with 0.4 percent coming from aquaculture. This increased the national agricultural Gross Domestic Product (GDP) by 8.9 percent and generated 1.75 million jobs for Malaysians, (Chong, 2023).

Aquaculture has become one of the sources of income for some people. Aquaculture is the breeding, rearing, and harvesting of fish, shellfish, algae, and other organisms in all types of water environments, (National Oceanic and Atmospheric Administration, 2019).

Aquaculture is now considered one of the largest sources of food today. The popularity of aquaculture is increasing, leading to a rise in demand for seafood. The rancher's economy becomes more stable with the advancement of technology. Assisting local residents in upgrading their lives by providing them with high-demand job opportunities is crucial. Furthermore, aquaculture can reduce operational costs, produce more product, and, most importantly, be environmentally sustainable.

***Importance of automation in aquaculture***

Automation is the use of machines or technology to perform tasks without much human intervention. The approach tries to streamline processes, enhance efficiency, and reduce human error. Learn more about automation from this article, (Kanade, 2024).

Due to rising demand for seafood, the aquaculture industry is increasingly turning to automation technologies to improve the efficiency of productivity. Therefore, opportunity to explore artificial intelligence in aquaculture. Artificial intelligence can be practiced in aquaculture. This is because using artificial intelligence can detect any changes in the disease suffered by the fish and can identify the disease suffered by the fish. This method can assist aquaculturists in identifying fish infections sooner, which can enhance treatment results and lessen the disease's ability to spread to other fish populations, (Rather et. al, 2024).

**Robotic fish feeders**

***Functionality and features***

A robotic fish feeder offers numerous benefits, making it a valuable tool for both casual fish owners and professional aquarists. One of its primary advantages is the ability to provide a consistent feeding schedule, which is essential for the health and well-being of fish. Regular feeding routines reduce stress and promote healthy growth, ensuring fish receive the nutrients they need. Additionally, robotic feeders prevent common issues like overfeeding or underfeeding by dispensing precise portions of food. Overfeeding can lead to poor water quality, obesity, and harmful ammonia spikes from uneaten food, while underfeeding weakens fish and makes them more susceptible to disease. By automating the feeding process, these devices maintain a balanced environment in the tank, reducing waste and preserving water quality.

For fish owners, robotic feeders offer unparalleled convenience, saving time and effort, especially for those with busy schedules or during vacations. They eliminate the need for manual feeding or reliance on pet sitters, ensuring fish are cared for even when the owner is away. Many models are versatile, capable of handling various food types such as flakes, pellets, and granules, making them suitable for a wide range of fish species. Advanced feeders also allow customizable feeding schedules and remote control via apps, providing flexibility and precision.

In addition to being user-friendly, robotic feeders contribute to the overall health of the aquarium ecosystem. They minimize the risk of water contamination caused by uneaten food and reduce the frequency of water changes, ultimately saving costs in the long run. For professional and commercial use, such as in aquaculture, these feeders automate large-scale feeding, ensuring uniform distribution and reducing labor costs. By integrating seamlessly with other automated systems, robotic fish feeders enhance the efficiency and sustainability of aquarium management, making them an indispensable tool for maintaining a thriving aquatic environment.

***Automate feeding schedules based on fish behaviour***

The automatic fish feeder technology was developed to improve fish feed selection so that the fish receive a higher food intake and increased growth compared to the manual fish feeder. Most automatic fish feeders had the problem of controlling the amount of fish feed released. The right portion of fish feed supposedly based on the total weight of fish. Fish feed given to fish that are not hungry will be wasted. By monitoring specific behaviors and environmental cues, these systems aim to enhance fish health, improve growth rates and reduce feed wasted (Fish Farm Feeder, 2022) .

First example, computer vision and machine learning that have a system equipped with cameras and deep learning algorithms analyse fish movements and behaviours to determine the optimal feeding time. Next, a sensor integration that detects the environmental changes such as the water ripples caused by fish activity to infer the hungry levels of fishes. A proposed method combines counting the nutrients and estimating ripples behaviour to control the feeding machines effectively.

***Environmental conditions***

The robotic fish feeder is an advanced solution that can automate the feeding process in aquariums by dynamically adjusting to the environmental conditions, optimizing feeding schedules and portions. These are sensor-enabled systems that monitor critical parameters such as a water temperature, pH and quality. On the change of these conditions, the operation of the feeder changes, which may delay or reduce the food dispensation to avoid stress on the fish and maintain a healthy aquatic environment.

In addition to environmental monitoring, robotic feeders monitor general activity of fish, change behavior or increased activity and regulate the quantity of food dispensed. The feeders are interfaced with automatic portion control thereby delivering food in very accurate amounts required by the species of fish maintained in the tank. Most of them interface with the natural light and day night cycles for feeding at times when fish naturally feed.

Advanced feeding robots can also be integrated with other aquarium automation, including filtration and lighting systems, for even further optimization of the overall health of the aquarium.

Besides that, adaptive algorithms enable the feeder to learn from the conditions in the tank over time, refining its operation for maximum efficiency. In summary, robotic fish feeders offer an efficient, adaptive solution that ensures proper nutrition for fish while maintaining a stable and healthy aquarium ecosystem.

***Types and advantages of robotic fish feeders***

Figure 1: Single fish feeders (Fish Farm Feeder, 2022)

There are six types of fish feeders. The first type of fish feeders as shown in figure 1 is the single fish feeder for aquaculture. Single fish feeders are individual feeders that are connected to a control panel. The advantage for single fish feeders is low-cost investment. They allow continuous dosing, (Fish Farm Feeder, 2022).

Figure 2: Moving feeders for fish farming (Fish Farm Feeder, 2022)

Figure 2 shows the second type of fish feeders named moving feeders for fish farming. Moving fish feeders is a moving truck with a complete feeding system. The advantage for moving feeders for fish farming is having the ideal feeding capacity for large areas with large tanks, (Fish Farm Feeder, 2022).

Figure 3: Rails feeders for aquaculture farms (Fish Farm Feeder, 2022)

Figure 3 is the rails feeders which are the third type of fish feeders for aquaculture farms. This type of feeders has silos and dispensers that circulate on a rail previously installed over the tanks at a fish farm. The advantage for these feeders is it contributes to labour savings. It has centralized software for feeder and feeding management, (Fish Farm Feeder, 2022).

Figure 4: Drag chain feeding system (Fish Farm Feeder, 2022)

Figure 4 shows the drag chain feeding system. These feeding systems work through pipes with a drag system. The advantage for this feeding system is it has a single feeding line for transporting feed, (Fish Farm Feeder, 2022).

Figure 5: Central feeders (Fish Farm Feeder, 2022)

Next, the figure 5 is the central feeders. These feeders are located in the centre of the farm, with pipes connected to each tank. The advantage for these feeders is it allows them to mix feeding pellets. It permits centralizing pellet storage as well as creating random feeding with multiple doses, (Fish Farm Feeder, 2022).

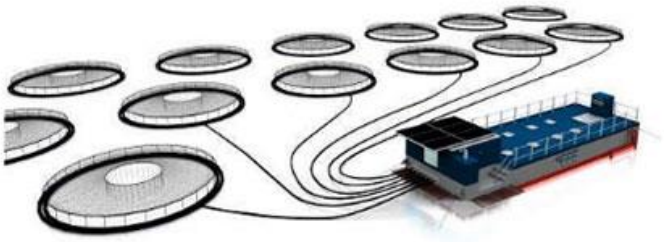

Figure 6: Barges for fish feeding in lakes and sea (Fish Farm Feeder, 2022)

The sixth type as shown in figure 6 is the barges for fish feeding in lakes and sea. In order to be able to feed fish in large areas located far from land, centralized feeders are integrated into a barge. They are usually used for feeding cages in sea or lakes, (Fish Farm Feeder, 2022). The advantage of these feeders is that they can be used for large quantities of cage and in a larger area.

***Benefits of robotic fish feeders***

There are a lot of robotic fish feeders benefits. First of all, it can optimize the food usage and reduce food waste. This is because robotic fish feeders can feed farmed fish at the right time that has been set in the system on the control panel. In fact, this can ease the use of excessive human labor to feed fish if the large livestock area will again make it difficult to feed at the same time. Furthermore, with the use of robotic fish feeders, the food given to farmed fish is in the same quantity. This will cause no excessive feeding in the fish cage as well as prevent the waste of fish food (Ratiwy & Haetami, 2023).

Second, robotic fish feeders can further improve the efficiency of fish growth and health. This is because with robotic fish feeders, the amount of fish food distributed is exactly according to the needs of each fish cage. The nutrients distributed will also be given according to the needs of farmed fish. This allows each farmed fish to get the proper nutrition as well as increase the growth of farmed fish. Indirectly, the health of farmed fish is also guaranteed because they get adequate nutrition and reduce stress in farmed fish, reducing the risk of getting diseases that will lead to the continued stability of farmed fish health.

Other than that, maintain water quality and be environmentally friendly. An excess of food that is not consumed by fish will be decomposed underwater, thus leading to water pollution. This can be

proven because robotic fish feeders will only distribute food supplies to fish according to the prescribed needs.

**Automated cleaning systems**

A robot cleaning fish tank and net is an intelligent cleaning device used for cleaning fish tanks and maintaining devices such as fish net's tools. Primarily, robotic cleaners for fish tanks remove algae, wash glasses, vacuum, and purify the water. Devices such as magnetic algae scrubbers or automatic gravel cleaners assist in cleaning by relieving manpower and sharing the workload. For home aquariums, and even commercial aquaculture, systems to automatically clean fish nets have become common. These systems improve water flow and help prevent diseases by cleaning the nets of algae, debris, and biofouling. By automating such tasks, robot cleaners save a considerable amount of time while reducing stress on the fish, hence enhancing the aquatic environment

***Functionality and features***

RoboSnail is an intelligent robotic cleaning solution designed to make aquarium glass maintenance quick and easy, for the best clarity and a much healthier aquatic environment. Engineered for autonomous operation, it comes pre-programmed to perform daily cleaning cycles, with the added effect of preventing algae build up while keeping the glass surfaces pristine. Utilizing strong magnetic adhesion, the RoboSnail is securely attached to the glass of the aquarium and glides around with ease due to its sleek and low-profile design (Fpsbackuptest, 2012).

Equipped with a programmable timer, this novelty gadget will enable users to plan cleaning according to their schedule. Made from durable, nontoxic materials, the RoboSnail is energy-efficient and safe for the aquatic ecosystem. Quiet operation minimizes disturbance to aquarium inhabitants, while advanced safety mechanisms include edge detection and obstacle avoidance sensors that allow precise navigation around decorations and uneven surfaces.

The RoboSnail can be used with different thicknesses of glass and different tank sizes, hence being versatile on various aquariums. Once it finishes its cycle of cleaning, the device automatically returns to its resting position for ease of access. The RoboSnail reduces manual cleaning drastically, improves water quality, and is a professional solution in maintaining an aquarium.

**Robots clean fish tanks and nets**


Figure 7: RoboSnail an aquarium Roombas is a small robot that functions as a vacuum (Fpsbackuptest, 2012) .

The fish tank and net cleaning robot refers to an innovative solution that automates aquarium maintenance and the cleaning of important tools such as fishing nets. In the case of fish tanks, robotic devices are designed to perform tasks such as removing algae, cleaning glass or acrylic surfaces, vacuuming debris from substrates, and even monitoring and maintaining water quality. These robots, which can include magnetic algae scrubbers, automatic gravel vacuums, or more advanced underwater cleaning robots, significantly reduce the time and effort required for manual cleaning. They ensure a consistent level of cleanliness, which is important for the health of the aquatic environment and the well-being of the fish and plants in the tank (Fpsbackuptest, 2012).

When it comes to cleaning fish nets, robotic or automated systems are often used in both home aquariums and large-scale aquaculture setups. The system is designed to remove algae, biofouling and other debris that can accumulate on fishing nets over time. In home aquariums, smaller automated devices can clean and sanitize hand nets, ensuring they remain free of contaminants that may harm fish. In commercial fish farming, robotic net cleaners are used to clean large nets that enclose fish in open. water environments, maintaining proper water flow and preventing the accumulation of harmful substances that can lead to disease outbreaks

The use of robotic cleaners for fish tanks and nets offers many benefits, including saving time, reducing manual work and minimizing the risk of spreading contaminants. This device also helps maintain a healthier and more stable aquatic environment by ensuring that cleaning tasks are done regularly and thoroughly. Whether for hobbyists maintaining small home aquariums or professionals managing large-scale aquaculture operations, robotic cleaning technology represents a valuable tool to facilitate maintenance and improve the overall health of aquatic ecosystems.

***Enhanced water quality and fish health***

The Robotic Aquarium and Net Cleaning System will remain the transformative tools needed in solving the best water quality to maintain aquatic life. Advanced technologies now perform key maintenance of consistent care of the aquarium environment. Such systems contribute to a generally healthier ecosystem by preventing some of the most prevalent problems with freshwater aquariums, such as algae growth and accumulation of organic wastes due to poor circulation of water (Fpsbackuptest, 2012).

One of the most valued advantages of robotic cleaners is preventing algae formation on the glass of an aquarium. If allowed to grow, algae will block the penetration of light, which is necessary for the photosynthesis of water plants and disruption of the balance in the tank. Continuous removal of algae provides for good visibility and maintains the natural processes of keeping the water clean. Organic debris, such as food that is not consumed and waste from fish, along with decaying plant material, is effectively removed by robotic net cleaners. These substances, if left to accumulate, would degrade into harmful compounds such as ammonia, nitrites, and nitrates, which deteriorate water quality and may lead to stress, disease, or even mortality in fish.

Robotic systems provide the perfect precision and continuity with no chances of overcleaning, thus reducing the risks of perturbing beneficial bacterial colonies that attach themselves to gravel surfaces and other filter media. This bacterium is an important aspect in the process of biological filtration by degrading substances into much less harmful components to preserve the water's chemical balance. Moreover, these robots act in such a quiet manner that they do not disturb the fish at all, which is one of the most critical factors for their immune system and good health in general.

By automating routine maintenance tasks, robotic cleaning systems save time for the aquarium owner and create favourable, stable conditions for the aquatic life. These systems are especially helpful for larger or more complicated aquariums, where manual cleaning is time-consuming and less efficient. Conclusion Robotic aquarium and net cleaning systems enhance the quality and health of the water for the fish by sustaining regular maintenance, preventing waste build up that could be harmful, and preserving the ecological balance within the tank. This leads to an aesthetically pleasing, biologically stable, safe environment for aquatic life.

**Benefits of automated cleaning system**

An automated tank and net cleaning system present a large degree of advantage to aquarium owners by enhancing operational efficiency and, in turn, the health aspect of the aquatic environment (Fpsbackuptest, 2012). This system reduces time and effort by making regular maintenance easy without involving much in keeping the tank at its best. Automated cleaning prevents algae, debris, and waste from building up, allowing superior water quality and a healthier ecosystem for fish and other aquatic organisms. These systems can be programmed to operate at specific intervals, providing

consistent and comprehensive cleaning without the risk of missing spots or over-scrubbing areas. This will result in clearer water, more stable conditions in the tank, and an aesthetically pleasing environment. The automated systems are very discreet and efficient in operation, minimizing agitation among the creatures of the tank, which is usually present during manual cleaning. By preventing the build-up of these pernicious compounds, they promote long-term health for both life and plants that live in the water. Over time, automated cleaning systems bring economies through minimizing the need for cleaning supplies and reducing the risk of damage to tank surfaces. In conclusion, automated cleaning solutions provide a more efficient, effective, and sustainable way of maintaining aquariums, ensuring the aesthetic and ecological well-being of the tank.

**Conclusion**

In conclusion, aquaculture automation represents a transformative approach to addressing the challenges faced by the aquaculture industry. By integrating advanced technologies such as IoT, AI, robotics and machine learning, automation has the potential to enhance productivity, optimize resource utilization and ensure sustainability. These technologies allowed for efficient feeding systems, precise monitoring of water quality and real time health assessment of aquatic species, thereby reducing the waste and improving overall yield.

Moreover, this shift toward automation not only addresses the growing global demand for seafood but also ensures that aquaculture practices align with sustainable development goals. However, the adoption of these technologies also presents challenges, including high initial costs, technical complexity and the need for skilled labour.

As we move forward, aquaculture automation has the potential to set a new standard for the efficient and sustainable food production. By embracing innovation, aquaculture can become a cornerstone in ensuring global food security while preserving marine ecosystems for the future generations.

**References:**

Chong, A. (2023, May 5). Malaysia's Aquaculture Industry 5 Challenges. Maritime Fairtrade. https://maritimefairtrade.org/aquaculture-industry-malaysia-5-challenges-issues/

Fpsbackuptest. (2012, June 25). The RoboSnail: An Aquatic Roomba for Your Aquarium! Fpsbutest. https://fpsbutest.wordpress.com/2012/06/25/the-robosnail-an-aquatic-roomba-for-your-aquarium/

Kanade, V. (2024, February 26). What Is Automation? Definition, Types, Benefits, and Importance | Spiceworks. Spiceworks. https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-automation/

Rather, M.A., Ahmad, I., Shah, A., Hajam, Y.A., Amin, A., Khursheed S., Ahmad, I., & Rasool, S. (2024). Exploring opportunities of Artificial Intelligence in aquaculture to meet increasing food demand. Food Chemistry. X, 22, 101309–101309. https://doi.org/10.1016/j.fochx.2024.101309

National Oceanic and Atmospheric Administration. (2019). What is aquaculture? Noaa.gov. https://oceanservice.noaa.gov/facts/aquaculture.html

Pratiwy, F. M., & Haetami, K. (2023). Towards feed independence: Types of auto-feeder technologies for efficient fish farming. International Journal of Fisheries and Aquatic Studies, 11(4), 16–18. https://doi.org/10.22271/fish.2023.v11.i4a.2819

Fish Farm Feeder. (2022, April 5). Types of Automated Feeders Used in Aquaculture. https://www.fishfarmfeeder.com/en/types-automated-feeders-aquaculture/

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac- 2025*

# ASSESSING STUDENT PERCEPTIONS OF ACADEMIC ASSIGNMENTS

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**ABSTRACT**

*Academic assignments are critical in shaping student learning experiences, providing opportunities to apply theoretical concepts to practical scenarios. This study examines student perceptions of assignments, focusing on their clarity, relevance, and applicability to real-world contexts. A structured Likert-scale survey was employed to assess key factors, including the alignment of assignments with course objectives and their effectiveness in fostering critical thinking and problem-solving skills. The findings reveal the significance of clear instructions and well-defined objectives in enhancing student engagement and learning outcomes. This article offers actionable recommendations for educators to design assignments that bridge the gap between academic learning and practical applications, ensuring students are equipped with the skills needed for future success.*

***Keywords: student perceptions, academic assignments, learning experiences, critical thinking, problem-solving skills.***

## Introduction

Academic assignments are a vital component of education, helping students bridge theoretical knowledge with practical skills. Beyond assessing understanding, well-crafted assignments develop critical thinking, problem-solving, and industry-relevant competencies. As industries evolve, there is growing concern about whether assignments adequately prepare students for real-world challenges. This study examines student perceptions of assignments, focusing on their clarity, relevance, and alignment with industry needs. By analyzing feedback, it highlights how assignments can be enhanced to better equip students for professional success while fostering academic growth.

## Literature Review

Academic assignments play a crucial role in student learning and assessment, offering significant potential to enhance the overall learning experience. Typically, students are graded based on their progress of the assignments. Numerous studies on students' perspectives regarding assignments provide a range of insights. Students tend to have a positive perception of assignments when it includes hands-on activities, problem-solving tasks, and real-world applications (Samuel et al., 2024). Findings from Samuel et al. (2024) revealed that the complexity of the task, the level of instructor support, and previous

group work experience are other elements that affect how students perceive their experiences with group assignments. Well-organised group projects with precise instructions and equitable evaluation standards have been shown to increase student involvement and satisfaction (Chapman & Van Auken, 2001). Additionally, group projects help students develop essential skills such as communication, leadership, and conflict resolution (Oakley et al., 2004). Group work is a powerful tool for promoting the growth of a broader range of knowledge through debate, concept clarification, and evaluation of others' proposals (Hassanien, 2006)

However, Mir & Roy (2024) reported that students encounter psychological obstacles such as procrastination, task management, and pressure when dealing with assignments and deadlines. Factors influencing students' attitudes towards assignments include teaching styles, assignment length, time allocation, and course difficulty. Moreover, students listed some drawbacks of working in groups, including relying on others, lacking time management, and having poor commitment and attitude (Bentley & Warwick , 2013). Interestingly, students' perceptions of group work are primarily shaped by their past experiences rather than personality traits (ElMassah et al., 2020). According to Hassanien (2006), the biggest obstacles people have when working in a group are inadequate communication and low participation at meetings.

**Methodology**

This study utilized a quantitative approach to evaluate students' perceptions of academic assignments and their effectiveness in preparing students for practical, real-world applications. The participants consisted of 28 students enrolled in semesters 6 to 9 of the Civil Engineering program at UiTM Cawangan Pulau Pinang. All participants were taking the subject Further Differential Equations (MAT480) during the October 2024–February 2025 semester.

Data collection was conducted through a structured questionnaire distributed via Google Forms. The questionnaire included Likert-scale items designed to assess key aspects of the assignments, such as clarity of instructions, alignment with learning objectives, relevance to real-world applications, difficulty level, and assessment criteria. The questions were aimed at gathering insights into how well the assignments bridged theoretical knowledge with industry-relevant skills.

The responses were analyzed to identify patterns in student perceptions, focusing on how the assignments contributed to their learning experience and professional readiness. The study ensured anonymity and voluntary participation, complying with ethical guidelines for educational research.

**Result and Discussion**

The study included 28 students from semesters 6 to 9 of the Civil Engineering program at UiTM Cawangan Pulau Pinang. These participants were enrolled in the Further Differential Equations (MAT480) course, ensuring a focused perspective on the subject's assignments.

A majority of respondents (80%) agreed or strongly agreed that the instructions for the assignments were clear and easy to follow, while only a small fraction expressed uncertainty or disagreement. This highlights the effectiveness of the provided guidelines in facilitating task comprehension. Clear instructions play a crucial role in ensuring that students can focus on applying their knowledge rather than struggling with ambiguity.

Most students (75%) reported that the assignments aligned well with the course objectives, particularly in understanding differential equations and Fourier series. However, a small percentage suggested that certain tasks could better emphasize key objectives, indicating that slight modifications in assignment design.

Approximately 70% of respondents agreed that the assignments had a strong connection to real-world applications. Students highlighted the relevance of solving differential equations and analysing Fourier series to practical engineering scenarios, though some suggested incorporating more direct examples from industry practices. This feedback highlights an opportunity for educators to integrate real-world case studies, guest lectures from industry experts, or project-based assignments that simulate engineering scenarios.

The difficulty level of the assignments was rated as appropriate by 85% of students. Respondents appreciated the balance between challenge and accessibility, though a few noted that some questions were overly complex for their current skill level. However, a few respondents felt that certain questions were overly complex, suggesting that some assignments might require better scaffolding, such as guided problem-solving steps or additional practice exercises to support students struggling with advanced concepts.

A majority of students (78%) agreed that the marking scheme and assessment criteria were transparent and well-communicated, enabling them to understand performance expectations. Clearly defined rubrics and detailed feedback from instructors can further enhance student confidence and motivation.

Students indicated that the assignments enhanced their analytical and problem-solving skills, with 72% agreeing that the tasks contributed to their professional readiness. Some participants recommended integrating more collaborative or project-based tasks to further simulate real-world challenges. These suggestions align with modern educational approaches that emphasize experiential learning and real-world application of theoretical knowledge.

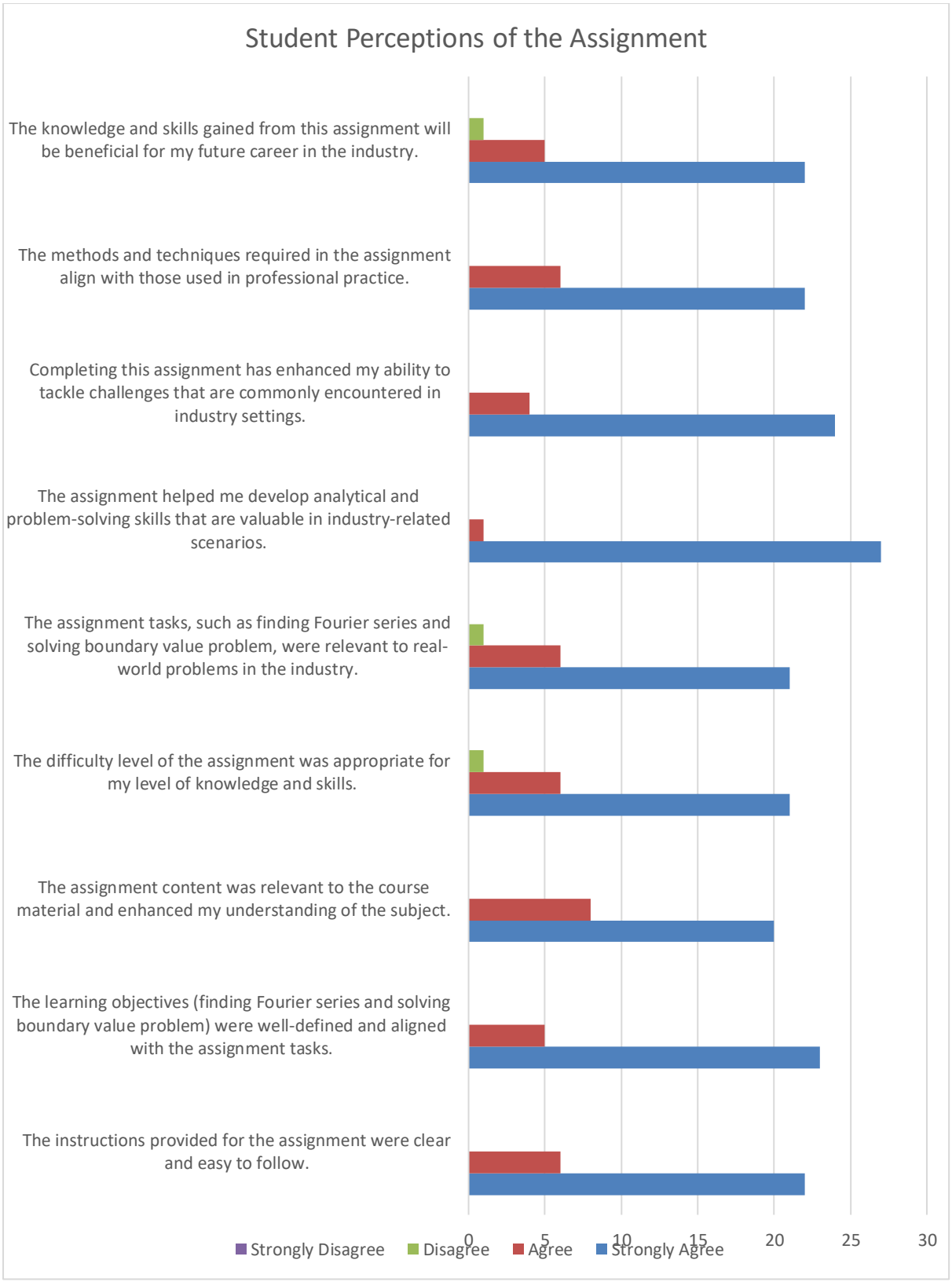


Figure 1: Student Perceptions of the Assignment

**Conclusion**

As a conclusion the assignments were generally effective in meeting educational objectives and preparing students for practical challenges. However, while a majority of students recognized the relevance of the assignments to real-world applications, some suggested that integrating more industry-based examples and collaborative elements could further enhance their practical value. This highlights an opportunity for educators to refine assignment design by incorporating case studies, project-based learning, and industry collaboration to bridge the gap between academic learning and professional demands. Overall, the study underscores the importance of continuously evaluating and improving academic assignments to ensure they remain effective in preparing students for real-world challenges. By aligning coursework with industry expectations and fostering essential skills, institutions can better equip graduates to transition seamlessly into the workforce. Future research could expand on this study by involving industry professionals in assignment development and assessing long-term impacts on student career readiness.

**References:**

Bentley, Yongmei & Shamim Warwick. (2013). An Investigation into Students' Perceptions of Group Assignments. *Journal of Pedagogic Development*, 3 (3),11-19.

Chapman, K. J., & Van Auken, S. (2001). Creating positive group project experiences: An examination of the role of the instructor on students' perceptions of group projects. *Journal of Marketing Education*, 23(2), 117-127.

ElMassah, S.S., Mostafa Bacheer, S., & James, R. (2020). What shapes students' perceptions of group work: personality or past experience? *International Journal of Educational Management*, 34, 1457-1473.

Hassanien, A. (2006). Student Experience of Group Work and Group Assessment in Higher Education. *Journal of Teaching in Travel & Tourism*, *6*(1), 17–39. https://doi.org/10.1300/J172v06n01_0

Mir, S., & Roy, S. (2024). Assignment Again! Investigating the Psychological Perspectives of Assignment and Assignment Deadlines among Tertiary Level Students. *English Language Teaching Perspectives*, 9(1-2), 117-130.

Oakley, B., Felder, R. M., Brent, R., & Elhajj, I. (2004). Turning student groups into effective teams. *Journal of Student-Centered Learning*, 2(1), 9-34.

Samuel, C., Dobler, E., Maru, B., & Tovar, M. (2024). How students' perceptions of assignments that help them learn can inform course design decisions. *The Canadian Journal for the Scholarship of Teaching and Learning, 15*(1).

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# COMPARATIVE STUDY FOR NOVICE ENGINEERING PROGRAMMER: C++ VS VBA PROGRAMMING LANGUAGES

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**ABSTRACT**

*The programming language significantly enhances students' problem-solving abilities; nonetheless, constructing a program is a complex endeavour due to insufficient metacognitive methods and the challenge of rectifying syntax errors. VBA dan C++ are both programming languages that covers all the fundamental features for novice programmers such as concept of declaration, input and output process and basic structure of programming such as sequence, selection and repetition. Descriptive survey has been done to 29 students in Degree of Civil Engineering to investigate the usability and compared the functionality of both languages in the learning process which consist of background, learning difficulties, practical applications, user experience and final thoughts. The outcome reveals that students have been more convenient with VBA for practical, beginner experience, ease of use and understand the concept to real-world problem solving. This result could serve as benchmarking on how to teach programming in a way novice can comprehend, thinking and learning in their perspective of studies.*

***Keywords: novice programmer, VBA, C++, programming language, comparative***

## Introduction

The role of programming languages in enhancing problem-solving skills among engineering students is unequivocally recognised. Learning to develop a functional program depends on comprehending the syntax and semantics of the specific language, which has proven to be the most formidable obstacles for students to overcome and excel.

In recent years, C++ has continued to advance, preserving its role as a robust and adaptable programming language. The C++20 standard introduced substantial improvements, such as ideas, coroutines, and modules, fundamentally transforming how developers compose and manage code (Crudu, 2024). These attributes have rendered C++ more efficient, comprehensible, and sustainable, addressing the requirements of contemporary software development. Moreover, the emphasis on performance enhancement via methodologies such as smart pointers and parallel programming has reinforced C++'s position in high-performance computing (adm-canpension, 2023a).

Conversely, VBA (Visual Basic for applications) is an essential instrument for automating processes within Microsoft Office programs. Notwithstanding speculation over its redundancy, VBA is extensively utilised owing to its profound connection with Excel, Word, and Access (*The Future of*

*VBA: Debunking the "VBA Is Dead" Myth – Triple Your Pay with Excel*, 2025). The capacity to automate monotonous tasks and provide customised capabilities has maintained VBA's relevance, particularly in sectors that depend significantly on Microsoft Office for their daily activities. The straightforwardness and availability of VBA makes it an appealing choice for non-programmers seeking to improve their productivity (Belfry, 2023).

The future of C++ appears auspicious, with continuous advancements focused on enhancing developer efficiency and code clarity. The next C++23 standard is anticipated to provide additional capabilities that will enhance the development process. Advancements in memory management and cross-platform development tools are enhancing C++'s versatility across diverse fields, ranging from embedded devices to huge business programs (adm-canpension, 2023a). The language is still a top option for developers looking for performance and versatility even as it develops (adm-canpension, 2023b).

Simultaneously, VBA's significance is enhanced by its extensive utilisation and user familiarity. The reliance of organisations on Microsoft Office sustains a robust need for VBA proficiency. The language's capacity to automate intricate operations and connect effortlessly with other Office products guarantees its ongoing significance (*The Future of VBA: Debunking the "VBA Is Dead" Myth – Triple Your Pay with Excel*, 2025; Belfry, 2023). Although contemporary technologies such as Python and JavaScript present alternatives, VBA's user-friendliness and direct relevance within Office applications render it a significant asset for numerous professionals (View, 2024). The significant of the comparison among both applications was presented in Table 1.

Table 1: Suggestion Table

| Feature/Aspect | C++ programming | VBA programming |
|---|---|---|
| Complexity | High complexity, steep learning curve | Lower complexity, easier to learn |
| Performance | High performance, suitable for intensive tasks | Moderate performance, suitable for automation within Office apps |
| Use Cases | System software, game development, real-time simulations, high-performance | Automating tasks in Microsoft Office, creating macros, simple applications |
| Syntax | Complex syntax with extensive features | Simple and straightforward syntax |
| Memory Management | Manual memory management (pointers) | Automatic memory management |
| Object-Oriented | Fully supports object-oriented programming | Limited support for object-oriented programming |
| Integration | Can be integrated with various systems and platforms | Deep integration with Microsoft Office applications |
| Career Opportunities | High demand in various industries like finance, game | Limited to roles involving Microsoft Office automation |

| | | |
|---|---|---|
| | development, and embedded systems | |
| Community and Resources | Large and active community with extensive resources | Smaller community, but plenty of resources for Office automation |
| Learning Curve | Steeper learning curve, but provides a strong foundation for other languages | Gentler learning curve, suitable for beginners and non-programmers |

**Methodology**

This study was conducted by collecting primary data directly from 29 number of the degree students of Civil Engineering in Universiti Teknologi MARA Cawangan Pulau Pinang. Online survey was delegated for them to answer some questions regarding to respondent background in terms of programming level, learning difficulties, practical applications, user experiences and final thoughts. The questions were carefully designed to fulfil the following objectives by considering the elements of easy learning of computer programming language for novice:

I. How effectives the learning software both for C++ and VBA in engaging students throughout teaching and learning session?
II. What is students' attitude towards the use of both programming language for practical application?
III. Which programming language is more versatile to be learned for novice programmer?

The questionnaire responses by the respondents were calculated using descriptive analysis of which frequencies and percentages were tabulated in order to better comprehend the result.

**Result and discussion**

Primarily as a background study, all 29 respondents have considered themselves as novice programmers with basis understanding and able to write a simple programming codes independently. All of them were experience in writing C++ programs and recently accomplished VBA programming language for another course. Figure 1 illustrates the level of difficulties between C++ and VBA in four levels which are easy, moderate, difficult and very difficult. According to the result 93 percent of students vote that easy and moderate for VBA, meanwhile 52 percent vote for difficult and very difficult for C++. This result clearly indicate students were find VBA easier to understand and learn.

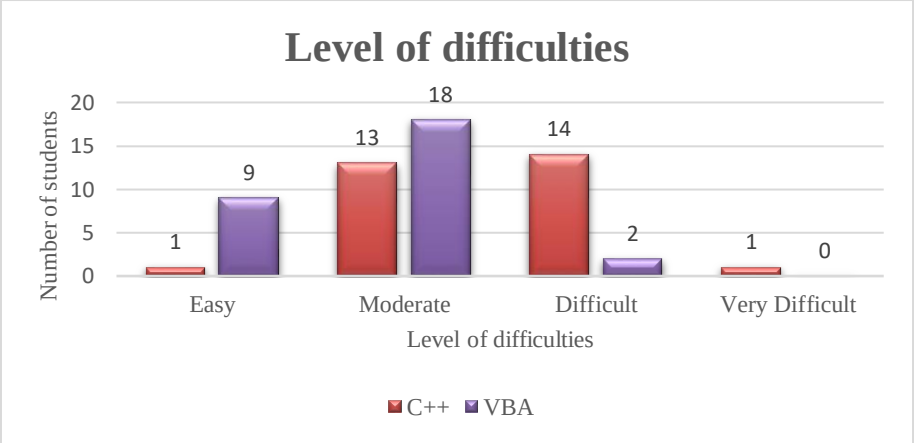


Figure 1: Comparison level of difficulties in learning

Learning time indicates appropriate time for students to catch up with each learning session after class. Figure 2 represents a week of learning progress taken by students and was split into four intervals of less than a day, 1 to 3 days, 4 to 7 days and more than 7 days of learning. The result shows that 70 percents of the students able to understand VBA within 3 days, meanwhile C++ taken longer time where 66 percent require more than 4 days and up to a week to comprehend with the C++ lesson.

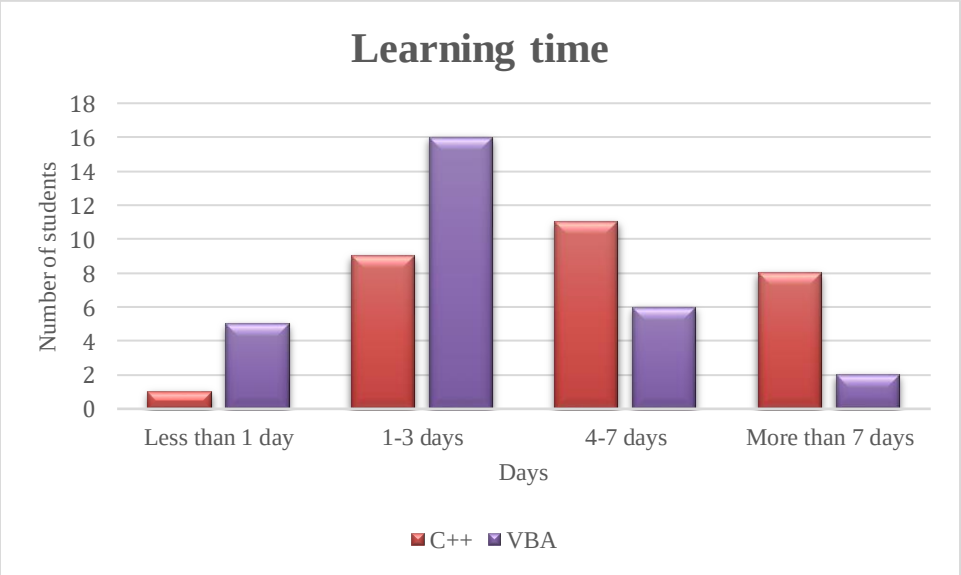


Figure 2: Comparison level of learning time for revision at each lesson learning in class

Regarding learning tools that facilitate better comprehension and further exploration of knowledge, it is noteworthy that over fifty percent agrees that classroom courses are the most beneficial learning resources, encompassing both instructional and practical learning processes for both languages.

Meanwhile, online tutorials, books, and trial-and-error options garnered less than 2 percent of their votes. Figure 3 illustrates the learning resources voted by the students.

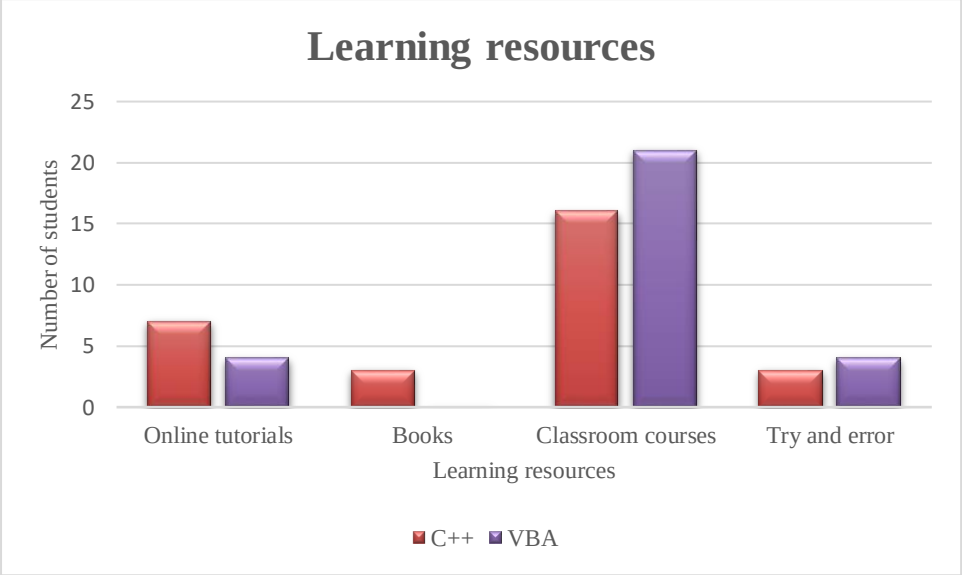


Figure 3: Comparison level of learning time for revision at each lesson learning in class

The next illustration in Figure 4 demonstrates how students perceive the constructed programming code as beneficial in addressing and resolving real-world problems. Both languages demonstrated their significance to the students, as over half of them deemed them useful or very useful. VBA received the highest score with 24 votes, while C++ garnered 21 votes. While C++ significantly contributes to careers in real-world applications, VBA demonstrates more utility for end users in daily tasks, showcasing its widespread applicability across various purposes.

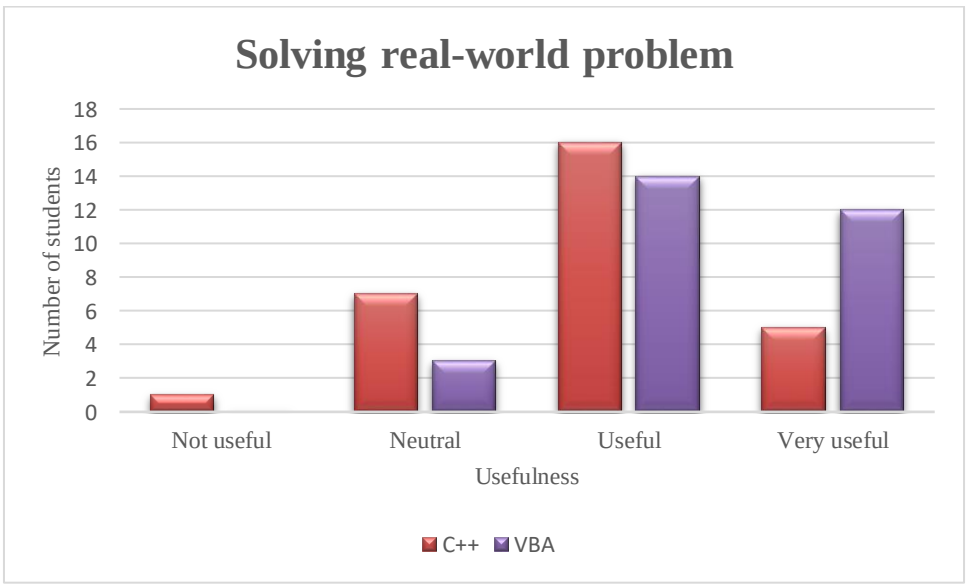


Figure 4: Comparison level of contribution to serve real-world problems

The prior vote is likely substantiated by the subsequent comparison about the diversity of functional tasks. Figure 5 illustrates the versatility of tasks pertaining to both general and automated tasks as evaluated by the students. The VBA achieves scores of 86 percent and 93 percent, respectively, for general and automated tasks in comparison to C++. This occurred because the implementation of VBA encompasses both coding and the end-user interface, allowing students to comprehend the process and application comprehensively from source code to completion. Regardless of both languages, students have acquired all the fundamental concepts of coding, beginning with variable declaration and the use of sequential, selection, and repetition programming structures.

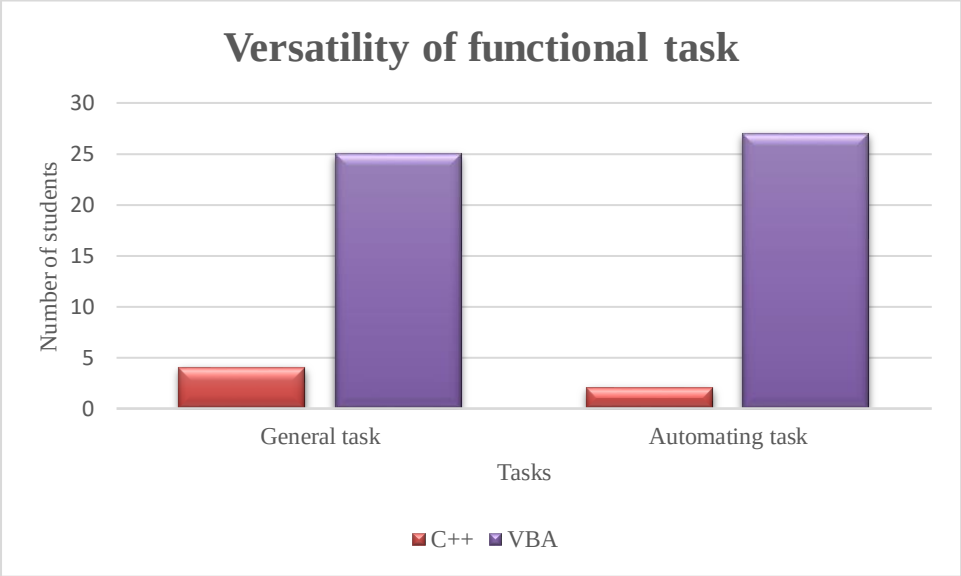


Figure 5: Comparison level of versatility of the languages for novice programmer learning process

The debugging process pertains to how students rectify their code syntax upon the detection of an error. Figure 6 delineates debugging levels categorised into four tiers: easy, moderate, difficult, and very difficult. Overall, VBA received the highest votes for moderate difficulty, with none classified as very tough, but C++ was predominantly chosen as difficult, with 2 percent rated as very difficult.

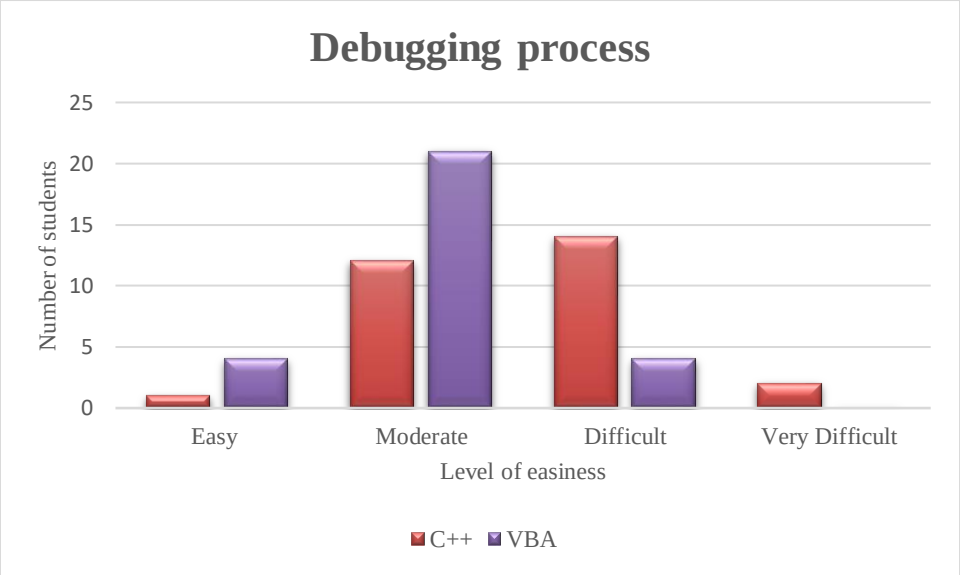


Figure 6: Comparison level of debugging experiences

The development of the environment is based upon the application utilised for writing, compiling, and executing the output. Figure 7 illustrates that VBA scores for neutral, intuitive, and very intuitive categories average approximately 10 votes, whereas C++ received 66 percent for neutral and 34 percent for intuitive. The implementation of DEV C++ emphasises students' understanding of syntax and semantics, facilitating basic output without GUI interaction. In contrast, VBA is centred on interface design and is completely connected with MS Office products, which are prevalent among users in Malaysia, both personally and in enterprises.

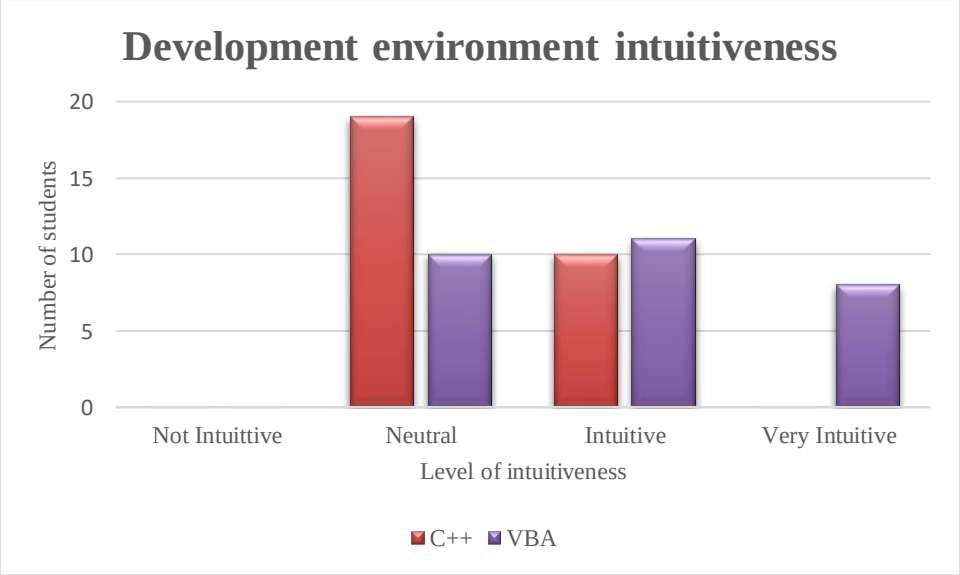


Figure 7: Comparison level of development environment

The satisfaction derived from learning is manifested in students' enjoyment of the educational experience. Figure 8 illustrates the votes for four levels of satisfaction, ranging from the least enjoyable to the most enjoyable: not enjoyable, neutral, enjoyable, and very enjoyable. Approximately 90 percent of students rated VBA as either enjoyable or very enjoyable, whereas 61 percent of students rated C++ as neither enjoyable or neutral. This sentiment arises mostly from the user-friendly nature of VBA program outputs, which seamlessly merge with the working interface, providing it more suitable and valuable for novices, particularly when students comprehend their expectations from real-world problems.

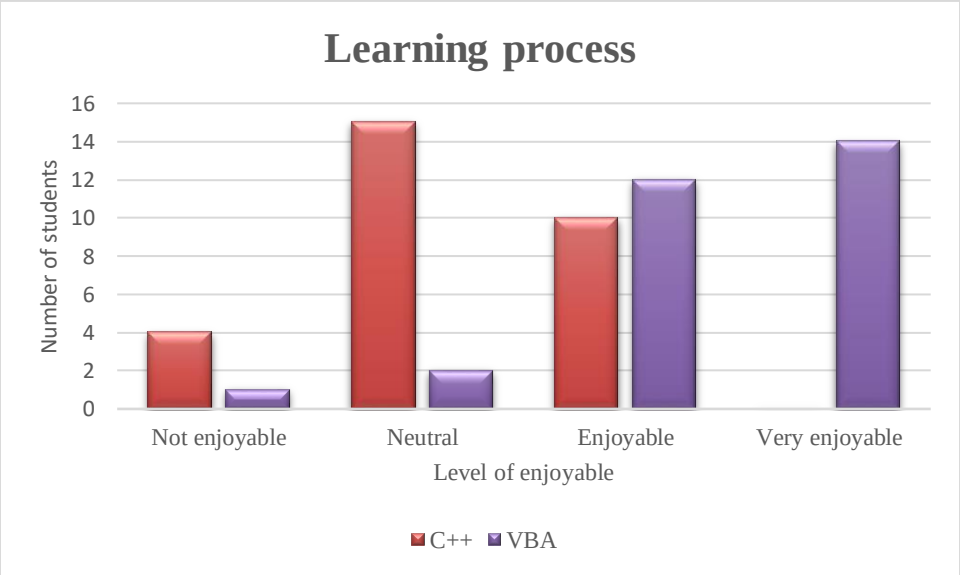


Figure 8: Comparison levels of enjoyment of the learning process

**Conclusion**

This study has fulfilled the objectives outlined in the methodology. C++ and VBA significantly influence the programming learning process for new programmers, particularly those with a background in engineering. They comprehended both approaches for writing source code and developed a foundational programming skill using them. Their attitudes towards learning aligned with expectations, since VBA promotes beneficial outcomes such as reduced stress and enjoyment, along with being straightforward and comprehensible for both general and automated tasks, intuitive, and easily applicable in real-world scenarios. Despite C++ offering numerous advantages for various facets of a software development career, students like VBA as an introductory learning tool since it allows them to comprehend its application to real-world problems around them.

**References:**

adm-canpension. (2023a, December 6). *Canada Pension Plan*. Canada Pension Plan. https://canpension.ca/articles/the-future-of-c-what-to-expect-in-2026

adm-canpension. (2023b, December 6). *Canada Pension Plan*. Canada Pension Plan. https://canpension.ca/articles/cpp-in-2024-the-future-of-c-programming-language

Belfry, M. (2023, August 7). *Is Excel VBA Still Worth Learning in 2024? - Onsite Training*. Onsite Training. https://www.onsite-training.com/is-excel-vba-still-worth-learning/

Crudu, A. (2024, October 29). *Keeping Up with the Latest Trends What Every C++ Developer Needs to Know*. Moldstud.com. https://moldstud.com/articles/p-keeping-up-with-the-latest-trends-what-every-c-developer-needs-to-know

OttoBotCode. (2022, February 9). *C++ GUI Programming For Beginners | Episode 0 - Introduction*. YouTube. https://www.youtube.com/watch?v=BjQhp0eHmJw

*The Future of VBA: Debunking the "VBA is Dead" Myth – Triple Your Pay With Excel*. (2025). Tripleyourpaywithexcel.com. https://www.tripleyourpaywithexcel.com/2024/10/15/the-future-of-vba-debunking-the-vba-is-dead-myth

View. (2024, October 27). *VBA Will Not Be Obsolete in the Next few Years*. Chanmingman's Blog. https://chanmingman.wordpress.com/2024/10/27/vba-will-not-be-obsolete-in-the-next-few-years/

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# KEKURANGAN MINAT DALAM MENGAMBIL NOTA DALAM MATEMATIK DAN KESANNYA

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**ABSTRAK**

*Amalan mengambil nota merupakan satu strategi pembelajaran yang berkesan untuk memahami dan mengingati konsep-konsep yang diajar, khususnya dalam subjek yang mencabar seperti matematik. Kekurangan minat untuk mencatat nota semasa kelas matematik menjadi kebimbangan yang semakin meningkat dalam bidang pendidikan. Pengambilan nota ialah strategi pembelajaran penting yang dapat meningkatkan pemahaman dan ingatan terhadap konsep matematik yang kompleks. Walau bagaimanapun, ramai pelajar mempamerkan ketidakaktifan terhadap amalan ini. Kajian ini mengenal pasti beberapa faktor yang menyumbang kepada penurunan minat ini, termasuk kekurangan motivasi, tahap penglibatan yang rendah dan gangguan digital. Untuk menangani isu ini, strategi yang berkesan dicadangkan, seperti kaedah pengajaran interaktif, latihan mengambil nota, penggunaan teknologi dengan berhati-hati, dan memperkasakan pelajar dalam proses pembelajaran mereka. Ia meneliti potensi alasan di sebalik kurangnya penglibatan ini, seperti anggapan tidak relevan, kaedah pengajaran yang tidak berkesan, atau kurangnya pemahaman mengenai manfaat pengambilan nota. Artikel ini juga menyiasat impak ketidaksukaan ini terhadap hasil pembelajaran pelajar dan prestasi akademik keseluruhan dalam matematik.*

***Katakunci: kurang minat, strategi pembelajaran, faktor penyumbang,kemerosotan, prestasi akademik***

## Pengenalan

Mengambil nota yang baik adalah salah satu strategi pembelajaran yang paling berkesan, terutamanya dalam subjek yang mencabar seperti matematik. Mengambil nota adalah kemahiran penting yang bukan sahaja diperlukan dalam dunia akademik, tetapi juga dalam kehidupan profesional dan peribadi. Bagi pelajar, kemahiran mengambil nota yang baik adalah kunci kepada kejayaan akademik, membangunkan pemikiran kritis dan bersedia untuk kerjaya masa depan. Ianya juga boleh membantu pelajar untuk mengingati dan memahami konsep yang kompleks. Namun begitu, terdapat penurunan yang ketara dalam amalan mengambil nota di kalangan pelajar.

Hasil kajian yang dilakukan oleh Swenson (2018) menunjukkan strategi dalam mencatat nota ini telah meningkatkan prestasi pelajar dalam pentaksiran. Nota yang diambil secara berkesan memainkan peranan yang besar dalam memperkukuhkan pembelajaran dan memudahkan proses ulangkaji. Mengambil nota membantu mengekod maklumat ke dalam ingatan pelajar. Proses menulis atau menaip melibatkan otak anda, menjadikannya lebih mudah untuk mengingati bahan tersebut.

Apabila pelajar mengambil nota, mereka terlibat secara aktif dengan bahan, yang menggalakkan pemahaman yang lebih mendalam seperti dalam kajian oleh Lombardi et.al. (2021). Ini membantu mereka memahami konsep yang kompleks dan mengenal pasti perkara utama. Tindakan mengambil nota memerlukan pelajar memberi perhatian kepada bahan yang dibentangkan. Ini membantu meminimumkan gangguan dan memastikan mereka terlibat dalam proses pembelajaran.

Selain itu, pengambilan nota yang berkesan merupakan asas bagi persediaan peperiksaan yang menyeluruh. Nota yang lengkap dan teratur berfungsi sebagai sumber rujukan utama untuk pelajar semasa mereka membuat persediaan menghadapi peperiksaan. Tanpa nota yang mencukupi, pelajar mungkin akan menghadapi cabaran besar dalam mempersiapkan diri mereka secara menyeluruh (Davidson, 2002). Sebaliknya, nota yang diambil dengan baik boleh menjadi panduan yang berharga dalam menyelesaikan soalan-soalan latihan dan ulangkaji, memberikan pelajar alat yang mereka perlukan untuk berjaya dalam peperiksaan. Menurut kajian oleh Haghverdi et.al. (2010), kurang minat dalam pengambilan nota matematik semasa kelas mempunyai kesan yang nyata terhadap pembelajaran pelajar dan mempengaruhi prestasi akademik pelajar. Pertama, tanpa nota yang baik, pelajar akan menghadapi kesukaran untuk memahami dan mengingati konsep-konsep penting dalam matematik.

**Memahami masalah**

Beberapa faktor yang menyumbang kepada kekurangan minat dalam mengambil nota termasuk:

*1. Kekurangan Motivasi*

Masalah kekurangan motivasi dalam kalangan pelajar terhadap subjek matematik adalah isu yang sering mendapat perhatian. Terdapat beberapa faktor yang menyumbang kepada kekurangan motivasi ini, yang seterusnya menyebabkan pelajar tidak aktif dalam mengambil nota. Salah satu faktor utama adalah persepsi negatif terhadap matematik. Ramai pelajar menganggap subjek ini sebagai sukar dan membosankan.

Cara pengajaran yang kurang menarik dan interaktif juga boleh menyumbang kepada persepsi kesukaran ini. Penggunaan teknik pengajaran yang tidak melibatkan pelajar secara aktif, seperti ceramah yang panjang dan latihan yang berulang, boleh menyebabkan mereka merasa bosan dan tidak bermotivasi (Meehan & Howard, 2023). Pelajar yang tidak terlibat secara aktif dalam proses pembelajaran cenderung untuk merasa lebih sukar memahami konsep matematik. Ini menyebabkan pelajar kurang minat untuk mengambil nota memandangkan tidak faham apa yang perlu ditulis.

2. *Tahap Penglibatan Rendah*

Format pengajaran tradisional mungkin tidak melibatkan semua pelajar, menyebabkan mereka kehilangan minat dan tidak mengambil nota. Pengajaran tradisional sering kali berpusat pada guru, di mana guru memberikan ceramah panjang dan pelajar hanya mendengar. Pendekatan ini sering kali tidak

melibatkan semua pelajar, menyebabkan mereka kehilangan minat dan tidak mengambil nota dengan aktif.

3. *Gangguan Digital*

Kehadiran peranti digital seperti telefon pintar, tablet, dan komputer riba di dalam bilik darjah telah membawa banyak faedah dalam proses pembelajaran, seperti akses kepada sumber-sumber pembelajaran yang luas dan kemudahan untuk berkomunikasi. Namun begitu, peranti digital juga membawa cabaran tersendiri, terutama dalam bentuk gangguan digital yang mengurangkan tumpuan pelajar terhadap pengambilan nota dan pembelajaran secara keseluruhan.

Salah satu isu utama yang timbul dengan kehadiran peranti digital adalah keupayaan pelajar untuk mudah teralih perhatian. Notifikasi dari media sosial, permainan dalam talian, mesej teks, dan pelbagai aplikasi lain sering kali menarik perhatian pelajar dari pelajaran mereka. Gangguan ini menyebabkan pelajar sukar untuk memberi tumpuan penuh kepada pengajaran dan nota yang diberikan oleh guru.

4. *Persepsi Kesukaran*

Matematik sering dianggap sebagai subjek yang sukar, dan pelajar mungkin merasa tertekan, menyebabkan mereka mengelak daripada mengambil nota. Persepsi ini boleh memberikan impak negatif kepada pelajar, menyebabkan mereka merasa tertekan dan akhirnya mengelak daripada mengambil nota atau terlibat secara aktif dalam kelas matematik.

**Kesan terhadap pembelajaran**

Isu nota tidak lengkap merupakan salah satu faktor yang boleh memberikan kesan negatif terhadap pembelajaran pelajar. Nota yang tidak lengkap boleh mengakibatkan pelajar kehilangan banyak maklumat penting yang diperlukan untuk memahami topik secara mendalam. Kesan ini dapat dilihat dalam beberapa aspek utama dalam pembelajaran.

Pertama sekali, nota yang tidak lengkap boleh menyebabkan kesukaran dalam mengulang kaji pelajaran. Apabila pelajar kembali semula kepada nota mereka untuk mengulang kaji, mereka mungkin mendapati bahawa terdapat banyak maklumat yang hilang atau tidak cukup jelas. Ini menyebabkan mereka sukar untuk memahami semula topik tersebut dan memerlukan usaha tambahan untuk mencari maklumat yang hilang, yang boleh memakan masa dan tenaga.

Selain itu, nota yang tidak lengkap boleh mengurangkan keberkesanan pembelajaran semasa kelas. Nota adalah alat penting yang membantu pelajar mengekalkan fokus dan tumpuan semasa pengajaran berlangsung. Apabila pelajar tidak mengambil nota dengan lengkap, mereka mungkin

kurang terlibat dalam proses pembelajaran dan mudah terlepas maklumat penting yang disampaikan oleh guru.

Nota yang tidak lengkap juga boleh memberi kesan kepada prestasi pelajar dalam peperiksaan. Tanpa nota yang lengkap, pelajar mungkin mengalami kesukaran untuk mengingati dan memahami konsep-konsep penting yang telah dipelajari. Ini boleh menyebabkan mereka kurang bersedia untuk menghadapi peperiksaan dan seterusnya memberi impak negatif kepada pencapaian akademik mereka.

Selain itu, nota yang tidak lengkap juga boleh memberi kesan kepada keyakinan diri pelajar. Apabila pelajar merasa bahawa mereka tidak mempunyai maklumat yang mencukupi untuk memahami sesuatu topik, mereka mungkin merasa kurang yakin dan tertekan. Ini boleh menyebabkan mereka kurang bersemangat untuk belajar dan mengambil bahagian dalam aktiviti kelas.

**Strategi untuk Penambahbaikan**

Penambahbaikan dalam pembelajaran matematik secara interaktif merupakan langkah yang penting dalam memastikan pelajar lebih terlibat dan bermotivasi untuk belajar. Dengan mengintegrasikan pendekatan interaktif dalam pembelajaran matematik, pelajar dapat merasa lebih terlibat dan termotivasi untuk belajar. Pendekatan ini bukan sahaja menjadikan pembelajaran lebih menyeronokkan tetapi juga membantu pelajar memahami dan Ini sekaligus memupuk minat dalam mengambil nota secara aktif dan baik.

Menurut Biggers & Lou, (2020), mengadakan bengkel pengambilan nota adalah satu langkah yang bijak untuk membantu pelajar menguasai teknik pengambilan nota yang berkesan dan menjadikan proses ini kurang menakutkan. Bengkel ini boleh dijalankan dengan melibatkan beberapa pihak yang berpengalaman dan mahir dalam pengajaran teknik pengambilan nota. Mengintegrasikan teknologi iaitu dengan menggunakan alat teknologi dalam pendidikan yang menggalakkan penglibatan dan kerjasama aktif boleh membantu mengurangkan gangguan digital.

**Kesimpulan**

Mengambil nota menggalakkan pembelajaran aktif, yang telah terbukti lebih berkesan daripada mendengar atau membaca pasif. Pelajar aktif cenderung untuk berprestasi lebih baik dari segi akademik dan mengekalkan maklumat lebih lama. Kemerosotan dalam mengambil nota dalam kelas matematik adalah masalah yang pelbagai aspek dengan implikasi yang signifikan terhadap kejayaan akademik pelajar. Dengan memahami punca-punca yang mendasari dan melaksanakan strategi yang disasarkan, pendidik boleh membantu pelajar mengembangkan amalan pengambilan nota yang lebih baik, seterusnya meningkatkan pengalaman pembelajaran dan prestasi akademik mereka.

**Rujukan:**

Ardeleanu, R., (2019). Traditional and Modern Teaching Methods in Mathematics. *Journal of Innovation in Psychology, Education and Didactics*. Vol.23, No.2, 133-140

Biggers, B. & Lou, L., (2020). Guiding Students to Success: A Systematic review of Research on Guided Notes as instructional Strategy from 2009-2019. *Journal of University Teaching & Learning Practice*. Vol. 17, Issue 3, Article 12

Davidson, A.R.(2002). Relationship of Study Approach and Exam Performance. https://doi.org/10.1016/50748-5751(01)00025-2

Haghverdi, H., Biria, R., & Karimi, L. (2010). Note-taking Strategies and Academic Achievement. *Journal of Language and Linguistic Studies*, 6(1), 0-109.

Lombardi, D., Shipley, T. F., Bailey, J. M., Bretones, P. S., Prather, E. E., Ballen, C. J., Knight, J. K., Smith, M. K., Stowe, R. L., Cooper, M. M., Prince, M., Atit, K., Uttal, D. H., LaDue, N. D., McNeal, P. M., Ryker, K., St. John, K., van der Hoeven Kraft, K. J., & Docktor, J. L. (2021). The Curious Construct of Active Learning. Psychological Science in the Public Interest, 22(1), 8-43. https://doi.org/10.1177/1529100620973974

Meehan, M. & Howard, E. (2023). The University Mathematics Lecture: to record, or not to record, that is the question. *Mathematics Education Research Journal*. 36. https://doi.org/10.1007/s13394-023-00444-2.

Swenson, M.R. (2018). Effective Note-Taking Strategies in The High School Math Classroom.

Voyer, D., Ronis, S.T., Byers,N.,(2022). The Effect of Notetaking Method on Academic Performance: A systematic review and meta-analysis, *Contemporary Educational Psychology*, Volume 68, ISSN 0361-476X, https://doi.org/10.1016/j.cedpsych.2021.102025

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# TAHAP PEMAHAMAN DAN KESUKARAN PELAJAR DALAM MATEMATIK: KAJIAN KES DIKALANGAN PELAJAR PRA-SAINS

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**ABSTRAK**

*Kajian ini bertujuan untuk menilai tahap pemahaman, penguasaan, dan persepsi pelajar terhadap subjek Matematik dalam kalangan pelajar Pra-Sains serta mengenal pasti tajuk yang paling mencabar bagi mereka. Kajian ini menggunakan skala Likert lima mata untuk mengukur tahap pemahaman, penguasaan, dan persepsi pelajar, yang didapati berada pada tahap sederhana dengan nilai min antara 3.00 hingga 4.00. Analisis korelasi menunjukkan hubungan positif yang signifikan antara pemahaman dan persepsi (r = 0.443) serta antara penguasaan dan persepsi (r = 0.614), mencadangkan bahawa pelajar dengan persepsi yang lebih tinggi terhadap subjek ini cenderung mempunyai pemahaman dan penguasaan yang lebih baik. Selain itu, dapatan kajian mendapati bahawa Indeks dan Logaritma merupakan tajuk yang paling sukar bagi pelajar, dengan 56% daripada mereka menganggapnya sebagai cabaran utama. Ini diikuti oleh tajuk Janjang (29%) dan Set (14%). Hasil kajian ini dapat memberikan panduan dalam merangka strategi pengajaran yang lebih berkesan, termasuk penyediaan latihan tambahan, pendekatan interaktif, dan bahan bantu mengajar yang sesuai bagi meningkatkan kefahaman dan penguasaan pelajar dalam Matematik Pra-Sains.*

***Katakunci: Matematik pra-sains, pemahaman, penguasaan, persepsi pelajar, tahap kesukaran***

## Pengenalan

Matematik di peringkat pra diploma sains memainkan peranan penting dalam menyediakan pelajar dengan asas yang kukuh dalam bidang matematik sebelum mereka melanjutkan pelajaran ke peringkat yang lebih tinggi. Tajuk-tajuk seperti Set, Indeks, Logaritma dan Jujukan Nombor merupakan antara konsep asas yang perlu dikuasai untuk memastikan pemahaman yang menyeluruh dalam bidang ini. Walaupun tajuk-tajuk ini penting, pelajar sering menghadapi kesukaran dalam memahami dan mengaplikasikan konsep-konsep tersebut dengan berkesan**.**

Kajian terkini mendapati bahawa pelajar universiti, khususnya pelajar tahun pertama, sering menghadapi cabaran besar dalam memahami konsep asas matematik, yang menjadi asas penting untuk kejayaan akademik mereka**.** Banyak pelajar bergelut dengan konsep asas matematik, yang memberi kesan negatif terhadap prestasi akademik mereka sepanjang pengajian (Villanueva-Cantillo et al., 2020). Kajian terdahulu juga menunjukkan wujudnya jurang antara prestasi matematik di peringkat sekolah menengah dan universiti. Sebagai contoh, 84% pelajar kejuruteraan gagal dalam ujian matematik asas walaupun memperoleh keputusan yang baik semasa di sekolah menengah (Fadzilah Salim et al., 2017). Untuk mangakas isu ini, penyertaan dalam kursus asas matematik bersama kelas

biasa didapati berkesan, dengan kadar kelulusan meningkat kepada 95% bagi pelajar yang hadir lebih separuh daripada jumlah sesi (Villanueva-Cantillo et al., 2020).

Bagi pelajar pra-diploma sains, kesukaran dalam menguasai topik-topik seperti Set, Indeks, Logaritma, dan Jujukan Nombor adalah antara cabaran utama yang menghalang mereka membina asas yang kukuh dalam matematik. Kelemahan dalam konsep awal serta kesukaran membaca dan memahami masalah matematik menjadi punca utama prestasi rendah (Roger Iván Soto Quiroz & Daniel Noboru Yogui Takaesu, 2020). Kesilapan seperti penggunaan sifat logaritma yang salah, langkah kerja yang tidak tepat, serta kelemahan operasi asas turut dilaporkan, menandakan pemahaman yang tidak mantap terhadap hukum logaritma (Halim, 2020; Desnani & Kartini, 2021). Kajian juga mengaitkan kesalahan ini dengan kecuaian pelajar dalam menggunakan data soalan dan kurangnya ketepatan dalam penyelesaian (Ong & Novisita, 2019). Oleh itu, pemahaman yang kukuh terhadap konsep asas logaritma dan kemahiran menyelesaikan persamaan logaritma adalah kunci kepada kejayaan pelajar dalam menguasai topik ini dan aplikasinya dalam pelbagai bidang ilmu (Siti, 2024).

Kesukaran utama yang dihadapi oleh pelajar dalam matematik, seperti kelemahan membaca soalan, penguasaan konsep asas yang rendah, ketidakhadiran kelas, dan motivasi yang lemah, terus memberi kesan kepada prestasi akademik mereka (Roger Iván Soto Quiroz & Daniel Noboru Yogui Takaesu, 2020). Di samping itu, tabiat pembelajaran dan sikap pelajar memainkan peranan penting, dengan kedua-duanya berkait rapat dengan pencapaian akademik seperti yang diukur melalui Purata Nilai Gred (Guinocor et al., 2020). Cabaran-cabaran ini menunjukkan keperluan mendesak untuk intervensi yang disasarkan, seperti kursus tambahan dan pendekatan pengajaran yang memberi tumpuan kepada kelemahan spesifik pelajar. Usaha sebegini bukan sahaja berpotensi meningkatkan pencapaian pelajar dalam matematik, tetapi juga dapat membantu mereka membangunkan keyakinan dan mengurangkan kadar keciciran dalam kalangan pelajar universiti. Kesinambungan usaha ini perlu difokuskan dalam konteks Matematik Pra-Sains untuk memastikan pelajar lebih bersedia menghadapi cabaran akademik seterusnya.

Oleh itu, kajian ini dijalankan untuk menilai tahap pemahaman dan penguasaan pelajar dalam ketiga-tiga tajuk utama, iaitu set, indeks dan logaritma, juga jujukan nombor, serta mengenal pasti tahap kesukaran yang dihadapi oleh mereka. Pemahaman awal pelajar terhadap konsep asas matematik adalah elemen penting yang mempengaruhi keupayaan mereka untuk menguasai tajuk-tajuk ini. Melalui penggunaan skala Likert, soal selidik ini akan membantu mengenal pasti tahap keyakinan pelajar dalam menggunakan konsep-konsep matematik ini dan menentukan tajuk yang mereka anggap paling mencabar.

**Metodologi**

Kajian ini menggunakan pendekatan deskriptif kuantitatif untuk menilai tahap pemahaman, penguasaan, dan persepsi kesukaran pelajar terhadap tajuk-tajuk dalam Bab 1 (Set) , Bab 2 (Indeks dan Logaritma) dan Bab 3 (Jujukan Nombor) dalam Matematik Pra-Sains. Sampel kajian terdiri daripada 40 orang pelajar yang mengikuti kursus Matematik Pertengahan di Universiti Teknologi Mara Cawangan Pulau Pinang, Kampus Permatang Pauh. Responden dipilih menggunakan kaedah pensampelan rawak sederhana daripada keseluruhan populasi. Data dikumpul melalui soal selidik berasaskan skala Likert lima mata (1 = Sangat tidak setuju hingga 5 = Sangat setuju) yang dibahagikan kepada tiga bahagian utama: pemahaman pelajar terhadap tajuk-tajuk yang dikaji, tahap penguasaan konsep matematik, dan persepsi terhadap tahap kesukaran setiap tajuk. Satu soalan tambahan juga disertakan untuk mengenal pasti tajuk yang paling sukar dan sebab pemilihannya.

Analisa kebolehpercayaan terhadap tiga bahagian soalan ini dijalankan terlebih dahulu menggunakan alpha Cronbach. Nilai alpha Cronbach yang baik adalah di antara 0.65 hingga 0.95 menurut Chua, 2014; Darusalam & Hussin, 2018. Data yang dikumpul dianalisis menggunakan perisian statistik SPSS 2.0 *(Statistical Pakage for Social Science)*. Analisis deskriptif digunakan untuk menentukan purata skor setiap item, manakala analisis korelasi menilai hubungan antara pemahaman dan penguasaan pelajar dengan persepsi kesukaran tajuk. Analisis frekuensi pula mengenal pasti tajuk yang paling kerap dianggap sukar, dan data kualitatif daripada soalan terbuka dianalisis secara tematik untuk mengenal pasti tema utama yang menyumbang kepada persepsi pelajar terhadap kesukaran tajuk tersebut.

**Analisa**

Hasil daripada analisa alpha Cronbach, nilai yang diperolehi adalah 0.953. Manakala nilai alpha Cronbach bagi setiap bahagian masing-masing adalah 0.917, 0.904 dan 0.82. Oleh itu kesemua item yang digunakan untuk kajian ini adalah sangat sesuai dan baik. Analisa seterusnya melibatkan deskriptif statistik iaitu min skor dan sisihan piawai bagi tahap pemahaman, penguasaan, dan persepsi kesukaran pelajar terhadap tajuk-tajuk dalam Bab 1,2 dan 3.

Jadual 1: Min skor dan sisihan piawai bagi Pemahaman Pelajar

| Soalan | Penerangan | Min | Sisihan piawai |
|---|---|---|---|
| A1 | Saya faham konsep asas dalam tajuk Set | 3.59 | 0.948 |
| A2 | Saya tahu cara menyelesaikan masalah berkaitan Indeks dan Logaritma | 3.00 | 0.922 |
| A3 | Saya boleh mengenal pasti pola dalam tajuk Jujukan | 3.46 | 0.977 |

| | | | |
|---|---|---|---|
| A4 | Saya dapat mengenal pasti perbezaan antara elemen dan subset dalam Set | 3.27 | 0.949 |
| A5 | Saya memahami hubungan antara Indeks dan Logaritma dalam persamaan matematik | 3.10 | 1.02 |
| A6 | Saya boleh menentukan had (limit) bagi sesuatu Jujukan berdasarkan formula yang diberikan | 3.24 | 0.994 |

Merujuk kepada Jadual 1, secara keseluruhan, tahap pemahaman pelajar berada pada tahap sederhana, dengan nilai min antara 3.00 hingga 3.59. Skor tertinggi dicatatkan bagi pemahaman konsep asas Set (Min = 3.59, SP = 0.948), manakala skor terendah adalah bagi penyelesaian masalah berkaitan Indeks dan Logaritma (Min = 3.00, SP = 0.922). Walaupun tahap pemahaman keseluruhan adalah sederhana, beberapa aspek seperti hubungan antara Indeks dan Logaritma serta perbezaan elemen dan subset memerlukan perhatian tambahan.

Jadual 2: Min skor dan Sisihan Piawai bagi Penguasaan Konsep Matematik

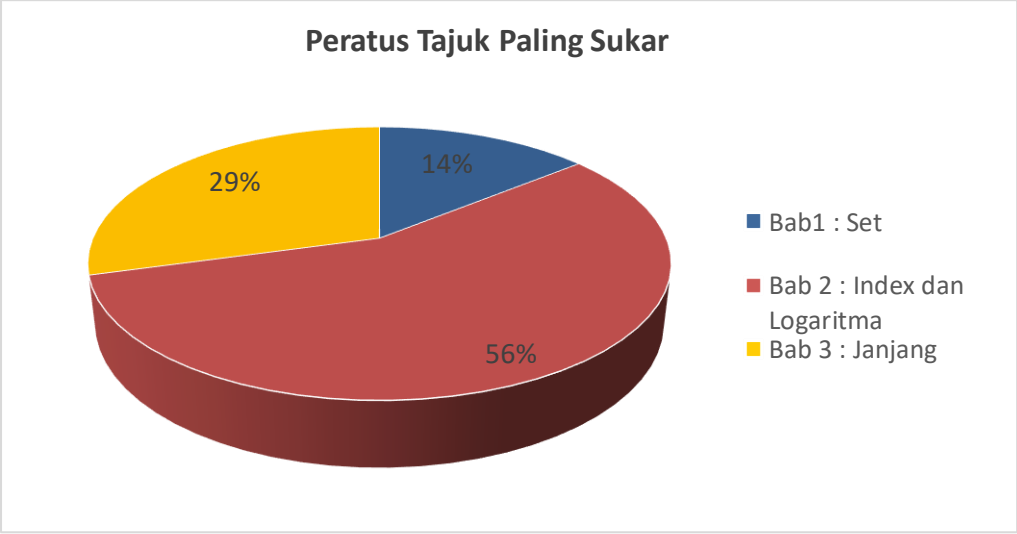
| **Soalan** | **Penerangan** | **Min** | **Sisihan piawai** |
|---|---|---|---|
| B1 | Saya yakin menggunakan operasi asas dalam Set, seperti union dan intersection | 3.49 | 0.952 |
| B2 | Saya boleh menyelesaikan soalan logaritma tahap sederhana tanpa bantuan | 3.15 | 1.085 |
| B3 | Saya boleh menulis formula umum bagi sesuatu Jujukan berdasarkan data yang diberikan | 3.46 | 1.002 |
| B4 | Saya boleh menyelesaikan masalah yang melibatkan operasi Set dengan lebih daripada dua kumpulan | 3.29 | 1.006 |
| B5 | Saya mampu menukarkan persamaan Indeks kepada Logaritma, dan sebaliknya | 3.05 | 1.048 |
| B6 | Saya boleh mencari jumlah n sebutan pertama bagi sesuatu Jujukan Aritmetik atau Geometri | 3.44 | 1.001 |

Jadual 2 pula menunjukkan bahawa tahap keyakinan pelajar juga berada pada tahap sederhana, dengan nilai min antara 3.05 hingga 3.49. Skor tertinggi dicatatkan pada keyakinan pelajar menggunakan operasi asas Set seperti kesatuan (*union*) dan persilangan (*intersection*) dengan Min = 3.49 dan SP = 0.952, manakala skor terendah adalah pada kebolehan menukarkan persamaan Indeks kepada Logaritma dan sebaliknya (Min = 3.05, SP = 1.048). Walaubagaimanapun pelajar dilihat memerlukan penekanan tambahan pada aspek yang lebih kompleks, seperti menukarkan persamaan dan menyelesaikan masalah dengan lebih daripada dua kumpulan dalam tajuk Set. Pendekatan pengajaran yang berfokus pada latihan berstruktur dan aplikasi praktikal dapat membantu meningkatkan keyakinan mereka.

Jadual 3: Min skor dan Sisihan Piawai bagi Persepsi Pelajar terhadap Tahap Kesukaran Set, Index dan Logaritma serta Jujukan

| Soalan | Penerangan | Min | Sisihan piawai |
|---|---|---|---|
| B1 | Saya yakin menggunakan operasi asas dalam Set, seperti union dan intersection | 3.49 | 0.952 |
| B2 | Saya boleh menyelesaikan soalan logaritma tahap sederhana tanpa bantuan | 3.15 | 1.085 |
| B3 | Saya boleh menulis formula umum bagi sesuatu Jujukan berdasarkan data yang diberikan | 3.46 | 1.002 |
| B4 | Saya boleh menyelesaikan masalah yang melibatkan operasi Set dengan lebih daripada dua kumpulan | 3.29 | 1.006 |
| B5 | Saya mampu menukarkan persamaan Indeks kepada Logaritma, dan sebaliknya | 3.05 | 1.048 |
| B6 | Saya boleh mencari jumlah n sebutan pertama bagi sesuatu Jujukan Aritmetik atau Geometri | 3.44 | 1.001 |

Seterusnya, Jadual 3 menunjukkan bahawa persepsi pelajar berada pada tahap sederhana hingga mencabar, dengan nilai min antara 3.24 hingga 4.00. Skor tertinggi dicatatkan pada keperluan latihan tambahan untuk menguasai tajuk Jujukan (Min = 4.00, SP = 0.866), iaitu yang menunjukkan bahawa pelajar memerlukan lebih banyak sokongan dalam tajuk ini. Sebaliknya, skor terendah diperoleh dalam kefahaman hukum asas Indeks dan Logaritma (Min = 3.24, SP = 1.044), iaitu yang mencerminkan kesukaran pelajar dalam memahami konsep asas tajuk tersebut.




Rajah 1 : Peratusan Tajuk Paling Sukar di antara Bab 1, 2 dan 3.

Hasil soal-selidik bagi tajuk yang paling sukar dipilih oleh pelajar adalah seperti dalam Rajah 1. Di dapati bahawa Bab 2 iaitu Indeks dan Logaritma merupakan tajuk yang paling mencabar dengan 59% pelajar memilihnya. Ini menunjukkan bahawa konsep ini memerlukan pemahaman yang lebih mendalam, terutamanya dalam manipulasi algebra dan penggunaan formula. Antara sebab yang disuarakan oleh pelajar adalah "susah untuk difahami dan lemah dalam asas matematik", "perlu memahami hukum log secara mendalam sebelum menjawab soalan" dan "terlalu banyak jalan kerja yang perlu dilakukan". Bab 3 iaitu Janjang pula berada di kedudukan kedua dengan 26%, yang menunjukkan bahawa walaupun sebahagian pelajar memahami konsep ini, masih terdapat cabaran dalam aplikasi dan penyelesaian masalah yang melibatkan janjang aritmetik serta geometri. Sementara itu, Bab 1 atau Set hanya dipilih oleh 14% pelajar sebagai tajuk paling sukar, menunjukkan bahawa kebanyakan pelajar tidak menghadapi kesulitan yang besar dalam memahami konsep ini. Oleh itu, perhatian khusus perlu diberikan kepada tajuk Indeks dan Logaritma melalui latihan tambahan, pendekatan interaktif, dan sesi ulang kaji yang lebih mendalam, diikuti dengan sokongan terhadap pemahaman konsep Janjang, manakala tajuk Set mungkin memerlukan pengukuhan asas bagi sebilangan kecil pelajar yang masih menghadapi masalah dalam mempelajari tajuk ini.

Jadual 4: Ujian Korelasi antara Persepsi dengan Pemahaman serta Penguasaan Pelajar

| | | **Pemahaman** | **Penguasaan** |
|---|---|---|---|
| **Persepsi** | **Pekali Korelasi** | .443** | .614** |
| | **Sig. (1-tailed)** | 0.002 | 0 |

**Korelasi adalah signifikan pada tahap 0.01

Seterusnya, hasil ujian korelasi antara persepsi (pembolehubah bersandar) dengan pemahaman dan penguasaan pelajar terhadap tajuk yang dikaji ditunjukkan dalam Jadual 4. Dapatan analisis menunjukkan terdapat korelasi positif sederhana yang signifikan antara persepsi dan pemahaman pelajar, dengan $r = 0.443$ ($p = 0.002$, $p < 0.01$). Ini bermaksud semakin tinggi persepsi pelajar, semakin meningkat pemahaman mereka terhadap tajuk tersebut. Sementara itu, nilai $r = 0.614$ ($p = 0.002$, $p < 0.01$) menunjukkan hubungan yang lebih kuat antara persepsi dan penguasaan pelajar. Dapatan ini mencadangkan bahawa peningkatan persepsi pelajar bukan sahaja berkait dengan pemahaman mereka tetapi juga berpotensi meningkatkan tahap penguasaan terhadap tajuk yang dikaji.

**Kesimpulan**

Kesimpulannya, tahap pemahaman, keyakinan, dan persepsi pelajar terhadap tajuk Set, Indeks dan Logaritma, serta Jujukan berada pada tahap sederhana. Pelajar menunjukkan pemahaman yang terbaik dalam tajuk Set, khususnya dalam konsep asas dan operasi seperti kesatuan (*union*) dan persilangan

(*intersection*). Namun, mereka menghadapi cabaran yang lebih besar dalam tajuk yang lebih kompleks seperti Indeks, Logaritma, dan Jujukan. Beberapa aspek yang memerlukan perhatian tambahan termasuk hubungan antara Indeks dan Logaritma, rajah Venn tiga kumpulan, serta formula umum Jujukan Geometri. Bagi meningkatkan kefahaman dan penguasaan pelajar secara menyeluruh, pendekatan seperti latihan intensif, pengajaran interaktif, dan aplikasi praktikal disarankan. Hasil kajian ini diharapkan dapat memberikan panduan yang berguna dalam mengenal pasti cabaran utama pelajar, selari dengan penemuan penyelidik terdahulu (Donuata & Pratama, 2021; Clenaghan, 2018), yang turut menekankan kesukaran dalam memahami logaritma dan jujukan. Selain itu, dapatan ini dapat menyumbang kepada penambahbaikan kaedah pengajaran dan pembelajaran, termasuk pembangunan bahan bantu mengajar dan penilaian yang lebih sesuai. Dengan ini, diharapkan kajian ini dapat membantu pelajar menguasai asas matematik yang penting sebagai persediaan untuk kejayaan akademik mereka.

**Rujukan:**

Chua, Y. P. (2014). Kaedah dan statistik penyelidikan buku 2 asas statistik penyelidikan (Edisi ketiga). Kuala Lumpur: Mc Graw Hill Education.

Darusalam, G., & Hussin. S. (2018). Metodologi penyelidikan dalam pendidikan (Edisi kedua). Kuala Lumpur: Penerbit Universiti Malaya.

Desnani, U., & Kartini, K. (2021). Analisis kesalahan siswa dalam menyelesaikan soal logaritma menggunakan tahapan kesalahan kastolan. Jurnal Cendekia: Jurnal Pendidikan Matematika, 5(1), 542-550.

Guinocor, M., Rodriguez, M., & Dizon, J. (2020). Mathematics Performance of Students in a Philippine State University.

Halim, D., Nurhidayati, S., Zayyadi, M., Lanya, H., & Hasanah, S. I. (2020). Commognitive analysis of the solving problem of logarithm on mathematics prospective teachers. Journal of Physics: Conference Series, 1(1), 1-11.

Hartono, W., Hadi, S., Rosnawati, R., & Retnawati, H. (2023). Exploration of student cognitive mathematics ability diagnostic instruments: Validity, reliability, and item characteristics. Pegem Journal of Education and Instruction, 13(3), 386-394

Salim, F., Ahmad, A., Waini, I., & Miswan, N. H. (2017). FTK Students' Performance in Mathematics: Comparison between SPM and First Year Exam. In MATEC Web of Conferences (Vol. 87, p. 04002). EDP Sciences.

Soto Quiroz, RI, & Yogi Takaesu, DN (2020). Analysis of difficulties presented by university students in basic mathematics.

Susanty, F. (2018). Mathematical connection ability and its application to logarithms in high school students.

Villanueva-Cantillo, J., Orozco-Guzmán, M., Acuña, F. M., Castro, S. O., & Malo, E. S. (2020, March). Impact of a basic mathematics course on the performance of college students in algebra subject. In Journal of Physics: Conference Series (Vol. 1514, No. 1, p. 012020). IOP Publishing.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# PERFORMANCE ANALYSIS OF ENGINEERING STUDENTS IN STATISTICS ASSESSMENTS

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**ABSTRACT**

*This study examines the performance of civil engineering students in probability and inferential statistics topics through two distinct assessment types: Assessment 1 (Quiz Individual) and Assessment 2 (Group Assignment). The Assessment 1 (Quiz Individual) focuses on probability topics such as binomial, Poisson, normal distributions, and sampling distributions, while the Assessment 2 (Group Assignment) evaluates their understanding of estimation, confidence intervals and hypothesis testing, including analyses of one mean, two means, one variance, and two variances. Additionally, a t-test for two means is conducted to determine if there is a significant difference between the mean scores of quizzes and assignments. The data includes scores from 26 civil engineering students, representing a subset of the total 346 engineering students across civil, chemical, mechanical, and electrical disciplines. The findings highlight key differences in individual and group performance, shedding light on common challenges faced by students in understanding statistical concepts and implications for improving teaching strategies.*

***Keywords: probability, statistics, quizzes, assignment, engineering***

## Introduction

Statistics is a critical component in engineering education, equipping students with the analytical tools necessary for data-driven decision-making in professional practice. Among the various statistical topics, probability and inferential statistics are particularly vital, providing a foundation for understanding uncertainty and variability in engineering processes. However, mastering these concepts poses significant challenges for students, as evidenced by varying performance levels in assessments. This study focuses on civil engineering students' performance in Assessment 1 (Quiz Individual) and Assessment 2 (Group Assignment), aiming to uncover patterns that can inform teaching strategies. By analyzing assessment data, this research contributes to a broader understanding of how students engage with statistical topics and identifies areas requiring pedagogical intervention. Additionally, the study employs hypothesis testing to evaluate whether there is a statistically significant difference between the mean scores of quizzes and assignments, further enriching the analysis.

Statistical literacy is crucial for university students across disciplines, particularly in engineering and data-driven fields. Studies have shown that many first-year university students struggle with basic statistical concepts, such as selecting appropriate descriptive statistics and creating meaningful data visualizations (Setiawan & Sukoco, 2021). This lack of proficiency extends to Pakistan, where research has revealed low statistical literacy among undergraduate students (Hassan et al., 2020). To address these challenges, experts advocate for curriculum reforms that emphasize real-world data analysis, decision-making under uncertainty, and the integration of data science concepts (Burrill, 2020). Additionally, introducing data literacy frameworks that encompass technical, legal, and ethical perspectives can help equip engineering students with essential skills for the digital age (Giese et al., 2020). Improving statistical education at both secondary and university levels is necessary to enhance students' ability to interpret and utilize data effectively in their academic and professional lives.

Collaborative learning environments can enhance student engagement and performance in various academic settings, including statistics and computer science courses (Mesghina et al., 2024; Wu et al., 2024). Group dynamics play a crucial role in these environments, with factors such as equal participation, peer interaction, and social presence influencing learning outcomes (Strauss & Rummel, 2021; Qureshi et al., 2021). While the presence of expert peers can benefit struggling students, this effect is not consistent across all groups (Wu et al., 2024). Interestingly, group composition (heterogeneous or homogeneous) does not significantly impact individual learning or discussion engagement (Mesghina et al., 2024; Wu et al., 2024). Social factors, including interactions with peers and teachers, positively influence collaborative learning and student involvement, ultimately affecting learning performance (Qureshi et al., 2021). Despite challenges in group dynamics, students generally perceive collaborative learning as valuable, promoting opportunities for positive interactions and revealing misunderstandings (Mesghina et al., 2024; Strauss & Rummel, 2021).

Recent research advocates for active learning strategies in teaching probability and statistics, with a focus on flipped classrooms (FC) and technology-enhanced teaching. Studies have shown that FC approaches can improve student performance, engagement, and critical thinking skills in introductory statistics courses (Farmus et al., 2020). A meta-analysis revealed that students in FC settings achieved 6.9% higher final performance outcomes compared to traditional lecture-based classrooms (Farmus et al., 2020). The FC model has been successfully implemented in various contexts, including mathematics for computer science courses, where it enhanced collaboration and problem-solving skills (Dori et al., 2020). Additionally, incorporating project-based learning components can further improve student performance and attitudes towards FC (Dori et al., 2020). Even in online settings, FC strategies have shown promise in addressing passivity issues and motivating engineering students in statistics courses (Andersson & Kroisandt, 2021).

**Methodology**

This study employs a quantitative approach to analyze the performance of 26 civil engineering students in two types of assessments: individual quizzes and group assignments. The Assessment 1 (Quiz Individual) assesses topics in probability, including Binomial, Poisson, Normal distributions, and sampling distributions, while the Assessment 2 (Group Assignment) covers estimation, confidence intervals and hypothesis testing involving one mean, two means, one variance, and two variances. Descriptive statistics, including mean is used to summarize performance. Based on the descriptive statistics show that the mean score for the quiz is 72, while the mean score for the group assignment is 85, based on a sample of 26 students.

To further analyze the data, a hypothesis testing procedure is conducted to determine if there is a statistically significant difference between the mean scores of quizzes and assignments. The hypotheses are formulated as follows:

$H_0$: There is no significant difference between the mean scores of quizzes and assignments ($\mu_1 = \mu_2$).
$H_1$: There is a significant difference between the mean scores of quizzes and assignments ($\mu_1 \neq \mu_2$).

A paired t-test is applied, as the data represents matched scores for the same group of students across two assessment types. The p-value is calculated to determine the significance of the results. Statistical analysis is conducted using a 95% confidence level ($\alpha = 0.05$). The results of the hypothesis test, p-value is presented in the findings and discussion section.

**Findings and Discussion**

Based on Figure 1, the bar chart compares quiz and group assignment marks for 26 civil engineering students. The data clearly shows that students perform better in group assignments than in quizzes, with average scores of 85 and 72, respectively. Most students achieve higher marks in group assignments, indicating that collaborative work enhances their performance. In contrast, quiz scores vary significantly, with some students particularly students 3, 13, 17, 23, and 26 scoring noticeably lower. This suggests that quizzes, which require individual effort and quick problem-solving, pose greater challenges for certain students.

Several factors may contribute to this difference in performance. Quizzes assess independent understanding and the ability to apply concepts immediately, whereas group assignments allow discussion, research, and peer support. Additionally, weaker students may benefit from working with stronger peers in group tasks, leading to overall higher scores. To address this gap, providing targeted

revision and additional practice questions could help improve quiz performance. Incorporating quiz-style questions into group assignments may also strengthen individual comprehension while preserving the advantages of teamwork.

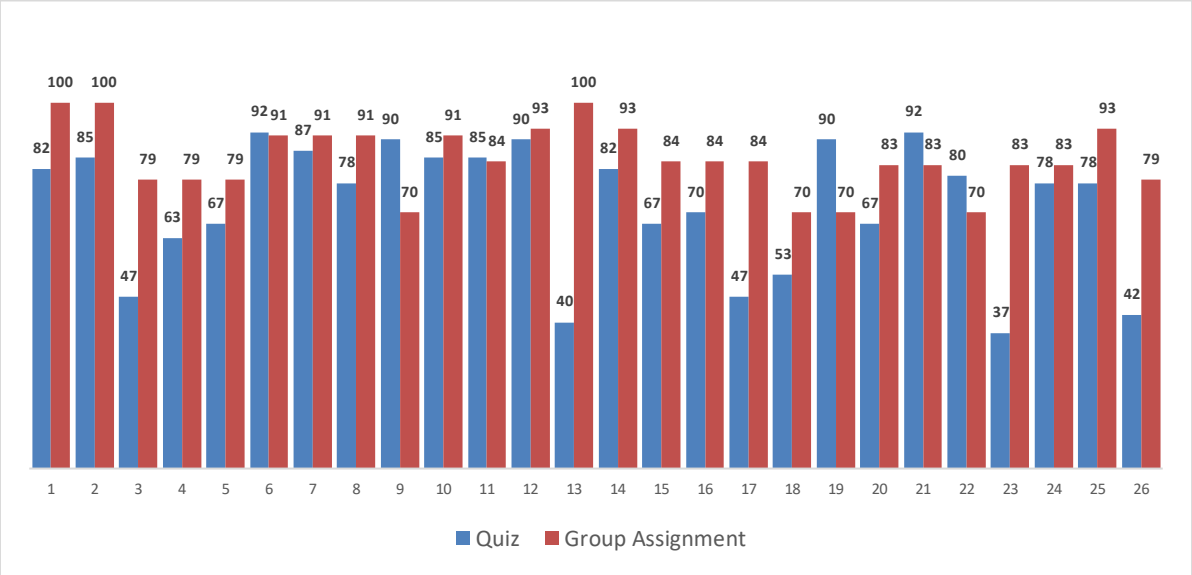


Figure 1: Comparison of Quiz and Group Assignment Scores

The paired t-test results indicate a significant difference between the mean scores of quizzes and assignments (p-value < 0.05), leading to the rejection of the null hypothesis. This finding supports the hypothesis that students exhibit better performance in group assignments compared to individual quizzes, likely due to the collaborative nature of group work and the relatively higher level of guidance provided during assignments. The data also show a wide range of performance among students, indicating variability in statistical aptitude within the cohort. This underscores the need for differentiated instructional strategies to address diverse learning needs. Comparisons with other engineering disciplines could provide further insights into the impact of curriculum design on statistical performance.

## Conclusion

This study highlights significant differences in civil engineering students' performance on individual and group assessments in statistics, emphasizing the challenges of mastering probability concepts and the benefits of collaborative learning in inferential statistics. The hypothesis testing confirms a statistically significant difference between the mean scores of quizzes and assignments, suggesting that students perform better in collaborative settings. The findings suggest the need for targeted interventions, such as active learning strategies and differentiated instruction, to address students' learning gaps. Future research could explore longitudinal data across all engineering disciplines to

provide a more comprehensive understanding of statistical education in engineering. This study contributes to the ongoing discourse on enhancing statistical literacy in engineering education, with implications for curriculum design and instructional practices.

**References:**

Andersson, C., & Kroisandt, G. (2021, June). Work in Progress: First Experiences with a Flipped Online Statistics Classroom for Engineering Students. In *2021 International e-Engineering Education Services Conference (e-Engineering)* (pp. 103-106). IEEE.

Burrill, G. (2020). Statistical literacy and quantitative reasoning: Rethinking the curriculum. In *New skills in the changing world of statistics education: Proceedings of the roundtable conference of the International Association for Statistical Education (IASE), Held online*.

Dori, Y. J., Kohen, Z., & Rizowy, B. (2020). Mathematics for computer science: A flipped classroom with an optional project. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(12).

Farmus, L., Cribbie, R. A., & Rotondi, M. A. (2020). The flipped classroom in introductory statistics: Early evidence from a systematic review and meta-analysis. *Journal of Statistics Education*, *28*(3), 316-325.

Giese, T. G., Wende, M., Bulut, S., & Anderl, R. (2020, April). Introduction of data literacy in the undergraduate engineering curriculum. In *2020 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1237-1245). IEEE.

Hassan, A., Ghaffar, A., & Zaman, A. (2020). An investigative study on university students' statistical literacy in Pakistan. *sjesr*, *3*(1), 159-164.

Mesghina, A., Hong, G., & Durrell, A. (2024). Cooperative learning in introductory statistics: Assessing students' perceptions, performance, and learning in heterogeneous and homogeneous groups. *Journal of Statistics and Data Science Education*, 1-26.

Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engagement. *Interactive Learning Environments*, *31*(4), 2371-2391.

Setiawan, E.P., & Sukoco, H. (2021). Exploring first year university students' statistical literacy: A case on describing and visualizing data. *Journal on Mathematics Education*, *12*(3), 427-448.

Strauß, S., & Rummel, N. (2021). Promoting regulation of equal participation in online collaboration by combining a group awareness tool and adaptive prompts. But does it even matter?. *International Journal of Computer-Supported Collaborative Learning*, *16*(1), 67-104.

Wu, T., Tang, X., Wong, S., Chen, X., Shaffer, C. A., & Chen, Y. (2024). The Impact of Group Discussion and Formation on Student Performance: An Experience Report in a Large CS1 Course. *arXiv preprint arXiv:2408.14610*.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 –Mac - 2025*

# A REVIEW OF THE EFFECTIVENESS OF GUIDED NOTES: CAN IT SUPPORT STUDENTS' NOTE TAKING IN MATHEMATICS LECTURE?

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**ABSTRACT**

*Guided notes are essentially teacher-prepared handouts that help students take more effective notes during a lesson or lecture. Guided notes can be used in a variety of subjects and for students of all ages. They are particularly helpful for students who struggle with notetaking or have learning disabilities. Guided notes, which include pre-prepared handouts with essential concepts and partially finished examples, are expected to boost student engagement and comprehension when compared to typical note-taking approaches. The study examines the benefits and effects of guided notes on students' strategies for taking notes in class, their ability to recognise and document key information, and their subsequent exam performance. Additionally, this study assesses the value of guided notes as a teaching tool in college-level mathematics courses and offers suggestions for how to use them to enhance student learning.*

***Keywords: guided notes, handout, approaches, pedagogy, behaviour***

## Introduction

Students frequently find mathematics lectures to be quite difficult. Effective note-taking might be challenging for students due to the fast-paced environment, abstract ideas, and intricate problem-solving procedures. Conventional note-taking techniques, which require students to write down every word the lecturer says, can be very inefficient and frequently result in verbatim copying without careful consideration of the material. This may make it more difficult to understand and remember important mathematical ideas. Achievement in learning is influenced by the teacher's mastery and skills in explaining the lesson so that students do not feel bored, which has been very monotonous in teaching teachers, which can cause students to be lazy to learn, especially in mathematics. According to Fields (2021), teachers provide guided notes to help students master course topics. Guided notes are valuable for students because they assist students organise their learning activities and increase their understanding of teacher-presented content in mathematics classrooms. Mathematics teachers create guided notes for brief lectures, longer units of work, grading periods, and semester-long courses. Guided notes, whether lengthy or short, help students master mathematics at all levels.

The learning method is a manner for students to carry out learning activities, such as how they prepare to study, take lessons, conduct self-study activities, develop learning patterns, and take tests. The quality of the learning process determines the quality of the learning outputs. An excellent method of learning will result in less success or failure to learn (Agus, 2009). One potential remedy for these issues is the use of guided notes, which are pre-made handouts that contain important details and partially finished examples.

Students often become preoccupied with replicating everything accurately rather than paying attention to the lecturer's comments (Freitag, 2020). This can pose major issues with their capacity to make sense of the content delivered during a lecture because the instructor's explanations frequently contain information necessary for students' ability to comprehend the subject, such as informal representations of a concept or ideas in a proof (Fukawa-Connelly et al., 2017; Lew et al., 2016). The challenge worsens if the instructor moves quickly through the material, as is common with traditional mathematics lecturers at universities (Harris & Pampaka, 2016). Furthermore, the research shows that students frequently do not record the lecturer's oral explanations of definitions, theorems, and proofs (Fukawa-Connelly et al., 2017). As a result, depending on their lecture notes, they may struggle to understand the subject later at home.

Using guided notes could be one way to deal with these issues. According to Austin et al. (2004), these are preprinted lecture notes that have blanks in specific areas that students must fill in as the presentation goes on. This is a relatively new approach to teaching university mathematics, according to Iannone and Miller (2019). The study examined students' perceptions regarding guided notes and how they affect their note-taking habits. In the study, some students said that guided notes improved their ability to follow the lecturer's instructions.

**Literature Review**

The theoretical basis for guided notes' efficiency is cognitive load theory. Traditional note-taking can put a strain on students cognitive abilities as they attempt to listen, comprehend, and write at the same time. According to Konrad et al. (2011), guided notes reduce cognitive load by giving a pre-organized structure and crucial information, allowing students' cognitive resources to focus on grasping the concepts and actively engaging with the subject. Guided notes promote active participation by offering a framework for taking notes. Students are more likely to pay attention, ask questions, and participate in discussions when they are actively filling in the blanks and providing examples.

Several research have investigated the effect of guided notes on student understanding and academic achievement in mathematics. Some students recorded the non-written comments as well as some of their own links between sections of the lecture, but when taught using the traditional chalk-and-talk method, students do not recognise the value of lecturers' unwritten comments and only write

what is written on the board in their notes (Iannone & Miller, 2019). These studies have generally shown good results, with students utilising guided notes displaying better knowledge of mathematical concepts and greater test scores than students using traditional note-taking methods. The structured format of guided notes assists students in identifying and organising significant information, allowing for the development of a more coherent comprehension of the content.

However, the literature identifies some potential limits of guided notes. Some studies have revealed that students may become overly reliant on guided notes, impeding the development of independent note-taking skills. Furthermore, the usefulness of guided notes is dependent on the quality of the notes and how they are applied in the classroom. If the guided notes are poorly prepared or not matched with the lecture subject, they may be ineffective.

**Benefits of Guided Notes**

Guided notes are a set of notes that provide students a diagram of the class's main themes and subtopics. Students that use guided notes write down the delicate aspects that they need to know for each subject and keep these notes in their interactive notebooks (Austin et al., 2002; Gregory, 2009). According to Smith and Clason (2017), teachers use guided notes to help students acquire knowledge, concepts, and abilities throughout the curriculum. As information is presented in lectures, presentations, or reading assignments, the student fills in the blanks to complete the guided notes, efficiently identifying the most important details (Hanlon, 2012).

Using guided notes in mathematics lectures allows lecturers and students to focus on specific topics without having to write everything down. This can save time and allow students to focus on the lecturer instead than writing, which is crucial for understanding the topic. Recent qualitative research with limited sample sizes have corroborated this hypothesis for university mathematics lectures (Cardetti et al., 2010; Iannone & Miller, 2019). Students who take accurate notes and study them later have higher test scores than those who only listen to lectures and read the text. Inaccurate or incomplete lecture notes are of limited value for subsequent study. Guided notes help students maintain the information they need to solve problems or master advanced math concepts and skills (Heward,2019). He also found that guided notes improve math mastery for both students with and without note-taking skills. They should be widely employed in mathematics classrooms to boost student engagement with course content. To complete their guided notes, students must actively respond to lecture topic through listening, looking, thinking, and writing. In the study by Krapf and Pfefferkorn (Citation2022), for example, 42.1% of the 209 participants said that guided notes helped them sustain their attention, 27.8% said that they allowed them to think and write at the same time, and 20.6% said they helped them memorise the subject. However, a few students also complained that they cannot follow the professor even if guided notes were provided due to a rapid presentation speed.

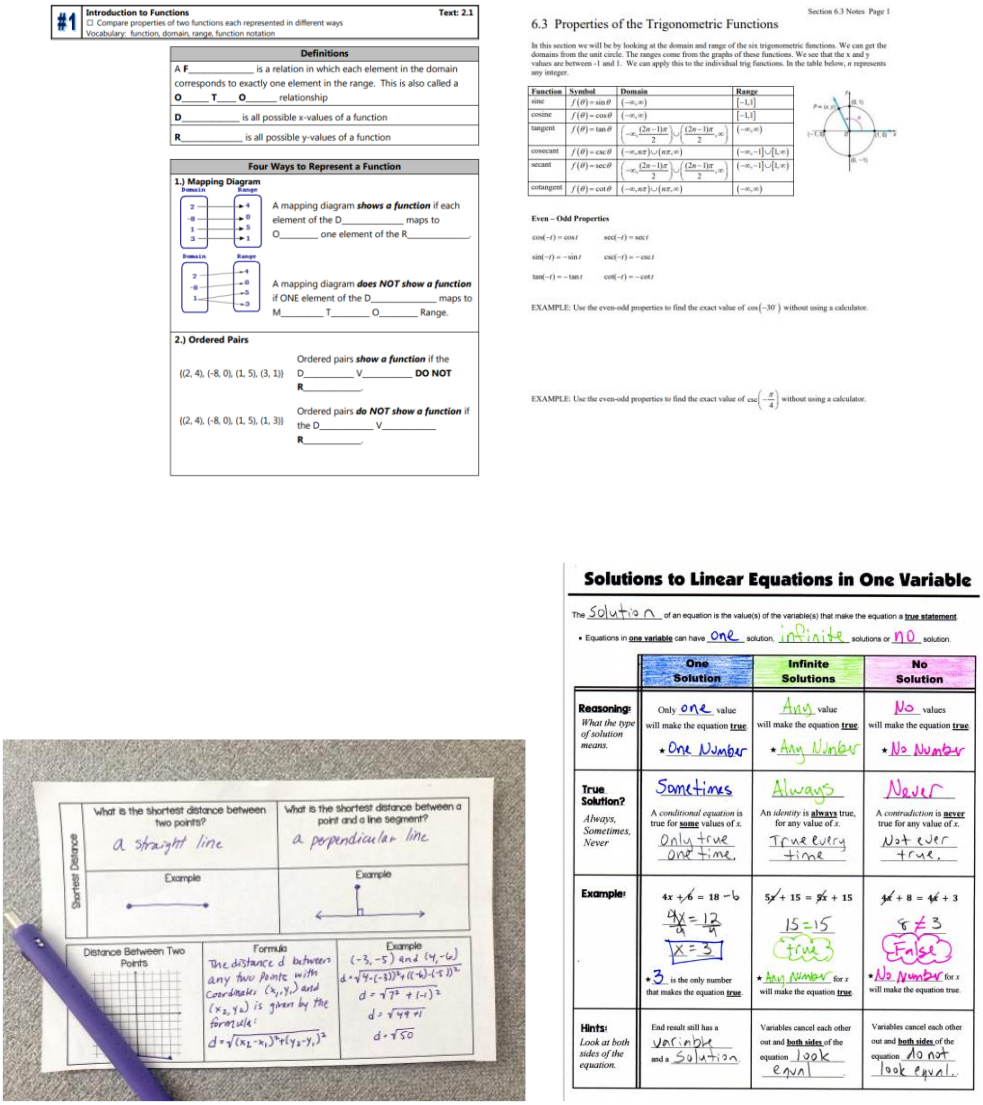


Figure 1: Examples of guided notes in mathematics

## Conclusion

The use of guided notes in mathematics is seen to improve students' learning performance and thus increase the achievement of learners in mathematics. With these guided notes, students will no longer miss a topic if they do not attend class and miss important notes during the note-taking process. Some studies have revealed that students may become overly reliant on guided notes, impeding the development of independent note-taking skills. Furthermore, the usefulness of guided notes is dependent on the quality of the notes and how they are applied in the classroom. If the guided notes are poorly prepared or not matched with the lecture subject, they may be ineffective. However, the literature identifies some potential limits of guided notes.

**References:**

Ardeleanu, R., (2019). Traditional and Modern Teaching Methods in Mathematics. *Journal of Innovation in Psychology, Education and Didactics*. Vol.23, No.2, 133-140

Austin, J. L., Lee, M., & Carr, J. P. (2004). The Efects of Guided Notes on Undergraduate Students' Recording of Lecture Content. *Journal of Instructional Psychology*, 31(4).

Cardetti, F., Khamsemanan, N., & Orgnero, M. C. (2010). Insights regarding the usefulness of partial notes in mathematics courses. *Journal of the Scholarship of Teaching and Learning*, 10(1), 80–92.

Feudel, F., Panse, A. Can Guided Notes Support Students' Note-taking in Mathematics Lectures?. *Int. J. Res. Undergrad. Math. Ed.* **8**, 8–35 (2022). https://doi.org/10.1007/s40753-021-00146-9

Feudel, F., & Panse, A. (2024). Facilitating notetaking with guided notes – students' preferences regarding positions for blanks and preprinted parts. *International Journal of Mathematical Education in Science and Technology*,1–22. https://doi.org/10.1080/0020739X.2024.2310622

Field, S. (2021). Teachers Perceptions of Using Guided Notes for Mathematics Number Systems. *Concordia University Chicago ProQuest Dissertations & Theses*.

Freitag, M. A. (2020). Note-Taking Practices of Students in College Mathematics. *International Journal of Research in Undergraduate Mathematics Education*, 6(1), 65–89.

Fukawa-Connelly, T. P., Weber, K., & Mejía-Ramos, J. P. (2017). Informal content and student notetaking in advanced mathematics classes. *Journal for Research in Mathematics Education*, 48(5), 567–579

Harris, D., & Pampaka, M. (2016). 'They [the lecturers] have to get through a certain amount in an hour': frst year students' problems with service mathematics lectures. *Teaching Mathematics and Its Applications: An International Journal of the IMA*, 35(3), 144–158

Iannone, Paola & Miller, Dominic. (2019). Guided notes for university mathematics and their impact on students' note taking behaviour. Educational Studies in Mathematics. https://doi.org/101. 10.1007/s10649-018-9872

Konrad, Moira & Joseph, Laurice & Itoi, Madoka. (2011). Using Guided Notes to Enhance Instruction for All Students. *Intervention in School and Clinic* - INTERVENTION SCHOOL CLINIC. 46. 131-140. https://doi.org/10.1177/1053451210378163

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac- 2024*

# GAMIFICATION AND INTERACTIVE LEARNING: A STRATEGY FOR REDUCING MATHEMATICS' ANXIETY

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**ABSTRACT**

*Innovations like gamification and interactive learning have revolutionized digital education by altering the way standard online teaching approaches are used. This is due to the fact that gamification in e-learning is redefining conventional educational methods and offering a creative way to increase student motivation, engagement, and retention of the material. Mathematics is often perceived as one of the most challenging subjects, with many students experiencing anxiety with a feeling of tension, fear, or apprehension that interferes with mathematical performance. This anxiety can lead to avoidance of math-related tasks, lower confidence, and poor academic outcomes. With the rise of online education, new teaching strategies are needed to create engaging and stress-free learning environments. One promising approach is gamification and interactive learning, which integrate game-based elements such as points, badges, challenges, and adaptive feedback to make learning mathematics more enjoyable and less intimidating. By shifting the focus from memorization to an interactive, problem-solving experience, gamification can help students develop a positive mindset toward mathematics while improving motivation and retention. This paper explores the types and roles of gamification in reducing mathematics anxiety and the impact on student engagement and confidence in learning mathematics.*

***Keywords: gamification, interactive learning, education tool, anxiety, mathematic***

## Introduction

Mathematics, often regarded as one of the most difficult subjects, poses significant challenges for many students. According to (Dowker et al., 2016), many studies over the years have indicated that many people have extremely negative attitudes to mathematics, sometimes amounting to severe anxiety. A considerable number of learners experience mathematics anxiety, a psychological phenomenon characterized by feelings of fear, tension, or apprehension that negatively impact their mathematical performance. This anxiety can lead to avoidance behaviours, reduced self-confidence, and ultimately, poor academic outcomes. While (Luttenberger et al., 2018) studied and showed that math anxiety takes immediate effect in math-related situations such as examinations or in the classroom. With the increasing shift towards online education, there is a growing need for teaching strategies that make mathematics more engaging and less intimidating. Additionally, (Mutodi & Ngirande, 2014) also found that mathematics anxiety is one psychological factor that affects students' achievement and their general

practices. Therefore, facilitators/teachers should strive to understand mathematics anxiety and implement teaching and learning strategies and study habits that can help them overcome anxiety.

In order to reduce the anxiety of mathematics, gamification was approached to transform mathematics into an engaging and enjoyable experience. Gamification can be part of student's educational lives in the years to come(Karamert & Kuyumcu Vardar, 2021). For example, when the facilitators/teachers ask a math question, students do not think about it in relation to society. So, by playing games, students commonly experience mastery, competence, enjoyment, immersion, or flow, all characteristics of intrinsically motivated human behavior. (Udjaja et al., 2018) also stated that gamification is a creative way of learning that has a tremendous power of influence to improve the level of learning independence and improve someone mathematic skills, subsequently expert system is needed to create content from mathematical learning. So, students are more likely to feel the connection between the subject and society. It will also increase student motivation and interest (Sakai & Shiota, 2016). Other than that, gamification and interactive learning are two of these developments that have attracted a lot of attention due to their potential to enhance the learning process, especially in difficult topics like mathematics. (Yiğ & Sezgin, 2021) found that gamification does not intend to provide learning directly, but it has an impact on many other learning variables through motivation, and engagement. Therefore, we can consider the use of gamification to solve the problem. Next, gamification is a dynamic substitute for traditional teaching techniques that uses game-based components including leaderboards, badges, points, and level up challenges. These techniques promote more profound learning and active participation by developing a sense of accomplishment and engagement.

**Examples of Gamification in Mathematics**

1. Reward-Based Learning

   Students receive rewards, such as stars or badges, for solving math problems correctly. Extra points can be given for completing bonus challenges or assisting classmates. A leaderboard can add an element of friendly competition, motivating students to improve.

2. Level Up Challenges

   Mathematical concepts are structured into levels, allowing students to advance as they master each topic. Just like in video games, each stage presents more complex problems, and successfully completing them unlocks new challenges or special rewards.

3. Story-Driven Math Adventures

   Math exercises can be made into an exciting adventure where students take on the roles of heroes and solve puzzles to advance in their quest by using a story line. In a "Math Quest," for example, completing equations could enable players to overcome challenges, solve mysteries, or save a virtual environment.

4. Interactive Digital Math Games

   Online platforms and mobile apps incorporate gamified elements to make learning more engaging. Tools like “Kahoot!” use timed quizzes and instant feedback, while games like “Prodigy” and “Dragon Box” create immersive role-playing experiences where students solve math problems to progress.

5. Real World Simulations

   Learning becomes more meaningful when math is applied to real-world scenarios. For instance, students can take part in a classroom "Math Market," where they purchase and sell goods using virtual cash, or manage a virtual budget for trip planning.

6. Classroom Math Tournament

   By setting up friendly competitions in the classroom, students may work together to solve challenges, which promotes excitement and teamwork.

However, interactive digital math games have gained popularity as an engaging tool for teaching mathematics. Technology in the classroom and exam administration helps retain students, while technology and nontraditional assessments are supported by pedagogy to improve student learning. Furthermore, students have a positive inclination toward participating in learning activities that incorporate technology (Malabayabas et al., 2024). While digital gamification holds promise for enhancing mathematical prowess, addressing diverse learning styles, and ensuring equitable access to technology are essential components for inclusive and effective education (Cai et al., 2024). Additionally, (Rachmiazasi Masduki et al., 2020) studied showed an improvement in performance and this improvement was statistically significant since the students got better achievement in their mathematics understanding by using interactive digital learning. These are some examples of interactive digital games for Mathematics.

**Example of Gamification Applications for Online Learning**

1. GeoGebra

   Figure 1 shows the home screen of GeoGebra. GeoGebra is an interactive geometry, algebra, and calculus tool that enables students to experiment with mathematical concepts through visual representations. It is useful for all levels of mathematics which are from basic geometry to advanced calculus and statistic. It combines geometry, algebra, calculus, statistics, and graphing tools into a single platform, making it an essential resource for both classroom learning and self-study. Additionally, it also allows students to experiment with math concepts dynamically rather than relying on static textbook examples.

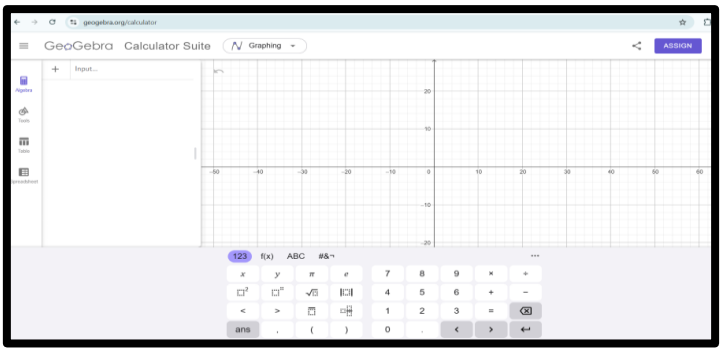


Figure 1: Home screen of Geogebra

2. Google Form & Kahoot!

   Figure 2 shows the home screen of Kahoot!. Kahoot! is a popular game-based learning platform that allows teachers, and students to create and play interactive quizzes, surveys, and discussions. Teachers can create quizzes and polls to check students' understanding in an interactive way and students have to compete by answering multiple- choice questions within a time limit in live mode. Points are awarded based on speed and accuracy, making it exciting and competitive. Indirectly, it may encourage collaboration, engagement, and friendly competition by turning learning into a social and interactive experience.


Figure 2: Home screen of Kahoot!

3. Prodigy Math Game

Figure 3 shows the home screen of Prodigy Math Game. It is a gamified learning platform where students solve math problems to progress in an adventure-based game. Students may explore a fantasy world, battle opponents, and complete quests by solving math problems. It also combines role-playing game (RPG) elements with curriculum-aligned math practice, making it enjoyable for students while reinforcing key mathematical concepts. Besides that, Prodigy Math Game is designed for both classroom learning and home practice, making it a versatile tool for students, teachers, and parents.

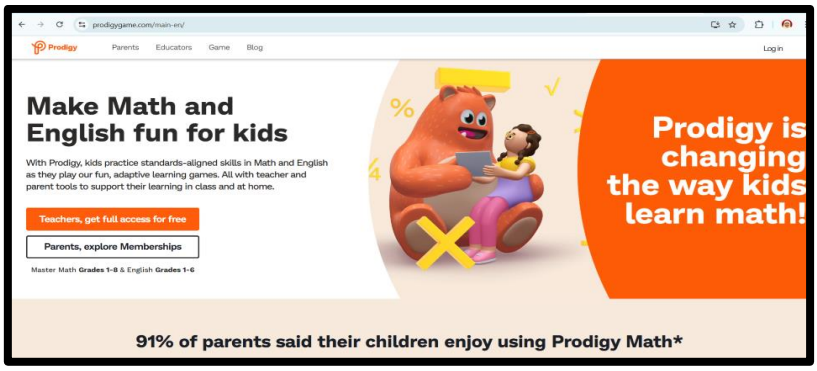


Figure 3: Home screen of Prodigy Math Game

4. Dream Box Learning

Figure 4 shows the home screen of Dream Box Learning. Dream Box Learning is an adaptive math platform that personalizes instruction based on students' responses and progress. The benefits of Dream Box Learning are encouraging independent learning by allowing students to progress at their own pace through interactive, personalized lessons. Other than that, Dream Box Learning provides instant feedback which allowing students to learn from their mistakes in real time.

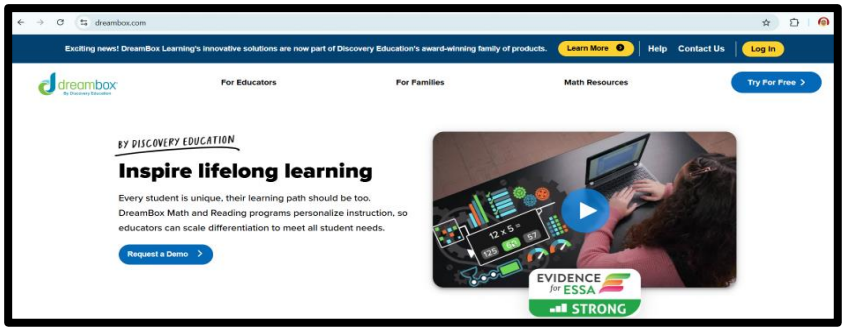


Figure 4: Home screen of Dream Box Learning

5. Quizizz

Figure 5 shows the home screen of Quizizz. Quizizz is an online learning platform that allows teachers and students to create and play interactive quizzes, polls, and lessons in an interesting way. It is a gamified quiz platform where students can answer multiple-choice, fill in the blank, and open-ended math questions at their own pace. The advantages of Quizizz for teachers is its auto-grading and detailed reporting features, which significantly reduce the time and effort required for assessments. When students complete a quiz, Quizizz automatically grades their responses in real time, eliminating the need for manual marking.

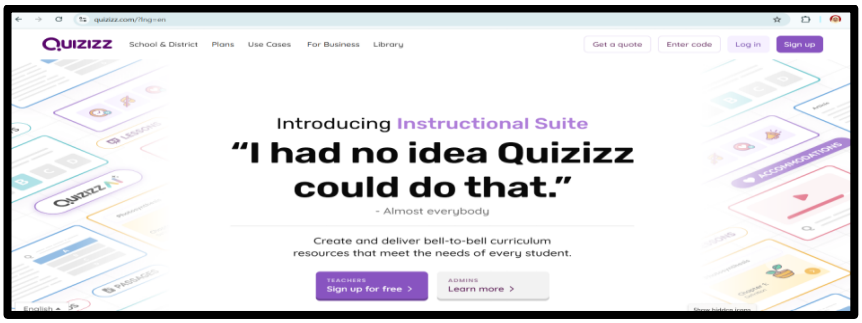


Figure 5: Home screen of Quizizz

6. Dragon Box

Figure 6 shows the home screen of dragon box game. Dragon Box is a series of educational games designed to teach mathematics, particularly algebra, in a fun and engaging way. This gamified with mathematical concepts through engaging, puzzle-like gameplay without initially using numbers or symbols. As players progress, the game slowly introduces numbers and traditional algebra notation, transitioning them to formal algebra seamlessly. The goal is to help students develop a deep understanding of algebraic principles in a way that feels like playing a game rather than studying math.


Figure 6: Home screen of Dragon Box

**Conclusion**

In conclusion, mathematics anxiety remains a significant barrier to students' academic success, often leading to avoidance behaviors and reduced confidence. Thus, the use of the developed gamified instructional materials and activities marked a highly significant difference in the level of academic performance in mathematics. More than that, incorporating gamification and interactive learning can transform mathematics into an engaging and less intimidating subject. Research has shown that gamified learning strategies such as reward-based learning, level-up challenges, and story-driven math adventures enhance motivation, engagement, and overall mathematical proficiency. Interactive digital tools further support these efforts by providing immediate feedback, fostering collaboration, and making learning more dynamic. While digital gamification has a lot of potential which allows students to sustain more interest compared to the non-gamified approach to learning with digital resources but it must be inclusive and accessible to all students. By implementing these innovative strategies, facilitators/teachers can create a more positive and effective learning environment that fosters Mathematical competence and reduces anxiety, ultimately improving student outcomes in Mathematics.

**References:**

Cai, S. J., Yu, J., Li, C., Journal, /, & Derasin, L. M. (2024). The Impact of Digital Gamification And Traditional Based Learning On Students' Mathematics Achievement: Evidence From The Philippines. https://doi.org/10.5281/zenodo.778108

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? In *Frontiers in Psychology* (Vol. 7, Issue APR). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2016.00508

Karamert, Ö., & Kuyumcu Vardar, A. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. *Journal of Educational Technology and Online Learning*, *4*(2), 96–114. https://doi.org/10.31681/jetol.904704

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. In *Psychology Research and Behavior Management* (Vol. 11, pp. 311–322). Dove Medical Press Ltd. https://doi.org/10.2147/PRBM.S141421

Malabayabas, M. E., Yazon, A. D., Tessoro, J. F. B., Manaig, K. A., & Sapin, S. B. (2024). Effectiveness of Mathematics-Gammified Applications for Learners Interactive Numeracy Growth (Math-Galing) in Enhancing the Academic Performance of Grade 11 Learners. *Advanced Journal of STEM Education*, *2*(1), 31–42. https://doi.org/10.31098/ajosed.v2i1.2324

Mutodi, P., & Ngirande, H. (2014). Exploring mathematics anxiety: Mathematics students' experiences. *Mediterranean Journal of Social Sciences*, *5*(1), 283–294. https://doi.org/10.5901/mjss.2014.v5n1p283

Rachmiazasi Masduki, L., Prayitno, E., & Yustina Rensi Dartani, M. (2020). The Implementation Of Interactive Multimedia In Improving Mathematics Learning Outcomes. *11*(2). http://journal.upgris.ac.id/index.php/eternal/index

Sakai, K., & Shiota, S. (2016). A Practical Study of Mathematics Education Using Gamification, 353-354.

Udjaja, Y., Guizot, V. S., & Chandra, N. (2018). Gamification for elementary mathematics learning in Indonesia. *International Journal of Electrical and Computer Engineering*, *8*(5), 3860–3865. https://doi.org/10.11591/ijece.v8i5.pp3860-3865

Yiğ, K. G., & Sezgin, S. (2021). An exploratory holistic analysis of digital gamification in mathematics education. *Journal of Educational Technology and Online Learning*, *4*(2), 115–136. https://doi.org/10.31681/jetol.888096

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# REVOLUTIONIZING EDUCATIONAL CONTENT CREATION WITH CANVA

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**ABSTRACT**

*Canva is a dynamic online design tool that has transformed e-learning by making instructional materials more engaging, accessible, and visually appealing. Its intuitive interface, AI-powered features, and real-time collaboration capabilities enable educators and students to create high-quality lesson plans, presentations, and interactive content. Grounded in multimedia and constructivist learning theories, Canva enhances digital literacy, fosters creativity, and supports active learning. Compared to traditional tools like PowerPoint, Canva offers automation, seamless sharing, and extensive multimedia integration. Recent advancements introduce AI-driven design enhancements, further streamlining content creation. Expanding offline access and subject-specific templates could further strengthen Canva's role in modern education.*

***Keywords: Canva, PowerPoint, digital, presentations, design***

## Introduction

Canva is a powerful online design tool that has transformed e-learning by increasing the visual appeal, accessibility, and engagement of instructional materials. It offers educators and students a user-friendly platform for producing excellent lesson plans, presentations, infographics, and interactive assignments. As digital learning has grown, Canva has emerged as a useful tool for online and blended learning. Through visually appealing tools, it enables instructors to promote collaborative learning, clarify difficult subjects, and increase student participation.

In education, especially in the digital age, interactive learning materials are essential. Piaget's constructivist learning theory states that when students actively contribute to the development of their own understanding, they learn more effectively (Ulya, 2024). According to Rais and Zulfa (2024), teachers can use Canva to make engaging and interactive lesson plans that improve student comprehension and the standard of learning in general. Traditional teaching and learning methods have changed in recent years due to the use of digital resources in education, which has created new chances to improve academic performance and student engagement. Therefore, AI technologies for presentation production have the potential to improve or replace PowerPoint by automating design, generating content, integrating real-time updates, and providing sophisticated data visuals. These tools improve

efficiency by removing manual activities and personalizing presentations (Sarimah Syed Abdullah et al., 2024).

In addition to using books and lectures, educators must also have a range of different learning resources at their disposal and adapt the curriculum and setting for each student. Everyone must understand how technology supports all current activities, especially those in the educational sector (Fitria, 2024). Besides that, Canva is a multimedia program that blends human senses to help students acquire their competences and comprehension (Angriani Nurja et al., 2022). It can be concluded that using the Canva program to create learning media effectively raised students' interest in learning and motivation by presenting instructional content in an interesting manner (Susanti et al., 2024).

**Benefits of Canva in eLearning Tools**

Canva is a modern, cloud-based design tool that provides a user friendly interface, professional templates, and AI-powered tools for producing visually appealing material. Because it can be used to generate visually appealing educational materials, Canva is currently an essential tool in eLearning. Its capabilities let students, teachers, and instructional designers create dynamic and interactive content. The following is a list of some of Canva is a better choice than PowerPoint:

Table 1: The Comparison Between Canva and PowerPoint

| Aspect | Canva | PowerPoint |
|---|---|---|
| **User friendly Interface** | ● Drag and drop design<br>● Pre-aligned, ready to use elements<br>● Quick access to design elements | ● PowerPoint requires manual formatting and alignment. |
| **AI-Powered Features** | ● Magic Design: Auto generates layouts<br>● Magic Write: AI writing assistant<br>● Magic Resize: Instantly adapts designs to different formats<br>● Background remover | ● PowerPoint lacks these integrated AI tools for content creation and resizing. |
| **Real-Time Collaboration** | ● Multiple users can edit simultaneously<br>● Easy sharing via a link<br>● Direct in design comments and feedback | ● PowerPoint files are often shared back and forth, complicating collaboration. |

| | | |
|---|---|---|
| **Multimedia and design elements** | ● Access to millions of stock photos, videos, icons<br>● Ability to add GIFs, animations, and interactive elements<br>● Integrated music and video editing | ● PowerPoint typically requires additional software or plugins for multimedia editing. |

Canva is the best choice for creating quick, visually appealing, and easily designed content. It makes the design process more effective and smooth by providing real-time collaboration and AI-powered tools. Across a range of devices, Canva offers accessibility and simplicity as a contemporary cloud-based solution. PowerPoint is still the preferable option for people that require advanced animations, detailed graphs, and offline accessibility.

**Significance of Canva in e-Learning Tools**

Canva has a big impact on e-learning and is very helpful for education. It enhances digital learning by making content more engaging, interactive, and accessible for both educators and students. Canva is revolutionizing e-learning for the following reasons:

Table 2: Significant Canva in e-Learning Tools

| Significant | Detail |
|---|---|
| Easy to use and time saving | Educators can quickly create professional-quality lesson materials using pre-made templates, without needing advanced design skills. |
| Encourages digital literacy and creativity | Students develop design thinking, storytelling, and presentation skills while expressing ideas creatively. |
| Accessible and economical | Canva for education is free, cloud-based, and works on any device, ensuring accessibility for all students and educators. |
| Enhancing visual learning and engagement | Canva makes learning materials visually appealing and easier to understand with infographics, posters, and animations. |
| Supports active and collaborative learning | Canva allows real-time collaboration, enabling students to work together on projects, study guides, and digital storytelling. |
| Integration with LMS platforms | Works seamlessly with Google Classroom, Microsoft Teams, and Moodle, allowing easy sharing of resources. |

Canva makes education more accessible, collaborative, and engaging, which greatly improves e-learning. It helps educators save time by providing ready-made templates and design tools, allowing them to create visually appealing educational materials efficiently. Furthermore, Canva encourages students' creativity by giving them the ability to create infographics, presentations, and other educational resources. Moreover, its use in the classroom supports the development of digital literacy skills, preparing students for a technology-driven world.

**New features in Canva**

Canva has introduced several innovative features to enhance user experience and expand its design capabilities. The best Canva features that can improve your design work are listed here.

Table 3: New Features in Canva

| Feature | Description |
|---|---|
| Magic Design | Generates layout options based on text prompts or images for instant inspiration. |
| Magic Edit | Enables selective modifications within images without affecting the entire design. |
| Magic Eraser | Removes unwanted objects from images seamlessly. |
| Magic Grab | Allows repositioning of subjects within images for greater flexibility. |
| Magic Expand | Expands image borders intelligently while maintaining quality. |
| Magic Animate | Simplifies adding animations to design elements. |
| Magic Morph | Applies creative effects to text and shapes. |
| Magic Media | Generates images or videos from textual descriptions. |
| Magic Write | Assists in generating written content. |
| Magic Animate | Simplifies adding animations to design elements. |
| Magic Morph | Applies creative effects to text and shapes. |
| Magic Media | Generates images or videos from textual descriptions. |
| Magic Write | Assists in generating written content. |
| Analog Meets AI | Merges traditional analog techniques with digital innovation. |
| Shape Theory | Uses bold shapes and warm colors in a modular style. |
| Opulence Era | Combines minimalist aesthetics with luxurious details. |
| Serious Fun | Adds elements of fun and joy to professional designs. |
| Future in Motion | Introduces motion elements to enhance rhythm and flow. |

Educators may easily create a cover page and show content using Canva's templates, which can be customized with instructional materials used in offline learning.

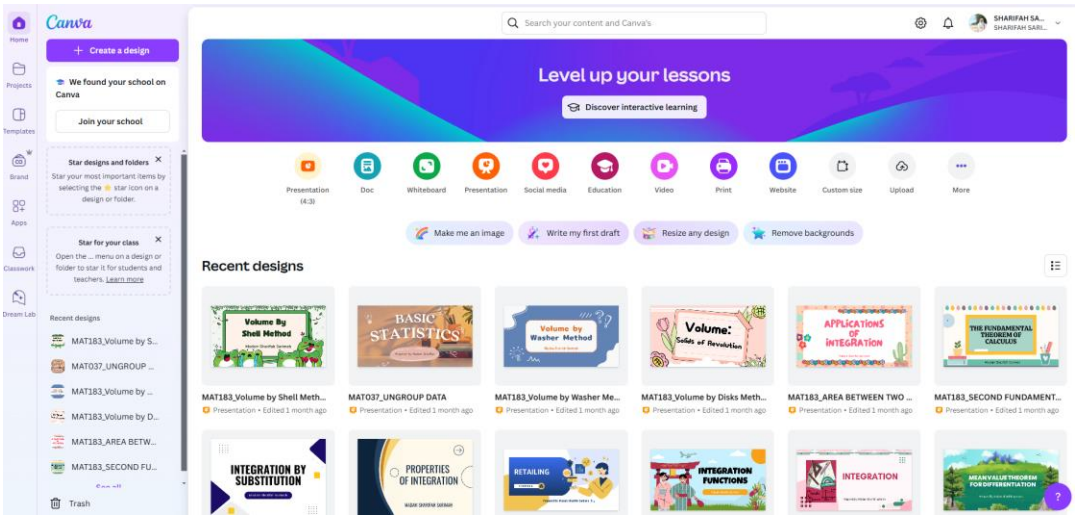


Figure 1: Canva Interface

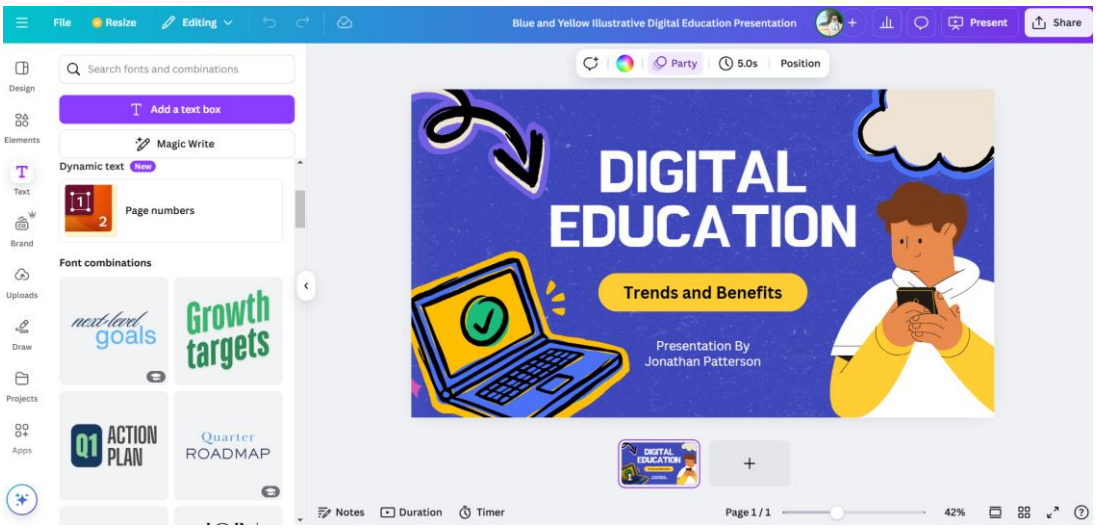


Figure 2: New Features in Canva

## Conclusion

Canva is a really helpful e-learning tool that provides learning possibilities that are easy to access, engaging, and collaborative. Despite some challenges, its integration into instructional strategies enhances student motivation, digital literacy, and instructional efficacy. Canva transforms traditional teaching methods into interactive digital learning experiences. It helps educators save time, allows students to express their creativity, and makes lessons more dynamic and visually appealing.

To maximize the benefits of Canva in education, several improvements should be considered. University should incorporate Canva training into educator professional development programs to enhance educators' digital skills and confidence in using the platform. Additionally, combining Canva with traditional teaching methods can create a more effective blended learning approach, ensuring a balanced integration of digital and conventional learning strategies.

Furthermore, expanding Canva's offline functionality would improve accessibility for students and educators in underprivileged areas with limited internet access. Lastly, developing more subject-specific templates and incorporating AI-driven customization can enhance Canva's adaptability across various academic disciplines, making it a more versatile tool for education.

**References**

Angriani Nurja, N., Fatin Kassiran, N., Thu, T., & Ying, P. (2022). The use of Canva as learning medium of MPU12012 Entrepreneurship. *Borneo Engineering & Advanced Multidisciplinary International Journal (BEAM), 1*(1), 22-27. https://beam.pmu.edu.my

Fitria, T. N. (2024). Using Canva in creating and designing e-Module for english language teaching. *SAGA: Journal of English Language Teaching and Applied Linguistics*, *5*(2), 111–122. https://doi.org/10.21460/saga.2024.52.194

Rais, R., & Zulfa, I. (2024). The influence of the Canva application in improving primary school student achievement in West Sumatra. *Journal of Social Science Utilizing Technology, 2*(1), 362–374. https://doi.org/10.55849/jssut.v2i1.813

Sarimah Syed Abdullah, S., Norsyiha Ahmad Shukri, F., Omar, M., Samsudin, N., & Sains Komputer, J. (2024). Evolving presentation dynamics: The synergy of PowerPoint and AI-powered tools. 28-34. https://appspenang.uitm.edu.my/sigcs/

Susanti, D. A., Dewi Purwitasari, E., & Sultonurohmah, N. (2024). The effectiveness of using Canva application as a science learning media in elementary schools. *BASICA Journal of Primary Education,4*(2), 89-100. https://doi.org/10.37680/basica.v4i2.6393

Ulya, Z. (2024). Penerapan teori konstruktivisme menurut jean piaget dan teori neuroscience dalam pendidikan. *Al-Mudarris : Journal Of Education, 7*(1), 12–23.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac- 2025*

# CORRELATION BETWEEN FORMATIVE ASSESSMENTS AND FINAL EXAMINATION PERFORMANCE IN A STATISTICS COURSE

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**ABSTRACT**

*This study investigates the correlation between formative assessments and final examination performance in a statistics course. The assessments include quizzes, tests, and group assignments, with the final exam serving as the dependent variable. A Pearson correlation analysis was conducted on a sample of 26 students. The findings reveal that Group Assignment has the highest correlation with the Final Exam ($r = 0.597$, $p < 0.05$), followed by Test ($r = 0.554$, $p < 0.05$), while Quiz shows no significant correlation ($r = 0.345$, $p = 0.085$ ($p > 0.05$)). Although Group Assignment exhibits the strongest correlation, its group-based nature may not accurately reflect individual student performance. In contrast, Test, conducted individually, emerges as a more reliable predictor of final exam outcomes despite its slightly lower correlation. Descriptive statistics indicate that Group Assignment has the highest mean score (84.885) while Quiz has the highest variability (SD = 17.6947). These results highlight the importance of considering assessment structure when evaluating student performance. The study provides insights for educators on optimizing formative assessments to enhance students' preparedness for summative evaluations.*

***Keywords: formative assessment, final examination, correlation, statistics, performance***

## Introduction

Assessment plays a crucial role in evaluating student learning and predicting academic success. Formative assessments, such as quizzes, tests, and group assignments, are designed to provide feedback and improve learning outcomes before the final summative assessment. However, the extent to which these formative assessments correlate with final exam performance remains an essential question in educational research. This study aims to examine the relationships between different formative assessment components and final exam performance in a statistics course. Educators can make informed decisions on assessment design to improve student learning by identifying which assessment types best predict final exam outcomes. In higher education, assessments serve not only as tools for measuring academic achievement but also as instruments for reinforcing learning. Studies have shown that well-structured formative assessments help students engage more actively with the course material and develop critical thinking skills. Quizzes, for example, are often used as low-stakes assessments to encourage regular revision and self-evaluation. Tests, on the other hand, provide a more comprehensive evaluation of students' understanding of key concepts, while group assignments foster collaboration and

application of knowledge to real-world problems. Despite their intended benefits, different types of formative assessments may impact student performance in varying ways. Quizzes may primarily assess short-term memory rather than deep understanding, while group assignments might not accurately reflect individual competency due to the collaborative nature of the task. In contrast, individually administered tests may serve as a better indicator of a student's grasp of the subject matter. Understanding the correlation between these assessments and final exam performance can help educators refine their instructional strategies and optimize assessment practices for better student outcomes. Moreover, the effectiveness of formative assessments in predicting final exam performance may depend on factors such as student motivation, study habits, and the alignment between assessment content and exam questions. This study seeks to bridge this gap by examining the correlation between different types of formative assessments and final examination scores, providing valuable insights for curriculum developers and educators looking to enhance student achievement through strategic assessment design.

Recent studies have explored the relationship between formative assessments and final exam performance in statistics courses. Morales et al. (2022) found that while passing or failing the final exam could be predicted using continuous assessment performance, precise grade forecasting was not possible. King (2023) reported a significant correlation between online formative assessment usage and exam performance in accounting. Kim et al. (2022) discovered that homework and in-class assignments predicted midterm exam grades, while homework and midterm exams predicted final exam performance in psychology courses. These studies highlight the potential of formative assessments in predicting and improving student performance, while also emphasizing the need for further research on their effectiveness across different disciplines and institutions. While some research indicates a moderate positive correlation between continuous assessment and final scores (Mgejwa, 2023), others suggest that precise grade prediction is challenging (María Morales et al., 2022). Factors such as assessment plan effectiveness may influence this correlation (Mgejwa, 2023). A model incorporating continuous assessment practices, teaching effectiveness, and students' personal studies has shown significant predictive strength for final grades (Agbonkpolo et al., 2020). Myombe & Mushi (2022) found strong positive correlations between CA scores and national exam results in Tanzania for multiple subjects, including biology, chemistry, physics, mathematics, and English. These findings emphasize the importance of continuous assessment in the learning process and its potential for predicting overall academic performance. However, the strength of this relationship may vary across different educational levels and subjects. Further research is needed to fully understand the complex interplay between continuous assessment and final exam outcomes across diverse educational settings.

Another research has explored the correlation between group assignments and final exam marks in higher education. A 2020 study of medical students found a moderate positive correlation (r=0.366) between peer assessment scores for group projects and final exam marks (Jamalludin Ab Rahman et al., 2020). However, earlier studies have shown mixed results. One study found no significant correlation between group and individual assessment marks (Plastow et al., 2010), while another reported varying correlations across different subjects, ranging from -0.033 to 0.228 (Adeeb et al., 2007). The use of peer assessment in group work has been investigated, with findings suggesting students take the process seriously and differentiate between group members' contributions (Johnston & Miles, 2004). These studies highlight the complexity of assessing group work and its relationship to individual performance, emphasizing the need for careful consideration when incorporating group assessments into overall grading schemes. Given the varying findings on the relationship between formative assessments and final exam performance, this study aims to contribute further insights into this area, specifically within the context of a statistics course. By analyzing the correlation between quizzes, tests, and group assignments with final exam scores, this research seeks to provide a clearer understanding of how different assessment components influence student achievement. The findings will not only inform educators on the effectiveness of their assessment strategies but also guide curriculum developers in designing assessment structures that better support student learning and success.

**Methodology**

This study employed a quantitative research design using Pearson correlation analysis to determine the relationship between formative assessments and final exam performance. Correlation analysis was chosen to measure the strength and direction of the relationships between different formative assessments and final examination scores. The sample consisted of 26 students enrolled in a statistics course. As this study is based on a case study approach, the sample size is limited to a single group of students from one class. The independent variables were scores from quizzes, tests, and group assignments, while the final exam score served as the dependent variable. Data were analyzed using SPSS software to determine correlation coefficients and statistical significance.

Figure 1 shows the bar chart of mean for Final Exam, Quiz, Test and Group Assignment. Descriptive statistics were computed to summarize student performance across different assessments. The results indicate that the mean score for the final exam was 72.962 (SD = 10.8027), while the coursework mean was 39.023 (SD = 4.9187). Among the formative assessments, Group Assignment had the highest mean score (84.885, SD = 9.1097), whereas Quiz exhibited the highest variability (SD = 17.6947), suggesting inconsistencies in student performance. These descriptive insights provide a

clearer understanding of student achievement across different assessment types, supporting the correlation analysis findings.

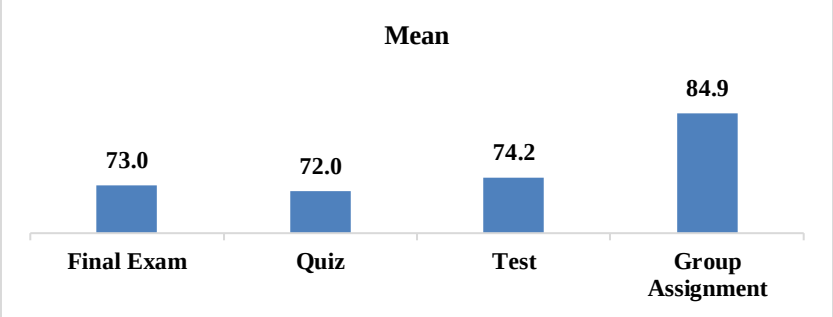


Figure 1: Mean for Each Assessment

**Analysis and Findings**

The correlation analysis reveals interesting insights into the relationship between formative assessments and final examination performance. Based on Table 1, the Pearson correlation results indicate that Group Assignment has the highest correlation with the Final Exam ($r = 0.597$, $p < 0.05$), followed by Test ($r = 0.554$, $p < 0.05$). Quiz, however, does not show a significant correlation with Final Exam performance ($r = 0.345$, $p = 0.085$ ($p > 0.05$)).

Table 1: Correlation Between Formative Assessments and Final Exam Scores

| | | Final_Exam | Quiz | Test | Group_Assignment |
|---|---|---|---|---|---|
| Final_Exam | Pearson Correlation | 1 | .345 | .554** | .597** |
| | Sig. (2-tailed) | | .085 | .003 | .001 |
| | N | 26 | 26 | 26 | 26 |
| Quiz | Pearson Correlation | .345 | 1 | .309 | .134 |
| | Sig. (2-tailed) | .085 | | .125 | .513 |
| | N | 26 | 26 | 26 | 26 |
| Test | Pearson Correlation | .554** | .309 | 1 | .437* |
| | Sig. (2-tailed) | .003 | .125 | | .026 |
| | N | 26 | 26 | 26 | 26 |
| Group_Assignment | Pearson Correlation | .597** | .134 | .437* | 1 |
| | Sig. (2-tailed) | .001 | .513 | .026 | |
| | N | 26 | 26 | 26 | 26 |

Although Group Assignment has the highest correlation, it is important to consider the nature of this assessment. Since it is completed in groups, students may benefit from peer contributions, which could inflate their individual scores. Collaboration in group assignments may help students reinforce their understanding, but it does not necessarily reflect their independent knowledge and exam readiness. On the other hand, Test is conducted individually, making it a more reliable indicator of a student's true understanding of the subject. Despite its slightly lower correlation than Group Assignment, Test remains a more relevant predictor of Final Exam performance as it assesses individual competency without external influences. Furthermore, Quiz exhibits the weakest correlation and is not statistically significant. One possible explanation for this is the content alignment between quizzes and the final exam. While quizzes covered Binomial, Poisson, Normal Distribution, and Sampling Distribution, only Normal Distribution and Sampling Distribution were tested in the final exam. The inclusion of topics not assessed in the final exam may have diluted the predictive power of quiz scores, explaining the weaker correlation observed.

In summary, while Group Assignment shows the strongest correlation with Final Exam, Test is a more meaningful predictor of student performance due to its individual nature. Additionally, the lower correlation of quizzes suggests that topic alignment between formative and summative assessments plays a critical role in determining their effectiveness as predictors of final exam performance. These findings highlight the importance of structuring formative assessments to accurately reflect students' knowledge and preparedness for summative evaluations.

**Conclusion**

This study examined the correlation between formative assessments and final exam performance in a statistics course. The results indicate that while Group Assignment has the highest correlation with final exam scores, Test serves as a more reliable predictor of individual performance. The findings suggest that assessment structure plays a crucial role in evaluating student learning. Educators should consider designing formative assessments that better align with summative assessments to enhance student preparedness. Future research could explore additional variables, such as student engagement and learning strategies, to further understand the factors influencing academic performance.

**References:**

Adeeb, M. A., Gujjar, A. A., & Malık, M. A. (2007). Correlation between marks obtained by students in assignments and final examination of master of education conducted by Allama Iqbal Open University. *Turkish Online Journal of Distance Education*, *8*(2), 120-126.

Agbonkpolo, M. U., Mamah, T. I., & Oyamendan, B. (2020). Predicting students' final grades for regulating the supervision of academic activities: A model of continuous assessment practices,

teaching effectiveness and students' personal studies. *Asian Journal of Assessment in Teaching and Learning*, *10*(1), 51-58.

Jamalludin, A. R., Razman, M. R., & Niza, S. (2016). Correlation between peer assessment score and final examination mark among IIUM first year medical students. *IIUM Medical Journal Malaysia*, *15*(2).

Johnston*, L., & Miles, L. (2004). Assessing contributions to group assignments. *Assessment & evaluation in higher education*, *29*(6), 751-768.

Kim, A. S., Stevenson, C. R., & Park, L. (2022). Homework, in-class assignments, and midterm exams: Investigating the predictive utility of formative and summative assessments for academic success. *Open Scholarship of Teaching and Learning*, *2*(1), 92-102.

King, D. (2023). Assessing the benefits of online formative assessments on student performance. *Journal of learning development in higher education*, (27).

Mgejwa, J. S. (2023). Correlation Between Continuous Assessment in Accountancy Modules and Students' Academic Performance in Higher Learning Institutions: The Case of Institute of Accountancy Arusha in Tanzania. *The Accountancy and Business Review*, *15*(3), 65-76.

Morales, M., Salmerón, A., Maldonado, A. D., Masegosa, A. R., & Rumí, R. (2022). An empirical analysis of the impact of continuous assessment on the final exam mark. *Mathematics*, *10*(21), 3994.

Myombe, G. L., & Mushi, P. S. (2022). The correlation between continuous assessment scores and national form four examination results in Tanzania: A Case Study of Morogoro Municipality. *East African Journal of Education Studies*, *5*(2), 455-465.

Plastow, N., Spiliotopoulou, G., & Prior, S. (2010). Group assessment at first year and final degree level: A comparative evaluation. *Innovations in Education and Teaching International*, *47*(4), 393-403.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# CLUSTER SAMPLING IN EDUCATIONAL RESEARCH: A PRACTICAL APPROACH

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**ABSTRACT**

*Cluster sampling is a widely employed probability sampling technique in educational research, particularly useful for large-scale studies where logistical and financial constraints limit the feasibility of simple random sampling. This method involves selecting entire clusters, such as schools, classrooms, or districts, rather than individual participants, making it ideal for educational settings with naturally occurring group structures. By streamlining data collection processes, cluster sampling enhances efficiency while ensuring representative sampling within a defined population. This paper explores the concept, significance, and practical application of cluster sampling in educational research. It discusses its advantages and limitations and provides an extensive review of empirical studies that have successfully applied this technique. Furthermore, it outlines the procedural steps required for effective implementation, ensuring methodological rigor and minimizing bias. The discussion highlights how cluster sampling has facilitated large-scale educational assessments, policy evaluations, and pedagogical research, reinforcing its value as a methodological tool in contemporary educational research.*

***Keywords: cluster sampling, educational research, sampling method, statistical analysis***

## Introduction

Educational research often requires the collection and analysis of data from large and diverse populations. However, obtaining data from every individual in a target population can be prohibitively expensive and time-consuming, particularly when research spans multiple institutions, regions, or even countries. Traditional sampling methods, such as simple random sampling, can become impractical when dealing with educational settings where individuals naturally exist within groups, such as schools, classrooms, or districts.

In such contexts, cluster sampling provides an efficient and cost-effective alternative by selecting entire groups, or clusters, for study instead of sampling individuals independently. This approach reduces logistical constraints while maintaining the representativeness of the sample. By leveraging naturally occurring clusters, researchers can efficiently collect data across large populations without compromising statistical integrity. This paper delves into the theoretical underpinnings of cluster sampling, its applications in educational research, and the methodological steps required for its effective implementation.

**Understanding Cluster Sampling**

Cluster sampling is a probability sampling technique where a population is divided into distinct clusters, and entire clusters are randomly selected for inclusion in a study. Each cluster should ideally represent the broader population to ensure generalizability. Unlike stratified sampling, which involves selecting individual elements from each subgroup, cluster sampling simplifies the selection process by treating whole groups as units of analysis.

There are two main types of cluster sampling: single-stage and multi-stage sampling. In single-stage cluster sampling, all individuals within selected clusters are included in the study. In contrast, multi-stage cluster sampling involves additional randomization within selected clusters, further refining the sample to enhance representativeness. The choice between these approaches depends on study objectives, resource availability, and population heterogeneity. Despite its efficiency, cluster sampling introduces potential challenges such as intra-cluster correlation, where similarities among individuals within a cluster can reduce statistical precision. However, with appropriate design considerations, these limitations can be mitigated, making cluster sampling a robust tool for educational research (Lohr, 2021).

**Application of Cluster Sampling in Educational Research**

Cluster sampling has been extensively applied in educational research, particularly in large-scale assessments, policy evaluations, and pedagogical studies. By using naturally occurring groups, such as schools and classrooms, researchers can conduct large-scale studies more efficiently while maintaining statistical validity. Below, we explore how cluster sampling has been applied in key research studies, demonstrating its practical utility and methodological rigor in educational research.

One of the most prominent examples of cluster sampling in educational research is the Programme for International Student Assessment (PISA), an international large-scale educational survey conducted by the Organisation for Economic Co-operation and Development (OECD, 2019). PISA assesses the knowledge and skills of 15-year-old students across various countries in subjects such as reading, mathematics, and science. PISA employs a two-stage cluster sampling approach. In the first stage, a sample of schools is randomly selected from each participating country, ensuring a diverse and representative selection of institutions that reflect regional and socioeconomic variations. In the second stage, a random sample of students within each selected school is drawn. This method allows researchers to make cross-national comparisons without the logistical burden of individually sampling students from an entire national population.

The use of cluster sampling in PISA ensures cost efficiency and operational feasibility in global educational assessments. However, it also requires careful statistical adjustments, such as weighting techniques, to account for intra-cluster correlation, ensuring that results accurately reflect the national

and international student populations. The findings from PISA have informed educational policies worldwide, shaping curriculum development, teaching strategies, and funding allocations in numerous countries.

The National Assessment of Educational Progress (NAEP), often referred to as the "Nation's Report Card," is another large-scale educational study that relies on cluster sampling. NAEP assesses the academic proficiency of students in the United States in subjects such as mathematics, reading, and science (NCES, 2021). Similar to PISA, NAEP uses a multi-stage cluster sampling design. In the first stage, schools are selected as primary clusters based on stratification criteria such as geographical location, school size, and student demographics. In the second stage, students within selected schools are randomly chosen to participate in the assessment. The cluster sampling approach allows NAEP to maintain a nationally representative sample without testing every student in the country. This method reduces data collection costs while providing accurate estimates of student achievement trends over time. NAEP results are used by policymakers, educators, and researchers to evaluate the effectiveness of educational reforms, track achievement gaps, and guide policy decisions at the federal and state levels.

The Trends in International Mathematics and Science Study (TIMSS) is another major international educational assessment that relies on cluster sampling. TIMSS measures the mathematics and science proficiency of fourth- and eighth-grade students across multiple countries (Mullis et al., 2019). TIMSS employs a two-stage cluster sampling process similar to PISA. In the first stage, schools are randomly selected within each country, ensuring diversity in terms of location, funding levels, and student backgrounds. In the second stage, entire classrooms within the selected schools are chosen, rather than individual students. This means that all students within a selected classroom participate in the assessment.

By clustering students within classrooms, TIMSS reduces logistical challenges and standardizes testing conditions, making administration more efficient. The results from TIMSS are widely used by governments and international organizations to compare educational performance globally, develop curriculum improvements, and inform teacher training programs.

A study by Gustafsson (2007) investigated school effectiveness in Sweden using cluster sampling. The research aimed to explore the impact of school-level characteristics on student achievement and educational outcomes. In this study, schools were chosen as the primary clusters, ensuring that data collection captured variations in teaching practices, administrative support, and student demographics. By selecting entire schools rather than individual students, the study was able to examine how institutional factors, such as teacher-student ratios and school funding, influenced academic performance. The findings provided valuable insights into the role of school environments in shaping student success. The study also demonstrated how cluster sampling can be used to assess

school-level differences in educational effectiveness, guiding policymakers in resource allocation and educational planning.

A study by Dunn et al. (2019) examined how class size affects student performance in Canadian primary schools. This study utilized classrooms as the cluster units, allowing researchers to compare different teaching conditions across multiple schools. By randomly selecting classrooms within various schools, the study ensured that differences in instructional methods, student-teacher interactions, and peer effects were systematically captured. The cluster sampling approach was particularly beneficial because it accounted for the fact that students in the same classroom share common educational experiences. Findings from this study contributed to ongoing debates on optimal class sizes, informing school district policies regarding teacher assignments, classroom resources, and curriculum adaptations.

Cluster sampling has also been used to evaluate the effectiveness of teacher training programs. A study by Goldhaber et al. (2020) examined the impact of professional development programs on teaching effectiveness by selecting entire school districts as clusters. In this research, rather than sampling individual teachers, entire districts were chosen, ensuring that variations in district-level training policies, resource availability, and administrative support were captured. The study compared districts that implemented intensive professional development programs with those that did not, analyzing the effects on student learning outcomes. The results provided crucial evidence on the importance of continuous professional development for educators, influencing teacher training policies at both state and national levels.

A study by Fryer (2014) evaluated the impact of merit pay systems on teacher performance and student achievement in the United States. The research used cluster sampling by selecting entire schools that implemented merit pay policies and comparing them to randomly selected control schools. By analyzing full schools rather than individual teachers, the study ensured that findings reflected the broader institutional impact of merit-based compensation, rather than just individual teacher responses. The study found mixed results, with some schools benefiting from merit pay while others showed no significant changes in student outcomes. The findings contributed to the broader discussion on performance-based incentives in education, shaping future policy decisions.

Longitudinal studies in education also benefit from cluster sampling. The Early Childhood Longitudinal Study (ECLS), conducted by the U.S. Department of Education, follows cohorts of students from early childhood through secondary school to track their academic and social development (NCES, 2021). ECLS uses schools as clusters, allowing researchers to follow students within structured learning environments while minimizing attrition rates. The use of cluster sampling in ECLS enables researchers to analyze long-term trends in student development, helping shape early childhood education policies and interventions.

**Process of Sampling Using Cluster Sampling**

The implementation of cluster sampling in educational research follows a structured process to ensure methodological rigor and representativeness. The first step involves defining the target population and identifying natural clusters within it. In educational settings, these clusters often include schools, classrooms, or districts. Once the clusters are established, researchers develop a sampling frame and determine the sampling approach—whether single-stage or multi-stage cluster sampling.

In single-stage cluster sampling, researchers randomly select a subset of clusters and include all individuals within them. This approach is particularly useful when intra-cluster variability is high, ensuring a diverse representation of the population. In multi-stage cluster sampling, an additional layer of randomization occurs within selected clusters, further refining the sample. For instance, after selecting schools as primary clusters, researchers may randomly select specific classrooms or grade levels within those schools to participate in the study.

Following the selection of clusters, researchers conduct data collection while ensuring adherence to ethical considerations, such as obtaining informed consent from participants and maintaining data confidentiality. Statistical adjustments, such as weighting techniques, are often applied during data analysis to account for clustering effects and enhance the accuracy of population-level inferences. Proper methodological execution ensures that findings remain valid and generalizable despite the inherent clustering of the sample.

**Conclusion**

Cluster sampling remains a fundamental methodological tool in educational research, enabling the efficient collection of large-scale, representative data. Its application in studies such as PISA, NAEP, TIMSS, and longitudinal research highlights its effectiveness in large-scale assessments. Moreover, school effectiveness research, class size studies, teacher training evaluations, and policy analysis further demonstrate its versatility in addressing key educational questions. While challenges such as intra-cluster correlation exist, careful study design and statistical adjustments help mitigate these issues. As educational research continues to evolve, cluster sampling remains an essential approach for conducting rigorous, policy-relevant, and impactful studies that contribute to the advancement of education worldwide.

**References:**

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

Goldstein, H. (2011). *Multilevel statistical models* (4th ed.). Wiley. Retrieved from https://onlinelibrary.wiley.com/doi/book/10.1002/9780470973394

Graham, S., Harris, K. R., & Mason, L. H. (2014). *Improving writing in the disciplines: A research synthesis*. Educational Psychology Review, 26(1), 1-21. https://doi.org/10.1007/s10648-013-9238-5

Hox, J. J. (2010). *Multilevel analysis: Techniques and applications* (2nd ed.). Routledge. Retrieved from https://www.taylorandfrancis.com/books/mono/10.4324/9780203852279/multilevel-analysis-joop-hox-mirjam-moerbeek-rens-van-de-schoot

Keele, L., & Zubizarreta, J. R. (2017). *Assessing the impact of new curricular approaches through cluster sampling*. Educational Research Quarterly, 40(2), 13-26.

Leithwood, K., Seashore Louis, K., Anderson, S., & Wahlstrom, K. (2004). *How leadership influences student learning*. Center for Applied Research and Educational Improvement, University of Minnesota. Retrieved from https://eric.ed.gov/?id=ED485932

Levy, P. S., & Lemeshow, S. (2013). *Sampling of populations: Methods and applications* (4th ed.). Wiley.

Lohr, S. L. (2019). *Sampling: Design and analysis* (2nd ed.). Chapman and Hall/CRC.

OECD. (2018). *The survey of adult skills: Reader's companion (2nd ed.)*. OECD Publishing. https://doi.org/10.1787/9789264307273-en

Selwyn, N. (2011). *Education and technology: Key issues and debates*. Continuum. Retrieved from https://www.accordance.com

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). Sage Publications.

Thompson, S. K. (2012). *Sampling* (3rd ed.). Wiley. Retrieved from https://www.wiley.com/en-us/Sampling%2C%2B3rd%2BEdition-p-9781118162934

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# FAKTOR-FAKTOR PELAJAR LEMAH DALAM ASAS ALGEBRA

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**ABSTRAK**

*Asas algebra adalah perkara penting dalam matematik, tetapi ramai pelajar menghadapi kesukaran untuk menguasainya, terutama apabila mereka melangkah ke alam universiti. Kajian ini bertujuan untuk mencari faktor utama mengapa pelajar lemah dalam asas algebra sejak di peringkat sekolah menengah. Beberapa faktor yang dikenal pasti termasuk cara pengajaran yang lebih menekankan hafalan daripada pemahaman, kurangnya latihan berterusan, dan kurangnya kaitan algebra dengan kehidupan seharian. Selain itu, tekanan akademik di sekolah dan perubahan topik yang cepat juga boleh menyebabkan pelajar sukar untuk menguasai algebra. Kekurangan penguasaan asas algebra ini memberi kesan kepada pembelajaran matematik di universiti, kerana pelajar sukar mengikuti topik yang lebih rumit. Oleh yang demikian, kaedah pengajaran perlu diperbaiki dengan memberi lebih banyak latihan praktikal dan sokongan tambahan kepada pelajar supaya mereka dapat menguasai asas algebra dengan lebih baik.*

***Katakunci: algebra, pembelajaran, teknik, pemahaman.***

## Pengenalan

Matematik adalah subjek yang memainkan peranan penting dalam pendidikan, dan salah satu komponen utama dalam pengajaran matematik adalah algebra. Asas algebra yang kukuh di peringkat sekolah menengah adalah penting untuk memastikan pelajar dapat menguasai konsep matematik yang lebih kompleks di peringkat universiti. Walau bagaimanapun, ramai pelajar menghadapi kesukaran dalam memahami dan menguasai asas algebra, yang akhirnya memberi kesan kepada pencapaian mereka dalam subjek matematik lanjutan. Kajian ini bertujuan untuk menyelidik faktor-faktor utama yang menyebabkan pelajar lemah dalam asas algebra sejak di peringkat sekolah menengah.

Li & Wang (2021) mengkaji bagaimana pengajaran berfokuskan pemahaman konsep algebra berbanding penghafalan prosedur memberikan kesan yang lebih baik terhadap penguasaan algebra pelajar di peringkat menengah. Kajian ini mendapati bahawa apabila pelajar didedahkan dengan cara pengajaran yang menekankan pemahaman, mereka lebih mudah memahami dan mengaplikasikan konsep-konsep asas algebra.

Menurut Ahmed & Ali (2022), faktor-faktor utama yang menyumbang kepada kesukaran pelajar dalam memahami algebra, termasuk kurangnya pemahaman tentang prinsip asas seperti persamaan linear dan manipulasi algebra. Kajian ini mencadangkan kaedah pembelajaran yang lebih praktikal untuk mengatasi masalah ini.

Patel & Verma (2021) pula menyatakan bahawa keberkesanan penggunaan alat teknologi seperti aplikasi pembelajaran interaktif untuk meningkatkan penguasaan pelajar dalam algebra. Dapatan kajian menunjukkan bahawa penggunaan aplikasi seperti GeoGebra dan alat pembelajaran dalam talian dapat membantu pelajar lebih memahami konsep algebra dengan lebih baik.

Pendekatan pembelajaran berasaskan masalah juga dapat membantu pelajar memperkukuhkan penguasaan asas algebra pelajar. Kajian dari Wang & Zhang (2023) ini menunjukkan bahawa apabila pelajar diberi masalah dunia nyata yang melibatkan algebra, mereka dapat melihat relevannya dan aplikasi algebra dalam kehidupan seharian, yang seterusnya meningkatkan minat dan pemahaman mereka terhadap subjek tersebut. Menurut Hasan et al. (2020), pengajaran algebra yang tidak mengaitkan konsep dengan situasi kehidupan sebenar menyebabkan pelajar sukar menguasai konsep tersebut. Kajian ini mencadangkan agar pengajaran algebra mengaitkan lebih banyak contoh situasi dunia nyata yang relevan dengan pelajar untuk meningkatkan kefahaman mereka.

Kumar & Sharma (2021) pula mengkaji sebab-sebab mengapa pelajar sering mengalami kesulitan dalam menyelesaikan ungkapan algebra, seperti menyelesaikan persamaan atau kembangan ungkapan algebra. Kajian ini menunjukkan bahawa masalah kognitif seperti kegagalan memahami langkah-langkah penyelesaian adalah antara punca utama yang menyebabkan kelemahan pelajar dalam algebra.

Selain itu, menurut Zhang & Liu (2021) pendekatan pembelajaran kolaboratif dijadikan satu cara untuk membantu pelajar menguasai algebra dengan lebih baik. Apabila pelajar belajar dalam kumpulan untuk menyelesaikan masalah algebra, mereka lebih cenderung untuk bertukar idea dan membincangkan konsep dengan lebih mendalam yang boleh membantu memperkuat pemahaman mereka.

Lee & Cho (2022) menyatakan bahawa keberkesanan model pengajaran yang menggabungkan aktiviti pembelajaran aktif seperti permainan matematik dan simulasi untuk meningkatkan penguasaan pelajar dalam algebra. Hasil kajian menunjukkan bahawa pelajar yang terlibat dalam pembelajaran aktif cenderung lebih baik dalam memahami dan mengaplikasikan konsep-konsep algebra berbanding pelajar yang hanya terlibat dalam pengajaran tradisional.

**Faktor-faktor Utama Pelajar Lemah dalam Asas Algebra**

Isu pelajar lemah dalam asas algebra bukanlah perkara baru, dan ia menjadi semakin ketara apabila pelajar melangkah ke peringkat universiti di mana konsep-konsep matematik yang lebih mendalam, seperti kalkulus dan statistik, memerlukan penguasaan asas algebra yang lebih kukuh. Berikut adalah beberapa faktor utama pelajar lemah dalam asas algebra yang telah dikenalpasti dari kajian ini.

**Pendekatan Pengajaran yang Tidak Fokus kepada Pemahaman Konsep**

Banyak kajian menunjukkan bahawa pengajaran matematik, khususnya algebra, sering kali lebih berfokus pada hafalan prosedur dan langkah penyelesaian tanpa memberi penekanan yang mencukupi kepada pemahaman mendalam mengenai konsep di sebalik masalah algebra. Pelajar yang hanya menghafal langkah-langkah penyelesaian tanpa memahami asasnya akan menghadapi kesukaran apabila berhadapan dengan masalah yang lebih kompleks, terutamanya apabila mereka perlu mengaplikasikan pengetahuan mereka dalam konteks yang berbeza. Pelajar sering diajar untuk mengikut prosedur atau formula tertentu tanpa mengetahui mengapa langkah-langkah tersebut diambil. Ini menyebabkan mereka sukar untuk mengaplikasikan pengetahuan dalam situasi baru atau lebih kompleks. Sebagai contoh, pelajar mungkin hanya tahu cara menyelesaikan persamaan linear tanpa memahami konsep asas seperti peraturan pembolehubah atau keseimbangan dalam persamaan. Akibatnya, mereka cenderung melakukan kesilapan berulang dan menghadapi kesukaran apabila berhadapan dengan masalah yang lebih rumit.

Pendekatan yang lebih berkesan adalah memberi penekanan kepada pemahaman konsep, yang membolehkan pelajar bukan sahaja mengingati langkah-langkah penyelesaian tetapi juga memahami logik dan rasional di sebalik setiap langkah, serta bagaimana ia berkaitan dengan dunia nyata. Ini akan membantu mereka menguasai algebra dengan lebih kukuh dan bersedia untuk cabaran yang lebih besar dalam matematik.

**Kesukaran Pelajar dalam Menghubungkan Algebra dengan Kehidupan Seharian**

Kesukaran pelajar dalam menghubungkan algebra dengan kehidupan seharian berlaku apabila mereka tidak melihat kaitan antara konsep algebra yang dipelajari dengan situasi dunia nyata. Pelajar sering kali menganggap algebra sebagai subjek yang abstrak dan tidak relevan dengan kehidupan mereka. Sebagai contoh, mereka mungkin tidak menyedari bahawa konsep algebra, seperti persamaan linear, boleh digunakan dalam perancangan kewangan, pengiraan masa atau kelajuan, atau dalam perniagaan.

Jika guru tidak mengaitkan contoh kehidupan sebenar dengan pembelajaran algebra, pelajar mungkin merasa subjek ini sukar dan membosankan. Oleh itu, dengan memberi contoh dunia nyata dan aplikasi praktikal, pelajar dapat melihat kepentingan dan kegunaan algebra, yang akan meningkatkan motivasi mereka untuk mempelajarinya dan memudahkan pemahaman konsep tersebut.

**Kekurangan Latihan dan Pengukuhan Berterusan**

Kekurangan latihan dan pengukuhan berterusan menyebabkan pelajar tidak dapat menguasai konsep algebra dengan baik. Tanpa latihan yang mencukupi, mereka sukar untuk mengingat formula, langkah penyelesaian, dan memahami cara mengaplikasikan konsep dalam pelbagai situasi. Latihan yang berulang membantu membina keyakinan dan meningkatkan kefahaman pelajar terhadap algebra.

Apabila pelajar tidak diberikan peluang untuk berlatih secara berterusan, mereka mungkin hanya faham secara sementara dan lupa selepas beberapa waktu. Oleh itu, pengukuhan melalui latihan yang konsisten dan pelbagai jenis soalan sangat penting untuk memastikan pelajar benar-benar menguasai topik dan dapat menjawab soalan yang lebih rumit dalam matematik.

**Kekurangan Penggunaan Teknologi dalam Pengajaran Algebra**

Kekurangan penggunaan teknologi dalam pengajaran algebra menghalang pelajar daripada memanfaatkan alat bantu visual dan interaktif yang dapat memudahkan pemahaman mereka. Alat seperti aplikasi matematik atau perisian pembelajaran dapat membantu pelajar melihat konsep secara visual dan menyelesaikan masalah dengan cara yang lebih menarik. Tanpa teknologi, pelajar mungkin menghadapi kesukaran memahami algebra. Penggunaan teknologi boleh meningkatkan pemahaman, memberi pengalaman pembelajaran yang lebih menarik, dan mempercepatkan proses pembelajaran.

**Kurangnya Pembelajaran Kolaboratif dalam Pengajaran Algebra**

Kurangnya pembelajaran kolaboratif dalam pengajaran algebra menghalang pelajar daripada belajar bersama dan berkongsi idea. Apabila pelajar bekerjasama dalam menyelesaikan masalah, mereka dapat saling membantu dan memperdalam pemahaman mereka terhadap konsep algebra. Tanpa pembelajaran kolaboratif, pelajar mungkin bekerja secara individu dan tidak mempunyai peluang untuk berbincang atau memahami pelbagai pendekatan dalam menyelesaikan masalah. Pembelajaran berasaskan kumpulan dapat meningkatkan kefahaman dan kemahiran komunikasi pelajar, serta memberi peluang untuk pembelajaran yang lebih aktif dan interaktif.

**Tekanan Akademik yang Tinggi dan Kurangnya Masa untuk Menguasai Konsep**

Tekanan akademik yang tinggi dan kekurangan masa menyebabkan pelajar tidak dapat memberi fokus yang mencukupi untuk menguasai konsep algebra. Dengan banyaknya subjek yang perlu dipelajari, pelajar terpaksa belajar secara tergesa-gesa, yang menghalang mereka daripada memahami konsep secara mendalam. Akibatnya, mereka tidak dapat menguasai asas algebra dengan baik sebelum beralih ke topik yang lebih kompleks. Untuk mengatasi masalah ini, pelajar memerlukan lebih banyak masa dan sokongan untuk memahami dan mengukuhkan pemahaman mereka dalam setiap topik.

Dari Jadual 1, seramai 30 orang pelajar telah menjawab kaji selidik didapati faktor utama kelemahan pelajar dalam asas algebra adalah kurang fokus kepada pemahaman konsep (35%) dan kekurangan latihan (20%). Selain itu, kesukaran menghubungkan algebra dengan kehidupan seharian (15%) turut menyumbang kepada kurangnya minat pelajar. Faktor lain seperti kurang penggunaan teknologi dalam pengajaran (10%), kurang pembelajaran kolaboratif (10%), dan tekanan akademik yang tinggi (10%) juga memberi kesan terhadap pemahaman dan prestasi pelajar dalam algebra. Oleh itu, pendekatan pengajaran yang lebih interaktif, penggunaan teknologi, serta bimbingan tambahan dapat membantu meningkatkan pemahaman pelajar.

Jadual 1: Jadual Analisa Faktor-faktor Pelajar Lemah dalam Asas Algebra

| Faktor | Peratusan (%) | Penjelasan |
|---|---|---|
| **Tidak Fokus kepada Pemahaman Konsep** | 35% | Pelajar sukar memahami asas algebra seperti pemfaktoran, persamaan, dan operasi algebra. |
| **Kurang Latihan** | 20% | Kekurangan latihan menyebabkan pelajar kurang mahir dalam menyelesaikan masalah algebra. |
| **Sukar Menghubungkan Algebra dengan Kehidupan Seharian** | 15% | Ramai pelajar sukar melihat kaitan algebra dengan kehidupan seharian, menyebabkan mereka kurang minat dan motivasi untuk mempelajarinya. |
| **Kurang Penggunaan Teknologi dalam Pengajaran** | 10% | Cara pengajaran yang kurang menarik boleh menyebabkan pelajar bosan dan tidak faham konsep. Penggunaan teknologi seperti perisian matematik, aplikasi interaktif, dan simulasi dapat membantu pelajar memahami konsep algebra dengan lebih visual dan menarik. |
| **Kurang Pembelajaran Kolaboratif** | 10% | Jika kaedah ini jarang digunakan, pelajar mungkin kurang berpeluang untuk meneroka konsep secara aktif, bertukar pandangan, dan membina pemahaman yang lebih mendalam. |
| **Tekanan Akademik yang Tinggi** | 10% | Jadual pembelajaran yang padat dan pelbagai subjek untuk dikuasai menyebabkan pelajar kurang masa untuk memahami konsep algebra secara mendalam dan melakukan latihan yang mencukupi. |

**Kesimpulan**

Kesimpulannya, pelajar yang lemah dalam asas algebra sering kali disebabkan oleh beberapa faktor utama, termasuk pendekatan pengajaran yang tidak fokus kepada pemahaman konsep, kesukaran menghubungkan algebra dengan kehidupan seharian, kekurangan latihan berterusan, serta kurangnya penggunaan teknologi dan pembelajaran kolaboratif. Selain itu, tekanan akademik yang tinggi dan kekurangan masa untuk menguasai konsep juga memberi kesan kepada pemahaman pelajar. Untuk mengatasi masalah ini, pendekatan pengajaran perlu lebih berpusatkan pemahaman, mengaitkan algebra dengan aplikasi dunia nyata, menyediakan latihan yang mencukupi, serta memanfaatkan teknologi dan pembelajaran kolaboratif untuk memperkukuhkan penguasaan pelajar. Dengan langkah-langkah ini,

pelajar dapat meningkatkan pemahaman mereka terhadap algebra dan menghadapi cabaran matematik dengan lebih yakin.

**Rujukan:**

Ahmed, M., & Ali, M. (2022). *Challenges in Learning Algebra and Their Impact on Academic Performance*. Journal of Mathematics Education, 32(2), 150-165.

Hasan, S., Mohd, F., & Ali, M. (2020). *The Disconnect Between Algebra and Real-Life Applications.* International Journal of Educational Sciences, 15(3), 200-214.

Kumar, R., & Sharma, P. (2021). *Student Struggles with Algebraic Expressions: A Cognitive Perspective*. Educational Psychology Review, 33(1), 113-130.

Lee, Y., & Cho, K. (2022). *Active Learning Models in Algebra Education*. Journal of Educational Psychology, 117(4), 871-885.

Li, J., & Wang, L. (2021). *The Influence of Conceptual Teaching on Algebraic Understanding*. Mathematics Education Research Journal, 45(2), 342-357.

Patel, A., & Verma, R. (2021). *Impact of Technological Tools on Learning Algebra*. Computers in Education, 178, 104375.

Wang, Z., & Zhang, S. (2023). *Problem-Based Learning for Algebra Mastery*. Journal of Mathematical Education, 50(1), 58-70.

Zhang, L., & Liu, Q. (2021). *Collaborative Learning and Algebra Mastery*. International Journal of Mathematical Education, 46(3), 246-261.

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# STRATEGI PENGAJARAN BERKESAN DAN MENINGKATKAN KEFAHAMAN DALAM ALGEBRA DI KALANGAN PELAJAR

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**ABSTRAK**

*Algebra merupakan salah satu cabang matematik yang penting, namun ramai pelajar menghadapi kesukaran dalam menguasai konsep asasnya. Kajian ini bertujuan untuk mengenal pasti strategi pengajaran yang berkesan dalam meningkatkan pemahaman algebra di kalangan pelajar. Penyelidikan ini menganalisis pelbagai kaedah pengajaran, termasuk penggunaan teknologi, pembelajaran kolaboratif, pendekatan kontekstual, dan latihan berstruktur. Hasil kajian menunjukkan bahawa pendekatan interaktif, seperti penggunaan perisian matematik dan aplikasi dalam kehidupan seharian, dapat membantu meningkatkan kefahaman pelajar. Selain itu, bimbingan secara berfokus dan penyediaan latihan berperingkat turut memainkan peranan penting dalam memperkukuhkan asas algebra. Oleh itu, guru disarankan untuk menggabungkan pelbagai strategi pembelajaran bagi memastikan keberkesanan pengajaran algebra serta meningkatkan minat dan keyakinan pelajar terhadap subjek ini.*

***Katakunci: algebra, pembelajaran, strategi, pemahaman.***

## Pengenalan

Algebra merupakan asas penting dalam matematik dan memainkan peranan utama dalam pelbagai bidang sains, teknologi, dan kejuruteraan. Walau bagaimanapun, ramai pelajar menghadapi kesukaran dalam memahami konsep asas algebra, seperti pemfaktoran, persamaan linear, dan operasi algebra. Kelemahan ini boleh berpunca daripada pelbagai faktor, termasuk kaedah pengajaran yang kurang berkesan, kurangnya latihan berstruktur, serta sikap negatif pelajar terhadap matematik.

Kajian ini bertujuan untuk mengenal pasti strategi pengajaran yang berkesan dalam meningkatkan pemahaman algebra di kalangan pelajar. Dengan meneroka kaedah seperti penggunaan teknologi, pembelajaran kolaboratif, pendekatan kontekstual, dan latihan berperingkat, kajian ini berharap dapat memberikan cadangan praktikal kepada para pendidik. Melalui strategi yang lebih interaktif dan menarik, diharapkan pemahaman pelajar terhadap algebra dapat dipertingkatkan, seterusnya membantu mereka menguasai matematik secara keseluruhan.

Kajian ini juga akan membincangkan cabaran yang dihadapi dalam pengajaran algebra serta kepentingan menyesuaikan kaedah pembelajaran dengan keperluan pelajar. Dengan memperkenalkan strategi yang lebih efektif, diharapkan hasil kajian ini dapat menjadi rujukan kepada pendidik dalam memperbaiki teknik pengajaran mereka dan meningkatkan pencapaian pelajar dalam matematik.

Kajian oleh Janet Jahudin dan Nyet Moi Siew (2022) menunjukkan bahawa Model Bar, yang merupakan teknik visual, membantu pelajar memahami hubungan antara nombor dan operasi algebra dengan lebih mudah. Dalam kajian mereka, pelajar yang diajar menggunakan Model Bar menunjukkan peningkatan ketara dalam pencapaian berbanding pelajar yang diajar menggunakan kaedah tradisional. Ini membuktikan bahawa pembelajaran berasaskan visual dapat membantu pelajar membina kefahaman yang lebih kukuh dalam algebra.

Di samping itu, kajian oleh Nor'ain Mohd. Tajudin et al. (2015) meneliti peranan guru dalam pengajaran penyelesaian masalah algebra. Kajian ini mendapati bahawa guru memainkan peranan penting dalam membimbing pelajar memahami konsep asas sebelum memperkenalkan soalan yang lebih kompleks. Guru yang menggunakan pendekatan berorientasikan masalah dunia sebenar mendapati bahawa pelajar lebih mudah mengaitkan algebra dengan kehidupan harian mereka, seterusnya meningkatkan kefahaman dan minat mereka dalam subjek ini. Hasil kajian ini menunjukkan bahawa strategi pengajaran yang menekankan konteks dunia sebenar boleh membantu pelajar memahami konsep algebra dengan lebih mendalam.

Satu kajian oleh Jahudin dan Siew (2022) mendapati bahawa penggunaan Kaedah Model Bar, sama ada secara individu atau digabungkan dengan pembelajaran koperatif, dapat meningkatkan kemahiran berfikir algebra dalam kalangan pelajar Tingkatan Satu. Selain itu, kajian oleh Leow (2023) menunjukkan bahawa program "Zero 2 Hero" yang menggunakan kaedah Tarsia bersama bimbingan rakan sebaya berjaya memperbaiki kemahiran asas algebra pelajar Tingkatan Lima. Di samping itu, kajian oleh Tajudin et al. (2015) menekankan kepentingan persepsi dan amalan pengajaran guru dalam penyelesaian masalah algebra, di mana pemahaman mendalam guru terhadap topik ini adalah kritikal untuk keberkesanan pengajaran. Secara keseluruhan, pendekatan yang menggabungkan teknik visual, kolaboratif, dan sokongan rakan sebaya didapati berkesan dalam meningkatkan pemahaman dan kemahiran pelajar dalam algebra.

Kajian terkini dalam strategi pengajaran algebra menekankan penggunaan teknologi dan pendekatan interaktif untuk meningkatkan pemahaman pelajar. Supermaniam dan Zaharudin (2021) mendapati bahawa aplikasi mudah alih multimedia interaktif berasaskan permainan dapat membantu murid dengan masalah pembelajaran memahami konsep pecahan dalam algebra.

Di samping itu, kajian oleh Rahman (2018) menekankan kepentingan strategi pengajaran yang berpusatkan pelajar dalam pembelajaran matematik. Pendekatan seperti pembelajaran koperatif dan penggunaan alat bantu visual didapati berkesan dalam meningkatkan pemahaman konsep algebra.

**Strategi Pengajaran Berkesan dalam Meningkatkan Pemahaman Algebra**

Berikut adalah srategi yang telah dikenalpasti bagi setiap pendekatan pengajaran yang lebih interaktif dalam meningkatkan pemahaman algebra di kalangan pelajar:

***Penggunaan Teknologi dalam Pengajaran***

Teknologi memainkan peranan penting dalam menjadikan pembelajaran algebra lebih menarik dan mudah difahami. Antara teknologi yang boleh digunakan termasuk perisian matematik seperti GeoGebra, Desmos, dan Wolfram Alpha yang membolehkan pelajar meneroka konsep algebra secara visual dan interaktif. Aplikasi Interaktif yang menyediakan latihan dan permainan matematik boleh membantu meningkatkan minat pelajar terhadap algebra. Video Pembelajaran di platform seperti Youtube , Tiktok atau MOOC (Massive Open Online Courses) membolehkan pelajar mengulang kaji mengikut kadar pembelajaran mereka sendiri. Penggunaan teknologi bukan sahaja menjadikan pembelajaran lebih menyeronokkan tetapi juga membantu pelajar membina pemahaman yang lebih mendalam melalui eksplorasi dan percubaan sendiri. Pembelajaran berasaskan permainan seperti di platform Kahoot! dan Quizizz juga dapat menjadikan latihan algebra lebih menyeronokkan dan membantu meningkatkan pemahaman melalui kuiz interaktif. Aplikasi Mudah Alih dan e-Pembelajaran seperti Photomath membolehkan pelajar mendapatkan penyelesaian langkah demi langkah bagi masalah algebra dan membantu pelajar memahami konsep dengan lebih baik.

***Pembelajaran Berasaskan Konteks***

Pendekatan pembelajaran berasaskan konteks membantu pelajar memahami algebra dengan lebih mudah dan bermakna dengan mengaitkannya dengan situasi dunia nyata. Ini penting bagi pelajar sekolah kerana mereka sering menghadapi kesukaran untuk melihat kegunaan algebra dalam kehidupan seharian. Dengan menggunakan pendekatan ini, konsep algebra dapat diajar dengan lebih menarik dan relevan kepada pelajar, meningkatkan minat mereka terhadap matematik.

Antara contoh bagaimana pembelajaran berasaskan konteks boleh diterapkan dalam pengajaran algebra di peringkat sekolah ialah guru boleh menggunakan situasi yang dekat dengan kehidupan pelajar untuk mengajar konsep algebra. Berikut adalah contoh situasi yang boleh digunakan ialah:

- Situasi 1

Pelajar boleh diberikan senario seperti membeli barang di pasar raya dan mengira jumlah harga selepas diskaun atau cukai. Contohnya:
*"Jika harga asal sebuah telefon ialah RM1,200 dan diberikan diskaun sebanyak 15%, berapakah harga selepas diskaun?"*

- Situasi 2

Pelajar boleh menggunakan algebra untuk menentukan jumlah simpanan mereka berdasarkan jumlah wang saku harian dan perbelanjaan mereka. Contohnya:
*"Ali mendapat RM5 sehari sebagai wang saku. Jika dia menyimpan RM2 setiap hari, berapa banyak wang yang akan dikumpulkan selepas x hari?"*

***Kajian Kes***

Pendekatan kajian kes dalam pengajaran algebra memberi peluang kepada pelajar untuk menerapkan konsep matematik dalam situasi kehidupan sebenar. Dengan menggunakan kajian kes, pelajar dapat memahami bagaimana algebra digunakan dalam perancangan dan penyelesaian masalah yang relevan dengan kehidupan mereka.

Salah satu contoh kajian kes yang boleh diterapkan dalam kelas ialah perancangan majlis sekolah. Dalam aktiviti ini, pelajar diminta untuk mengira bajet bagi sesuatu acara seperti jamuan kelas atau majlis akhir tahun. Sebagai contoh, guru boleh memberikan situasi berikut: *"Jika setiap pelajar menyumbang RM10 untuk majlis akhir tahun dan terdapat x orang pelajar dalam kelas, berapakah jumlah wang yang akan dikumpulkan?"* Soalan seperti ini membolehkan pelajar memahami konsep pemboleh ubah dan persamaan linear dalam konteks yang bermakna.

***Projek dan Simulasi***

Pendekatan projek dan simulasi dalam pengajaran algebra membolehkan pelajar meneroka aplikasi konsep matematik dalam situasi dunia sebenar. Dengan melibatkan pelajar dalam aktiviti hands-on, mereka dapat memahami bagaimana algebra digunakan dalam pelbagai bidang, sekali gus meningkatkan pemahaman dan minat mereka terhadap subjek ini.

Salah satu projek yang sesuai ialah projek reka bentuk dan bangunan, di mana pelajar diminta untuk mencipta reka bentuk bangunan kecil menggunakan konsep algebra dan geometri. Dalam aktiviti ini, mereka boleh mengira luas, perimeter, dan kos bahan berdasarkan formula algebra. Sebagai contoh, pelajar boleh diminta untuk mereka bentuk pelan rumah dengan ukuran tertentu dan menggunakan persamaan algebra untuk mengira jumlah bahan yang diperlukan. Aktiviti ini bukan sahaja membantu pelajar memahami algebra dalam konteks geometri, tetapi juga memperkenalkan mereka kepada konsep kejuruteraan dan seni bina.

Selain itu, pelajar juga boleh menjalankan eksperimen jualan dan keuntungan, di mana mereka mensimulasikan perniagaan kecil seperti menjual makanan ringan atau alat tulis di sekolah. Melalui projek ini, mereka boleh menggunakan algebra untuk mengira kos, keuntungan, dan kerugian berdasarkan jumlah barangan yang dijual. Sebagai contoh, mereka boleh diberikan situasi berikut: *"Jika kos membeli sebatang pen ialah RM1.50 dan dijual pada harga RM2.50, berapa banyak keuntungan diperoleh jika x batang pen dijual?"* Soalan ini membantu pelajar memahami konsep persamaan linear dalam perniagaan serta memperkenalkan mereka kepada prinsip asas ekonomi dan keusahawanan.

Melalui projek dan simulasi seperti ini, pelajar bukan sahaja dapat memahami konsep algebra dengan lebih mendalam tetapi juga dapat melihat kaitannya dengan kehidupan sebenar. Pendekatan ini menggalakkan pembelajaran secara aktif, meningkatkan daya kreativiti pelajar, dan membolehkan

mereka meneroka pelbagai bidang yang berkaitan dengan matematik, seperti kejuruteraan, ekonomi, dan analisis data.

***Kaedah Kolaboratif***

Pembelajaran kolaboratif memberi peluang kepada pelajar untuk bekerjasama, bertukar idea, dan membantu antara satu sama lain dalam memahami konsep algebra. Beberapa kaedah pembelajaran kolaboratif yang boleh digunakan termasuk:

i) Pembelajaran Berpasangan atau Berkumpulan

Pelajar boleh bekerjasama dalam menyelesaikan masalah algebra melalui aktiviti seperti perbincangan dalam kumpulan atau tugasan projek.

ii) Kaedah Jigsaw

Setiap pelajar dalam kumpulan diberikan sebahagian daripada konsep algebra untuk dipelajari dan kemudiannya mereka perlu mengajar rakan sekelas yang lain.

iii) Perbincangan Kelas dan Soal Jawab

Sesi soal jawab terbuka atau perbincangan secara aktif dapat membantu pelajar menyoal dan menjelaskan konsep kepada rakan mereka untuk memperkukuhkan pemahaman mereka sendiri.

***Latihan Berperingkat***

Pendekatan latihan berperingkat dalam pengajaran algebra membantu pelajar menguasai konsep secara sistematik, bermula dari asas sebelum berkembang ke tahap yang lebih kompleks. Dengan menggunakan strategi ini, pelajar dapat membina pemahaman yang kukuh, mengurangkan kebimbangan terhadap matematik, dan meningkatkan keyakinan mereka dalam menyelesaikan masalah algebra.

Salah satu strategi utama ialah latihan bertahap, di mana pelajar didedahkan kepada soalan asas terlebih dahulu sebelum beralih kepada soalan yang lebih mencabar. Contohnya, pelajar boleh bermula dengan operasi algebra mudah seperti penyelesaian persamaan linear asas ($x + 5 = 10$), kemudian secara beransur-ansur diperkenalkan kepada persamaan kuadratik dan konsep pemfaktoran. Latihan ini memberi peluang kepada pelajar untuk memahami asas manipulasi algebra sebelum mereka menghadapi cabaran yang lebih besar, sekali gus mengelakkan rasa tertekan atau keliru.

Selain itu, pendekatan Mastery Learning juga dapat membantu memastikan pelajar benar-benar memahami setiap konsep sebelum mereka bergerak ke tahap seterusnya. Dalam kaedah ini, pelajar hanya akan beralih ke konsep yang lebih sukar selepas mereka menguasai konsep sebelumnya. Sebagai contoh, sebelum mempelajari persamaan serentak, pelajar perlu memahami asas persamaan linear terlebih dahulu. Pendekatan ini memastikan bahawa tiada jurang dalam pemahaman pelajar dan setiap pelajar dapat belajar mengikut kadar perkembangan mereka sendiri. Guru boleh menggunakan

lembaran kerja bertahap, perbincangan berkumpulan, atau pembelajaran berbantu rakan sebaya untuk memperkukuhkan pemahaman pelajar pada setiap peringkat.

Tambahan pula, pengulangan dan peneguhan merupakan teknik penting dalam memastikan pemahaman jangka panjang. Pelajar boleh diberi latihan ulangan dalam bentuk kuiz, lembaran kerja, atau aktiviti interaktif untuk menguji pemahaman mereka secara berkala. Guru boleh menggunakan permainan matematik, aplikasi pembelajaran digital, atau sesi soal jawab bagi menjadikan pengulangan lebih menarik dan efektif. Pengulangan yang konsisten membantu pelajar mengenal pasti kelemahan mereka, membina keyakinan, dan meningkatkan kebolehan mereka dalam menyelesaikan masalah algebra.

Secara keseluruhannya, latihan berperingkat memberikan struktur yang sistematik dalam pembelajaran algebra. Dengan menggunakan pendekatan latihan bertahap, Mastery Learning, dan pengulangan, pelajar dapat memahami setiap konsep dengan lebih mendalam, mengelakkan kebingungan, dan membangunkan kemahiran penyelesaian masalah secara progresif. Strategi ini bukan sahaja meningkatkan keberkesanan pengajaran algebra tetapi juga membentuk pelajar yang lebih yakin dan berkemahiran dalam matematik.

**Kesimpulan**

Pendekatan pengajaran yang lebih interaktif memainkan peranan penting dalam membantu pelajar memahami konsep algebra dengan lebih baik serta meningkatkan minat mereka terhadap matematik. Pengajaran yang hanya berfokus kepada hafalan rumus dan penyelesaian mekanikal sering kali menyebabkan pelajar berasa bosan dan sukar memahami aplikasi sebenar algebra. Oleh itu, dengan menggabungkan pelbagai strategi pengajaran yang lebih dinamik, seperti penggunaan teknologi, pembelajaran berasaskan konteks, kaedah kolaboratif, dan latihan berperingkat, guru dapat menyediakan pengalaman pembelajaran yang lebih menarik, efektif, dan relevan dengan kehidupan pelajar.

**Rujukan:**

Jahudin, S. & Siew, N. M. (2022). The effects of bar model method and cooperative learning on algebraic thinking skills among Form One students. *International Journal of Academic Research in Progressive Education and Development*, 11(3), 222-240.

Kumar, R., & Sharma, P. (2021). Student Struggles with Algebraic Expressions: A Cognitive Perspective. *Educational Psychology Review*, 33(1), 113-130.

Leow, C. S. (2023). Implementation of "Zero 2 Hero" program to enhance algebra learning among secondary school students. *Journal of Mathematics Education*, 18(1), 112-130.

Nor'ain Mohd. Tajudin, Ismail, M. I., & Yaakub, M. S. (2015). Teachers' perception and practice in algebra problem-solving. *Malaysian Journal of Mathematical Sciences*, 9(2), 123-139.

Rahman, F. (2018). Strategi belajar mengajar matematik berbasis student-centered learning. Banda Aceh: Universitas BBG Press.

Supermaniam, R. & Zaharudin, R. (2021). Interactive mobile application for learning algebraic fractions among slow learners. *International Journal of Instructional Media*, 48(4), 85-101.

Tajudin, N. M., Ismail, M. I., & Yaakub, M. S. (2015). Teachers' perception and practice in algebra problem-solving. *Malaysian Journal of Mathematical Sciences*, 9(2), 123-139.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# THE DEVELOPMENT OF E-GEO APPLICATION FOR FORM SIX STUDENTS

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**ABSTRACT**

*The project highlights the modelling of a mobile e-learning platform specifically designed for Form 6 students. The project arises from the limitations of the traditional formula-based technique affordable to students by didactic lectures, non-interactive studying material, and no provision for customized learning opportunities. Through the incorporation of media including videos, animation, quizzes, and drag-and-drop exercises, E-Geo aims to stimulate a high degree of student engagement and deepen their understanding of difficult geographical notions, weathering and climatic systems, in this case. The design uses the ADDIE Model to provide a structured framework through the processes of the analysis, design, development, implementation, and evaluation. E- Geo contains content in line with the form-6 STPM Geography syllabus, further divided into modules addressing important topics together across all three semesters. In addition, E-Geo introduces game element types, like recognition badges, and progress tracking, to motivate the students and create a more interactive learning environment.*

***Keywords: development, E-Geo, Form six, e-learning, ADDIE Model***

## Introduction

Interactive e-learning offers students a more adaptable, customized, and engaging educational experience, supported by digital media technology and big data systems (Huang et al., 2024). Students today customize their learning experiences to fit their unique needs, interests, and learning preferences. By concentrating on subjects where they require additional help, students can connect more profoundly with the content. Adaptive content is a strategy that allows students to personalize their learning experience, enabling them to concentrate on the subjects they need to study the most. This method has become increasingly favored, as it allows learners to progress at their speed and provides teachers with an effective means to evaluate student achievement.

Geography subjects has been perceived as a difficult subject in the school curriculum that is difficult to teach. Students also find it difficult to get illustrative images from several topics involving elements such as weather and climate elements, radiation and drought as well as heat budgeting. Students also face delayed feedback from their teachers on the questions that they do not understand on certain topics. This happens when students do exercise on their own without guidance. Moreover, teachers may be overwhelmed by the volume of student questions, especially if they have a large class size. The thick and detailed nature of Form 6 Geography textbooks can also be challenging for students.

Animated learning applications can be one of the good teaching aids to deliver subject content like Geography. In general, most Android learning applications which were developed for assessing students to understand more on a certain topic can involve a prolonged process and some of them need to be attended to physically which can cause trouble for teachers and students. (Othman et al., 2022). Therefore, this application will be developed to improve form 6 students understanding of certain hard topics each semester. This project simplifies the learning process by applying interactive elements like drag-and-drop, quizzes, Animation, and multimedia that covers related topics to increase students' interest in Geography subjects. Animation plays a vital roles as an existing learning medium. This is because the visual form of the mobile is accompanied by audio that can be used to explain the content of the lesson that is difficult to convey (Rohana Mansor et al., 2020).

**Project Framework**

This project employs the ADDIE model as a framework to model the design and development of a mobile e-learning application for Form 6 Geography students. The ADDIE model provides an avenue for solving the existing educational issues in a stepwise manner and makes an engaging and interactive learning platform. ADDIE model consists of 5 phases which are Analysis, Design, Development, Implementation and Evaluation. Figure 1 shows the 5 phases in ADDIE model.

This analysis phase involves analysing the needs of Form Six Geography students, identifying learning gaps and challenges they face with specific topics across each semester (Pinem & Nurahmi, 2024). It also evaluates the educational goals and objectives of the E-Geo application to ensure alignment with the curriculum. Research on user personas and the target audience is essential in defining the functional requirements of the application.

The design phase consists of the structure and features of the E-Geo application. This process involves designing wireframes for the user interface (UI) as well as sketching the flow for lessons, quizzes and other learning mechanisms. The design will focus on being intuitive and user-friendly, with engaging elements such as interactive maps, videos, and assessments (Suratnu, 2023).

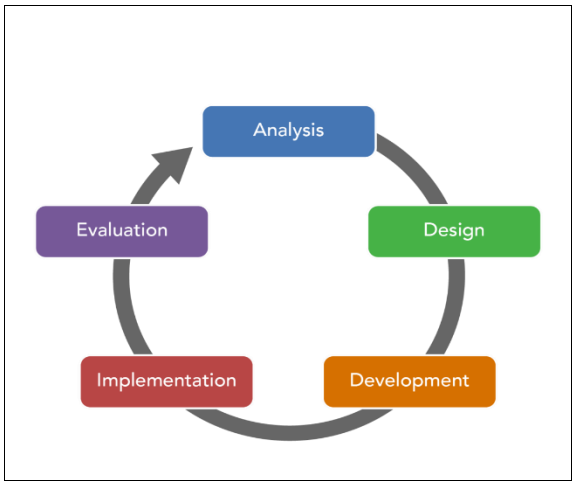



Figure 1: The ADDIE Model (Source: Lumen Learning, 2019)

This development of the E-Geo application includes scripting, engaging features, and event handling. In this phase, iterative testing will be done on this application to make sure that all features are working as intended (Hess & Greer, 2016).

The implementation phase ensures the successful deployment of the E-Geo application, focusing on engaging Form Six Geography students and addressing their learning needs. This phase involves usability testing, providing user guides, and offering interactive tutorials to help students navigate and use the app effectively. A user-centric approach is adopted, prioritizing student feedback and making real-time adjustments to enhance the learning experience.

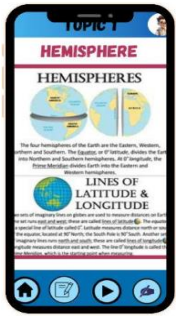
Finally, in the evaluation phase of the ADDIE model for the "E-Geo" application, the primary focus will be on determining its effectiveness in achieving educational goals and supporting Form Six Geography students. This will include collecting feedback from students and teachers through surveys and interviews, analysing student performance before and after using the app, and examining usage data to pinpoint areas for improvement. Teachers will offer insights into how well the app aligns with the curriculum. Additionally, technical testing will ensure the app operates smoothly across devices, providing valuable guidance for future updates to enhance its functionality and effectiveness (Nainggolan et al., 2023).

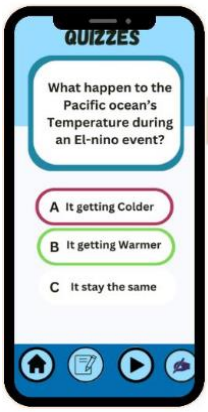
**Prototype**

Designing the storyboard is important to understand the flow of the system. Storyboards represent visually the arrangement of events, activities, or steps in a project. It consists of a number of illustrations, images, or sketches of the flow of an idea or system. Nevertheless, a user-interface design shows more detail features of the proposed system.

Table 1: Prototype Science Courseware for Standard 6 students

| No | Features | Description |
|---|---|---|
| 1 | Cover of E-Geo Application   | This cover page of the E-Geo application consists of a log-in button for users to continue to the next page. New users can also register a new account to use the application. |
| 2 | Login Page   | The current user needs to enter the email and password every time to log in to the E-Geo Application and proceed with the login button to move to the homepage. |
| 3 | Register Page   | Register page allow new users to fill a few details to complete the registration of a new account by using email, password, and confirm password. Users can continue to log in as usual to explore the application. |
| 4 | Home Page by Semester   | Homepage by semester appears after the user successfully login. This page consists of three selection buttons for each semester which are semesters 1,2 and 3. At the bottom page have 4 buttons that bring other content in this app which are quizzes, notes, video lessons, and the home button. |

| | | |
|---|---|---|
| 5 | Home Page by Content Category<br>  | This E-Geo application contains 4 education elements which are video, quiz, notes, and exercise for Form Six Geography students. Users can click any available button to explore the content |
| 6 | Video Content Page<br>  | This video page focuses on the related topic of form six geography so students can just click on the play button to watch the video. |
| 7 | Notes Content Page<br>  | The note page has an interactive feature consisting of a few notes on an important topic that can help students structure the description of the long topics. |
| 8 | Notes by Topic Page<br>  | This is the page after the user click on the selected topics available. These notes contain the perfect details and figures to explain any process involved in the topic selected for example Hemisphere |

| | | |
|---|---|---|
| 9 | Quizziz Page   | This page prepares interesting quizzes to increase user engagement. Users just need to choose the available answer in shown in the figure. The green oval will appear surrounding the correct answer while a red oval<br>will appear on the wrong answer. |

**Conclusion**

The development of E-Geo Application for Form 6 students provide a thorough approach with its educational goals, setting a strong foundation for wider adoptions. This project followed the five phases of the ADDIE Model: Analysis, Design, Development, Implementation, and Evaluation. Each phase played a vital role in structuring and effectively developing the E-Geo application. The project materials and processes were outlined step-by-step to ensure a smooth and efficient development workflow.

**References:**

Hess, A. K. N., & Greer, K. (2016). *Designing for engagement: Using the ADDIE model to integrate high-impact practices into an online information literacy course.* Communications in Information Literacy, 10(2), 264–282. https://doi.org/10.15760/comminfolit.2016.10.2.27

Huang, E. Y., Lin, S. W., & Huang, T. K. (2024). *What type of learning style leads to online participation in the mixed-mode e-learning environment? A study of software usage instruction.* Computers and Education, 58(1), 338–349. https://doi.org/10.1016/j.compedu.2011.08.003

Nainggolan, B., Juniar, A., & Silaban, R. (2023). Development of project-based interactive e- modules in accordance with the IQF integrated curriculum concept in learning organic chemical reactions to improve student chemistry learning outcomes. *Jurnal Pendidikan Kimia,* 15(3), 281–291. https://doi.org/10.24114/jpkim.v15i3.47366

Othman, N. F., Hamid, H., & Rizal, A. (2022). Development Of Animated Learning Applications for Weathering Topics of Form 6 Geography. Research and Innovation …, 2(1), 47–53. Downloaded from:https://publisher.uthm.edu.my/periodicals/index.php/ritvet/article/view/199%0Ahttps://publisher.uthm.edu.my/periodicals/index.php/ritvet/article/download/199/1853

Pinem, S., & Nurahmi, H. (2024). *UI/UX Textbook Development Using ADDIE and E-learning in the Multimedia Study.* KnE Engineering, 2024, 221–230. https://doi.org/10.18502/keg.v6i1.15370

Rohana Mansor, N., Zakaria, R., Abd. Rashid, R., Mohd Arifin, R., Hairiel Abd Rahim, B., Zakaria, R., & Mohd, M. T. (2020). *A Review Survey on the Use Computer Animation in Education*. IOP

Conference Series: Materials Science and Engineering, 917(1). https://doi.org/10.1088/1757-899X/917/1/012021

Suratnu, R. (2023). The Adoption of The ADDIE Model in Designing An Instructional Module. *IJIET (International Journal of Indonesian Education and Teaching*), 7(2), 262–270.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 - Mar - 2025*

# THE DEVELOPMENT OF SCIENCE COURSEWARE FOR STANDARD SIX STUDENTS

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**ABSTRACT**

*E-learning system has become one of the most significant platforms to achieve the vision for wide range, lifelong training to a wide variety of audiences. Thus, the development of Science courseware for standard 6 students is actually to prepare the student for specialize exam such as PKSK and UKKM. Standard 6 students are affected by limitations in traditional teaching methods, limitation integration of technology and difficulties in maintaining student focus. The development of the Science courseware utilizes interactive, and technology driven approaches to offer personalized learning experiences, incorporating features such as self- assessment resources, interactive experiment and gamified content to enhance engagement and attract student attention. By integrating technology into education, the proposed solution aims to assist students in understanding science concept, addressing their shortcomings and enhancing their preparedness for examinations.*

***Keywords: development, Science courseware, Standard six***

## Introduction

E-Learning is the delivery of educational content and experiences through digital platforms, providing flexibility in time and location for learners. Bates (2019) stated that e-learning is crucial in modern education as it encourages self-directed learning and accommodates various learning preferences It often uses multimedia resources, interactive content, and online assessments to enhance learning outcomes. This approach enables learners to access study materials, complete assignments, participate in discussions, and take exams online. Because it enables students to actively engage in learning at any time and from any location, e-learning delivers positive learning outcomes. Thus, a courseware that focuses on science can be very helpful for students to prepare efficiently. The aim of this e-learning courseware is to help Standard 6 students to prepare efficiently for Pentaksiran Kemasukan Sekolah Khusus (PKSK) and Ujian Kecenderungan Kemasukan MRSM (UKKM) exam.

The PKSK stand as a standardized exam in Malaysia for students applying to specialized schools such as Sekolah Berasrama Penuh (SBP) and Sekolah Menengah Kebangsaan Agama (SMKA).

The PKSK evaluate students based on their academic skills, critical thinking skills, and personal attributes to identify individuals suitable for advanced educational programs. Getting ready for PKSK typically requires concentrated learning on key topics, such as science, to ensure that students meet the high standards expected in these institutions.

While the UKKM is an exam created for students to enter Maktab Rendah Sains Mara (MRSM). It evaluates students in fundamental academic subject like Science, Math, and English, along with personal and social skills. Preparation for UKKM highlights the importance of comprehending science, particularly in zreas that require critical and analytical thinking (Azizan & Nor, 2021).

The traditional method in education involves teachers who provide lessons and students participating in lectures, textbooks, and workbooks provided by the government. In traditional classroom, one-size-fits-all strategy method is frequently employed in which the educator managing the lesson's speed and material without customizing it to suit individual learning requirements. Because of this, some students find it difficult to keep up, and others can find the pace excessively slow, which causes them to become disengaged.

To overcome the traditional method, the development of Science courseware for Standard 6 students is done by identifying the requirements for a Science subject courseware for PKSK and UKKM Preparation for standard 6 students besides evaluating the functionality and usability of the Science subject courseware for PKSK and UKKM Preparation for standard 6 students.

**Project Framework**

This project uses the ADDIE Model framework to organize the development of the Science courseware for standard 6 students. The ADDIE model is a systematic, well-recognized instructional design framework that helps in developing efficient learning experiences. This model is a well-established methodology for information transfer in adult education, and it has been widely utilized for the production of multimedia learning content. The ADDIE model is a widely utilized instructional design framework that represent Analysis, Design, Development, Implementation, and Evaluation. It is a repeated process that guides the development of productive and efficient educational experiences, especially in online learning environments. Every phase of the ADDIE Model has a distinct aim in guaranteeing that the educational content is thoughtfully designed, focused on the user, and oriented toward specific goals. Figure 1 shows the five stages in the ADDIE Model.

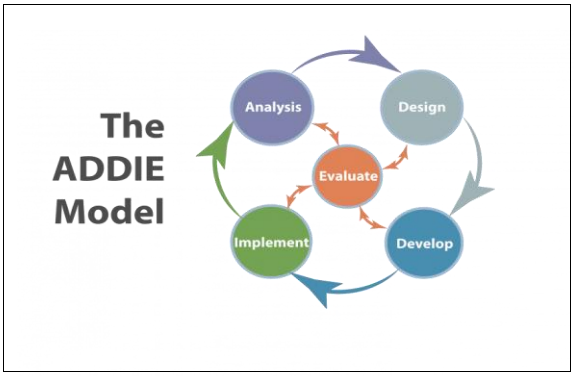


Figure 1: The ADDIE Model (Source: Capytech, 2025)

The Analysis phase is where the instructional designers focus on the learning needs, goals, and objectives. This would require an understanding of the learner backgrounds, the content to be taught, and finally, the context in which the e-learning will occur. This phase is important in e-learning for identifying technology requirements, learner preferences, and resources available (Clark & Mayer, 2018). Analysing the needs of Science Courseware for Standard 6 students is important to identify their learning gaps and setting specific goals for the courseware.

The design phase outlines the structure and strategy for the e-learning course. This involves making the content interesting and aligned to the user needs and learning objectives (Molenda, 2019). Designing the structure of the Science Courseware is crucial, including the multimedia elements and how they support learning.

Development phase might include constructing e-learning modules, interactive components, testing them for functionality and usability. It ensures that the learning experience is interactive and easily accessible while being technically sound. It means developing the science courseware, programming interactive components, and embedding multi-media features to provide a rich learning situation.

During implementation, the program is delivered to students. This e-learning phase include launching the course, providing access to learners, and assisting them through the learning process. In e-learning, effective implementation means ensuring a user-friendly platform and necessary tools and support for the learners (Stevens & Tate, 2020). This phase would involve testing the courseware with a small group of students from Standard 6 and gathering feedback to improve the learning experience.

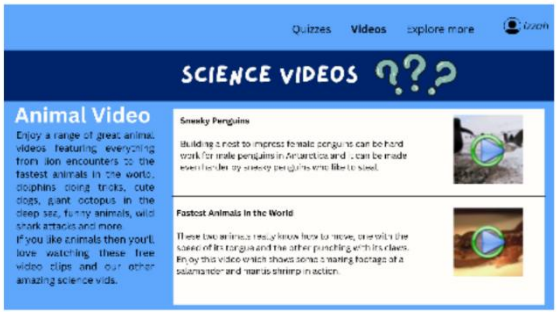
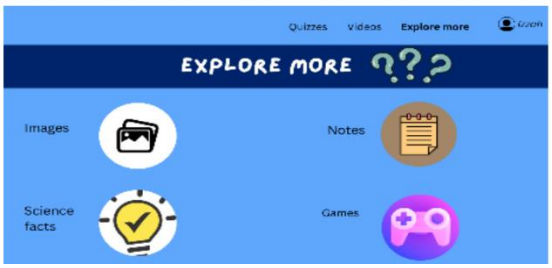
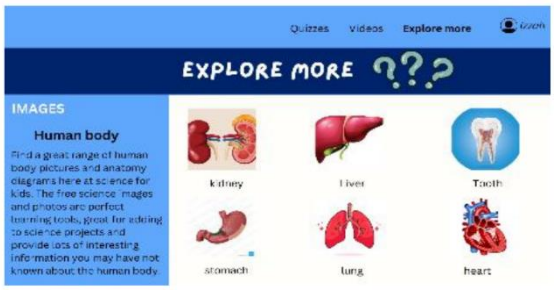
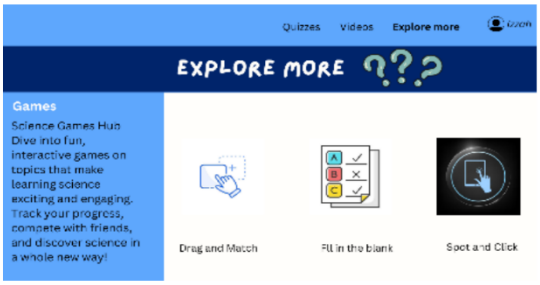
Finally, the evaluation phase is to identify the effectiveness of the system. It gather feedback from the learners, instructors, and stakeholders to determine whether the intended learning outcomes have been achieved. In this way, evaluation can be formative during development and summative once the implementation has happened (Morrison et al., 2019). To assess whether the courseware was actually successful, it would be important to consider how well it prepared students for their exams and perhaps how much understanding of science it developed.

**Prototype**

Designing the storyboard is important to understand the flow of the system. Storyboard will represent visually the arrangement of events, activities, or steps in a process or project. It consists of a number of illustrations, images, or sketches of the flow of an idea or system. The storyboard captures the sequence of lessons, interactive quizzes, videos, and other multimedia elements. A user-interface design shows more detail features of the proposed system.

Table 1: Prototype Science Courseware for Standard 6 students

| No | Features | Description |
|---|---|---|
| 1 | Home Page   | This Home Page introduces the platform with the tittle "Science Courseware for You!". It features vibrant illustrations like rockets, atoms, microscopes, and test tubes to create a fun and engaging science-themed atmosphere. The navigation bar at the top allows access to sections like Quizzes, Videos, and Explore More. |
| 2 | Main Menu Page   | This page presents a collection of Science quizzes categorized by topics of Standard 4, 5, and 6. Each category represents by an image that helps in visually connect users to the topic, enhancing engagement and easy to navigate. User can click on the image and it will navigate to each topic page. |
| 3 | Quizziz Page   | This page shows questions along by four answer option. The layout includes an eye-catching picture to visually support the question. The navigation menu at the top enables users to switch to different sections. The layout is clean and interactive, motivating users to participate in the quiz. |

| | | |
|---|---|---|
| 4 | Video Content Page<br>  | This page is the Science Videos section, specifically focusing on Animal Videos. The page includes an Introduction Section and Video Listings. Each video comes with a title, description, and a thumbnail that has a play button for easy access. |
| 5 | Explore More Page<br>  | This page represents four groups of addition science resources such as images, notes, science facts and games. The page uses clear icons for each category and a simple layout, making it easy for users to explore and access these resources |
| 6 | Image Content Page<br>  | This Image Content Page focus on the Human Body. It offers visual materials, including anatomy diagram of important organs. The page offers an interactive approach for user to learn about human anatomy. A short explanation explains the purpose of the images. |
| 7 | Notes Content Page<br>  | The Notes Content Page provide brief summaries for science topics. It includes diagrams and glossaries to make learning easy and interactive for users. |
| 8 | Games Content Page<br>  | This page shows an interactive science-themed games such as Drag and Match, Fill in the Blank, and Spot and Click. Its aims to make science education enjoyable. The simple layout ensures ease navigation and engagement. |

**Conclusion**

The development of Science Courseware for Standard 6 students is a great approach for the preparation of PKSK and UKKM. The system development follows the 5 phases in the ADDIE Model which are analysis, design, development, implementation and evaluation. The learning objectives, student needs, and system requirements were identified during the analysis phase. The design phase translates these insights into detailed plans, including content structure, user interface, and assessment strategies. The development phase focuses on creating the courseware, incorporating multimedia elements, interactive features, and assessment tools. Effective testing and teacher training is being done in the implementation phase. The evaluation phase involves measuring usability and functionality to get relevant feedback to improve the courseware continuously. This ongoing iterative cycle makes the courseware effective for creating good user experience and impactful in preparing students for PKSK and UKKM assessments.

**References:**

Bates, A. W. (2019). *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning*. BCcampus

Clark, R. C., & Mayer, R. E. (2018*). e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning* (4th ed.). Wiley.

Molenda, M. (2019). The ADDIE Model. In The Handbook of Research on Educational Communications and Technology (pp. 111-118). *Springer*.

Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2019). *Designing Effective Instruction* (8th ed.). Wiley.

Stevens, C., & Tate, J. (2020). *Evaluating e-Learning: A Guide to Designing and Delivering Effective e-Learning Programs.* Routledge.

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 - Mar - 2025*

# ENGINEERING STUDENTS' PERCEPTION OF MINITAB IN LEARNING STATISTICS

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**ABSTRACT**

*The integration of statistical software in engineering education has become essential for bridging the gap between theoretical concepts and practical applications. This study examines the effectiveness of Minitab software in enhancing students' understanding of statistical concepts in the STA408 course at Universiti Teknologi MARA (UiTM) Penang. A survey was conducted among 26 engineering students from various disciplines, assessing their perceptions of Minitab's usability, impact on learning outcomes, and relevance to future careers. Descriptive statistical analysis revealed that students generally had a positive experience with Minitab, particularly appreciating its visualisation features for interpreting statistical outputs. The findings suggest that incorporating Minitab into statistics courses promotes active learning, improves problem-solving skills, and enhances confidence in statistical analysis. As industries increasingly rely on data-driven decision-making, equipping engineering students with proficiency in statistical tools like Minitab is crucial for their academic and professional development.*

***Keywords: Statistics, Minitab Software, Engineering Students***

## Introduction

In the field of engineering education, the integration of statistical software into the curriculum has become increasingly prevalent. This tool is designed to enhance students' understanding of complex statistical concepts by providing hands-on experience. Minitab, in particular, has been widely adopted because of its user-friendly interface and robust analysis capabilities. Its application spans a variety of educational settings, aiming to bridge the gap between theoretical knowledge and practical application.

Recent studies have explored the effectiveness of incorporating Minitab into statistics education. For example, research conducted by Mairing (2020) examined the combined use of Minitab and Excel in an advanced statistics course. Research findings suggest that relying solely on one software is less effective in improving the learning outcomes of undergraduate students. On the other hand, an integrated approach, coupled with collaborative teaching methods, significantly improves student achievement in statistics learning.

In addition, Minitab's role in facilitating the understanding of statistical concepts has become a topic of discussion among educators. Eales and Stander (2009) highlight the software's ability to assist in teaching statistics in higher education. They emphasise that Minitab's intuitive design and

comprehensive features make it a valuable resource for both instructors and students, promoting a deeper understanding of statistical methodology.

Further investigations have shown the practical benefits of Minitab in educational settings. A study by Ramesh (2009) details how Minitab improves student learning in undergraduate mathematics and statistics programs. Research shows that software helps in developing statistical thinking and provides students with essential skills to perform statistical analysis.

Moreover, the evolution of Minitab has been noted for its impact on statistics education. Software development over the years has simplified the teaching and learning process, making statistical analysis more accessible to students. These developments have played an important role in transforming statistics from a theoretical subject to a practical and application-orientated discipline (Oldknow et al., 2010).

The integration of Minitab into the statistics curriculum has also been associated with improved student engagement. By providing a hands-on approach to data analysis, Minitab encourages active learning and helps students visualise complex statistical concepts, thereby improving overall understanding and retention of material (Okagbue et al., 2021).

Furthermore, the use of Minitab in teaching statistics is in line with the goal of modern education to equip students with practical skills relevant to their future careers. As industries increasingly rely on data-driven decision-making, proficiency in statistical software such as Minitab is an essential competency for engineering graduates (Setambah et al., 2019).

In summary, the incorporation of Minitab into engineering statistics courses has been shown to improve student learning outcomes, foster engagement, and provide practical skills that can be used in professional contexts. These findings emphasise the value of integrating user-friendly statistical software into educational programs to bridge the gap between theory and practice (Alqudah et al., 2024).

## Materials and Methods

### *Research Design and Study Procedure*

This data set consists of responses from 26 engineering students from Universiti Teknologi MARA (UiTM) Penang, who have used Minitab in the Statistics for Science and Engineering (STA408) course. Among the respondents, there were 8 female students and 18 male students. The data provided insight into their perceptions of Minitab's effectiveness in improving their understanding of statistical concepts.

The STA408 course, as discussed by Shaziayani et al. (2024), plays an important role in equipping engineering students with important statistical knowledge and analytical skills. This course provides a solid foundation in data analysis, hypothesis testing, and statistical software applications, making it particularly beneficial for students pursuing careers in engineering and data-driven fields. Given its hands-on approach and integration of tools like Minitab, STA408 is a valuable course that

students should consider to improve their problem-solving abilities and decision-making skills in real-world scenarios.

***Survey Design and Data Collection***

This study aims to explore students' opinions on the use of Minitab software in learning statistical concepts at Universiti Teknologi MARA (UiTM) Penang Branch. A structured questionnaire was used to collect data, which consisted of two main parts: (1) personal information, including gender, faculty (electrical, mechanical, chemical and civil engineering) and age, and (2) students' perceptions of the Minitab software, focusing on its effectiveness in improving their understanding of statistics. Responses were collected anonymously, and all data were anonymised to ensure privacy and reliability.

As shown in Table 1, the questionnaire included 20 questions with a five-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree) designed to measure students' perceptions of the usability, effectiveness, and impact of Minitab on their statistics learning experience. These questions include aspects such as confidence in performing statistical analysis, ease of use, and the role of software in improving problem-solving skills. The collected data were analysed using descriptive statistics to evaluate the overall effectiveness of Minitab in the STA408 course.

Table 1. Lists of Questions and the Items Coding

| **Questions** | **Item Coding** |
|---|---|
| I am confident in my ability to perform statistical analyses. | VAR1 |
| I am confident in interpreting statistical outputs from software tools. | VAR2 |
| I have had a positive experience using Minitab. | VAR3 |
| I found Minitab easy to learn and use. | VAR4 |
| I frequently used Minitab for my assignments and projects. | VAR5 |
| I am confident in my ability to perform statistical analyses after using Minitab. | VAR6 |
| I can apply the statistical knowledge I gained to real-world scenarios effectively. | VAR7 |
| I find Minitab useful for my future studies or career. | VAR8 |
| Using Minitab increased my interest in statistics. | VAR9 |
| Using Minitab has improved my understanding of statistical methods. | VAR10 |
| I feel more confident in exploring complex datasets after using Minitab. | VAR11 |
| Minitab provided useful visualizations that helped me understand statistical outputs better. | VAR12 |
| I find Minitab to be a valuable tool for enhancing my statistical analysis skills. | VAR13 |

| | |
|---|---|
| My ability to solve statistical problems has improved through my experience with Minitab. | VAR14 |
| I feel more prepared to tackle advanced statistical topics after using Minitab. | VAR15 |
| Using Minitab has increased my efficiency in performing statistical analyses. | VAR16 |
| Minitab's user-friendly interface made learning statistics more enjoyable for me. | VAR17 |
| I believe my career prospects in data analysis or related fields have improved through my experience with Minitab. | VAR18 |
| I am confident in teaching others how to use Minitab for statistical analyses. | VAR19 |
| I feel that Minitab has helped me grasp statistical concepts more quickly than other tools. | VAR20 |

***Descriptive Statistics***

The bar chart in Figure 1 depicts the age distribution of the students who participated in the study. The majority of respondents (65.4%) were 23 years old, making this the most common age group. A small number of students, 11.5%, are 22 years old, while 7.7% of respondents are 20 and 24 years old, respectively. Additionally, a minimum number of students aged 26 and 27, respectively representing 3.8% of the total, participated in the survey. This distribution shows that most students are within the typical university age range for undergraduate studies.

The data showed that the students surveyed were mostly in their early twenties, perhaps in their third or fourth year of study. The relatively low number of students aged 26 and 27 indicates that mature students or those pursuing postgraduate studies are not significantly represented in the survey. This distribution is helpful in understanding the demographics of typical students who engage with Minitab software in their statistics coursework.

While the pie chart in Figure 2 presents the distribution of students according to their respective engineering faculties at UiTM Pulau Pinang. The largest group, 42.3% of respondents, belonged to PPKK (Chemical Engineering), which is 11 students. PPKM (Mechanical Engineering) follows closely, comprising 34.6% of students. Meanwhile, PPKA (Civil Engineering) represented 19.2% of participants, and PPKE (Electrical Engineering) accounted for the smallest share of 3.8%, which is 1 student only.

This distribution shows that the majority of students who use Minitab in their coursework come from chemical and mechanical engineering backgrounds. Civil and Electrical Engineering students also participated but in smaller numbers, suggesting fewer students from these faculties were available for this study.

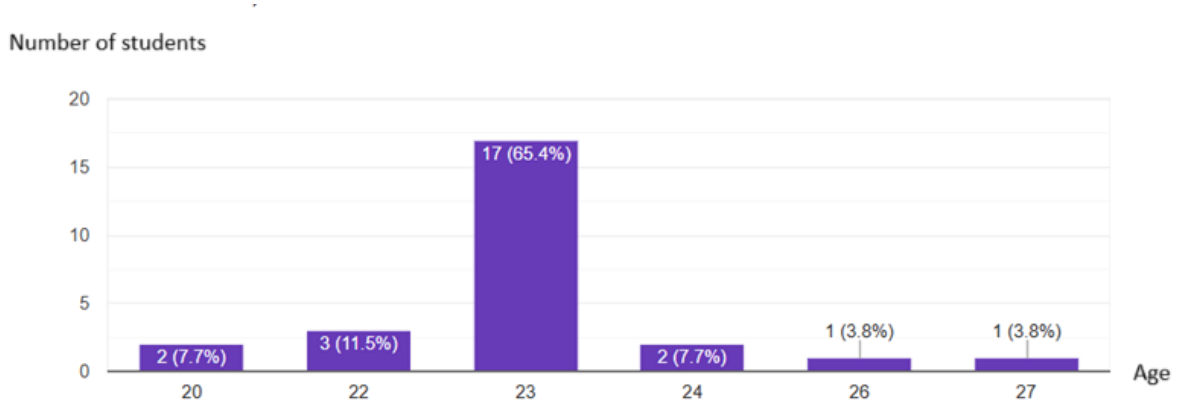


Figure 1. Age Distribution of Students

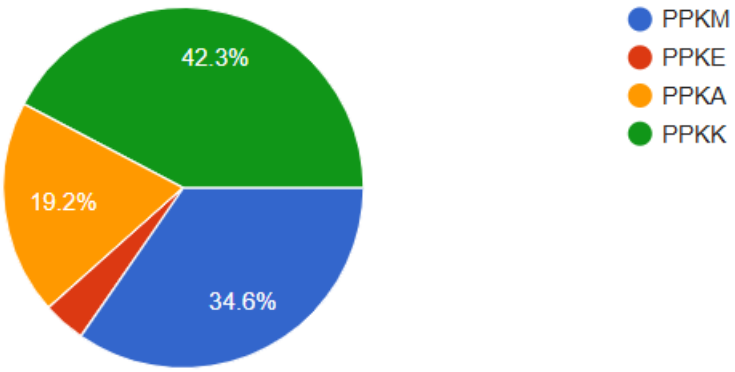


Figure 2. Distribution of Engineering Students by Faculty at UiTM Penang

Furthermore, Table 2 showed the descriptive statistics of students' perceptions regarding the effectiveness of Minitab software in learning statistical concepts in the STA408 (Statistics for Science and Engineering) course at UiTM Penang. The table summarizes the minimum, maximum, mean, standard deviation, and skewness values for 20 different perception-based questions, which were measured on a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The mean scores range from 3.92 to 4.24, indicating generally positive student perceptions of Minitab's role in improving their statistical understanding. The standard deviation values range from 0.759 to 0.909, suggesting some variation in students' responses.

From the table, the highest mean score (4.24) is recorded for VAR12, which suggests that students found Minitab's visualizations particularly useful in understanding statistical outputs. Other high-scoring variables, such as VAR3, VAR9, VAR10, VAR14, and VAR18 (mean = 4.16), indicate that students generally had a positive experience with Minitab, found it effective in increasing their

interest in statistics, and believed it improved their problem-solving skills. Meanwhile, the lowest mean score (3.92) for VAR1 and VAR5 suggests that while students were fairly confident in their ability to perform statistical analyses, they may not have used Minitab as frequently for assignments and projects.

The skewness values range from -0.354 to -0.913, indicating a negatively skewed distribution for all variables. This suggests that most students responded with agreement or strong agreement regarding Minitab's effectiveness. However, variables with relatively lower skewness (e.g., VAR1 and VAR5) indicate a more balanced spread of responses, suggesting that some students might have been neutral or disagreed regarding their confidence in performing statistical analyses. Overall, these findings highlight that students perceive Minitab as a valuable tool for learning statistics, reinforcing its role in enhancing their statistical knowledge and practical skills.

Table 2. Descriptive Statistics of Students' Perceptions on the Use of Minitab in STA408

| **Variable** | **Minimum** | **Maximum** | **Mean** | **Standard Deviation** | **Skewness** | |
|---|---|---|---|---|---|---|
| | | | | | **Statistics** | **Standard Error** |
| VAR1 | 2 | 5 | 3.92 | 0.812 | -0.354 | 0.464 |
| VAR2 | 2 | 5 | 4.12 | 0.781 | -0.79 | 0.464 |
| VAR3 | 2 | 5 | 4.16 | 0.8 | -0.838 | 0.464 |
| VAR4 | 2 | 5 | 4.08 | 0.862 | -0.586 | 0.464 |
| VAR5 | 2 | 5 | 3.92 | 0.909 | -0.556 | 0.464 |
| VAR6 | 2 | 5 | 4.12 | 0.781 | -0.79 | 0.464 |
| VAR7 | 2 | 5 | 4.12 | 0.833 | -0.709 | 0.464 |
| VAR8 | 2 | 5 | 4.08 | 0.909 | -0.529 | 0.464 |
| VAR9 | 2 | 5 | 4.16 | 0.8 | -0.838 | 0.464 |
| VAR10 | 2 | 5 | 4.16 | 0.8 | -0.838 | 0.464 |
| VAR11 | 2 | 5 | 4.08 | 0.759 | -0.759 | 0.464 |
| VAR12 | 2 | 5 | 4.24 | 0.879 | -0.913 | 0.464 |
| VAR13 | 2 | 5 | 4.2 | 0.816 | -0.899 | 0.464 |
| VAR14 | 2 | 5 | 4.16 | 0.85 | -0.768 | 0.464 |
| VAR15 | 2 | 5 | 4.12 | 0.833 | -0.709 | 0.464 |
| VAR16 | 2 | 5 | 4.2 | 0.816 | -0.899 | 0.464 |
| VAR17 | 2 | 5 | 4.12 | 0.781 | -0.79 | 0.464 |
| VAR18 | 2 | 5 | 4.16 | 0.898 | -0.712 | 0.464 |
| VAR19 | 2 | 5 | 4.08 | 0.759 | -0.759 | 0.464 |
| VAR20 | 2 | 5 | 4.08 | 0.812 | -0.66 | 0.464 |

## Conclusion

This study highlights the positive impact of integrating Minitab software into the STA408 course, demonstrating its effectiveness in improving students' statistical understanding, engagement, and analytical proficiency. The findings suggest that Minitab's user-friendly interface and robust analytical tools enhance learning experiences by facilitating hands-on data analysis, fostering self-regulated learning, and preparing students for data-driven decision-making in their future careers. As engineering education evolves, incorporating advanced statistical software into curricula will continue to play a pivotal role in equipping students with essential skills for professional success.

**References:**

Alqudah, H & Khasawneh, M. (2024). Assessing cognitive flexibility: Quantitative insights into the impact of adaptive learning technologies in special education.*International Journal of Data and Network Science, 8*(3), 1463-1470.

Eales, J., & Stander, J. (2009). Using Minitab for teaching statistics in higher education. *MSOR Connections, 9*(3), 6-8. https://doi.org/10.11120/msor.2009.09030006

Mairing, J. P. (2020). The Effect of Advance Statistics Learning Integrated Minitab and Excel with Teaching Teams. *International Journal of Instruction, 13*(2), 139-150. https://doi.org/10.29333/iji.2020.13210a.

Okagbue, H., Oguntunde, P., Emmanuela, C. M., Obasi, & Akhmetshin, E. (2021). Trends and usage pattern of SPSS and Minitab Software in Scientific research. *Journal of Physics: Conference Series.* 1734. 10.1088/1742-6596/1734/1/012017.

Oldknow, A., Taylor, R., & Tetlow, L. (2010). Teaching mathematics using ICT. *New York, NY: Continuum International Publishing Group*.

Ramesh, N. (2009). The role of Minitab in teaching and learning statistics. *MSOR Connections, 9*.

Setambah, M. A., Tajudin, N. M., Yaakob, M. F., & Saat, M. I. (2019). Adventure learning in basic statistics: Impact on undergraduates critical thinking. *International Journal of Instruction, 12*(3), 151-166.

Shaziayani, W. N., Sarimah, S., Norsyiha, F., & Mawardi Omar (2024). The Importance of Minitab Software In The Subject Of Statistics (Sta408) Among Engineering Students. *SIG CS@e-Learning*, *8*, 21-27.

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# THE IMPORTANCE OF LECTURERS' FEEDBACK IN ENHANCING STUDENTS' ACADEMIC PERFORMANCE

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**ABSTRACT**

*Lecturers' feedback is an essential component of the learning process, significantly influencing students' academic performance and overall development. Good feedback gives students precise direction on their development, assisting them in recognizing their strengths, addressing their weaknesses, and improving their comprehension of the course material. Additionally, it acts as a motivating tool, inspiring students to remain involved and actively participate in their education. Students can modify their study techniques as needed when they receive timely, constructive feedback that develops critical thinking, problem-solving abilities, and self-improvement. This paper explores the role of lecturers' feedback in higher education, emphasizing its importance in guiding students' learning, enhancing comprehension, and fostering academic improvement. Various types of feedback, including written, verbal, formative, and summative feedback, are examined to highlight their impact on student performance. The study also discusses the benefits of constructive feedback, such as increased motivation, critical thinking, and self-reflection. However, challenges in delivering effective feedback, such as time constraints, student engagement, and clarity, are also acknowledged. Strategies for overcoming these challenges, including the use of digital tools and structured feedback methods, are proposed. By fostering a feedback rich learning environment, both lecturers and students can contribute to academic excellence and continuous improvement.*

***Keywords: Lecturers' feedback, learning process, academic performance***

## Introduction

Feedback is a fundamental aspect of the teaching and learning process, playing a crucial role in students' academic success. According to Abde et al (2024), feedback is information regarding responses to a product or a person's performance on a task that is used as a basis for development. Feedback from lecturers acts as a guiding tool in higher education, assisting students in evaluating their development, improving their comprehension, and doing better. Giving students constructive criticism helps them identify their areas of strength and growth, which helps them improve their learning methods and succeed academically.

By collecting, considering, and acting upon student input, lecturers can inspire dedication and motivation, promote students' success, and enhance their performance. Furthermore, developing feedback is an inexpensive and very successful method of improving schools (Al Maharma & Abusa'aleek, 2022) Feedback is more important than just fixing errors. It also helps students think critically, reflect on themselves, and become more motivated to study. Feedback encourages a deeper comprehension of the material and helps students develop confidence in their skills when it is given in

a timely, helpful, and understandable way. It also improves the interaction between the instructor and the students, fostering an engaging classroom where students are encouraged and treated with respect. Despite its importance, there are still issues in making sure that students receive and use feedback in an efficient manner. While some students can find it difficult to understand comments, others might not be motivated to take action. In a similar vein, time limits and big class sizes may make it challenging for lecturers to provide thorough and personalized feedback.

Lecturers and students communicate through feedback, in which the lecturers offer observations, recommendations, and assessments of the students' work. Good feedback enables students to identify their areas of strength, comprehend their errors, and make the required adjustments to their learning process. Without appropriate feedback, students can find it difficult to pinpoint their areas of weakness, which might delay their academic progress.

The purpose of this paper is to highlight the significance of lecturers' feedback in enhancing students' academic performance. It will discuss different types of feedback, its benefits, strategies for providing effective feedback, and the challenges that lecturers may face in delivering it. By understanding the importance of feedback, both students and lecturers can work together to create a more effective learning environment.

**Types of Feedback and Their Role in Learning**

Feedback is information provided to students regarding how well they performed on a learning assignment, typically with the goal of enhancing that performance. Good feedback encourages students' drive and self-control in addition to pointing out their areas of strength and growth. According to recent research, feedback should be immediate, precise, and unambiguous in order to have the greatest possible influence on learning outcomes (Lipnevich & Panadero, 2021). Without these elements, feedback may be ineffective or even counterproductive, leaving students confused or disengaged.

There are different types of feedback, including formative and summative feedback, written and verbal feedback, as well as peer and self-assessment. Each type plays a distinct role in enhancing students' learning experiences, with formative feedback focusing on improvement during the learning process, while summative feedback evaluates performance at the end of a task or course.

Table 1 below shows the different types of feedback and their description.

.Table 1: The Different Types of Feedback and Description

| Types of Feedback | Description |
|---|---|
| Written Feedback | Written remarks, frequently on reports, essays, or assignments. Students can now examine and consider the feedback at their own pace. |
| Verbal Feedback | Oral comments given in class, during tutorials, or during one-to-one meetings. It enables engaged conversations and provides instant information. |
| Formative Feedback | Continuous feedback is given during the learning process to track development and direct enhancements prior to final assessments. |
| Summative Feedback | Following the completion of an assignment or test, feedback provided summarizes overall performance and is frequently accompanied by a grade or score. |
| Peer Feedback | Feedback provided by fellow students, encouraging collaborative learning and the development of evaluative skills. |
| Self-Feedback | When students assess their own work, it encourages reflection and self-directed learning. |
| Electronic Feedback | Digital feedback is frequently given quickly and effectively through emails, online platforms, or educational software. |

Understanding the different types of feedback helps both lecturers and students use them effectively to enhance learning. By incorporating a combination of these feedback methods, educators can support students in improving their academic performance.

**Benefits of Lecturers' Feedback for Students**

Feedback plays a crucial role in improving students' academic performance by providing them with guidance on their progress and areas for improvement. Giving students constructive criticism enables them to close the achievement gap between their present performance and the learning objectives they have set. According to Al Maharma and Abusa'aleek (2022), students' academic performance has been significantly impacted by the comments they receive from their teachers. Thus, it is essential to analyse this feedback.

Feedback that is well structured helps students to think back on their errors, improve, and make the required corrections. Moreover, feedback contributes to students' motivation and confidence. Constructive and formative feedback fosters a growth mindset, helping students perceive challenges as learning opportunities rather than failures. Forsythe and Johnson (2016) in their research state that the

goal of good feedback is to help students become conscious and convert that awareness into positive behavioural changes. The effectiveness of feedback also depends on its quality and delivery. Feedback should be timely, specific, and actionable to have a meaningful impact on students' academic development. Furthermore, the use of digital platforms has enhanced the accessibility of feedback, allowing for quicker response times and continuous engagement in the learning process.

The power and potential of feedback to improve student learning, performance and education experience is supported by the literature as stated by Williams, A. (2024). Feedback is more important than just fixing errors. It also helps students think critically, reflect on themselves, and become more motivated to study. Feedback encourages a deeper comprehension of the material and helps students develop confidence in their skills when it is given in a timely, helpful, and understandable way. It also improves the interaction between the instructor and the students, fostering an engaging classroom where students are encouraged and treated with respect.

**Challenges in Providing Feedback**

Providing effective feedback is essential for student learning, but lecturers often face several challenges in this process. Despite its significance, challenges remain in ensuring that feedback is effectively provided and utilized by students. Some students may struggle to interpret feedback, while others may lack the motivation to act on it. Similarly, lecturers may face difficulties in delivering detailed and individualized feedback due to time constraints and large class sizes.

Table 2 below outlines some of the key challenges lecturers face when providing feedback, along with descriptions and potential solutions.

Table 2: Challenges and Potential Solution in Providing Feedback

| Challenges | Description | Potential Solution |
|---|---|---|
| Time Constraints | Large class sizes, making it difficult to provide detailed and timely feedback to each student. | Use digital technologies for automatic feedback. |
| Student Engagement | Some students may not actively review or apply the feedback provided. | Encourage feedback discussions and require students to reflect on feedback received. |
| Clarity and Specificity | Feedback that is too generic could not assist students comprehend how to go better. | Provide clear, specific, and actionable feedback aligned with learning objectives. |

| | | |
|---|---|---|
| Emotional Impact | Negative feedback may demotivate students and reduce confidence. | Use a balanced approach with constructive criticism and positive reinforcement. |
| Technological Limitations | Some students may lack access to digital tools for receiving electronic feedback. | Ensure multiple feedback delivery methods, including in person and written feedback. |

Feedback does not exist in a vacuum, but rather in the messiness of relationships, resource constraints, and everything in between. The studies from Paris (2022) show that instructors face significant challenges when trying to give students effective feedback and how external factors influence it. The difficulties faced in giving their students useful feedback included their own emotions and mindsets, student behaviour and also the high workload brought on by large class sizes and institutional restrictions.

**Conclusion**

In conclusion, lecturers' feedback plays a vital role in enhancing students' academic performance by guiding their learning process, improving their understanding of course materials, and fostering self-reflection. Effective feedback, whether written, verbal, formative, or summative, helps students identify their strengths and areas for improvement, ultimately leading to better academic outcomes. Research has consistently shown that well-structured, timely, and specific feedback contributes to students' motivation, engagement, and critical thinking skills.

In order to maximize the benefits of feedback, students must also take an active role in engaging with the feedback provided. This includes reviewing feedback carefully, seeking clarification when necessary, and implementing suggestions for improvement in their future work. Additionally, integrating multiple forms of feedback, such as peer and self-assessment, can further enhance students' learning experiences by encouraging collaborative learning and self-regulation. Feedback is a fundamental aspect of the teaching and learning process, and when delivered effectively, it can significantly contribute to students' academic growth and success. By addressing the challenges associated with feedback and implementing effective feedback strategies, educators can create a more supportive and enriching learning environment that fosters continuous improvement and academic excellence.

Furthermore, institutions play a crucial role in promoting effective feedback practices by providing educators with the necessary resources and support. Training programs, workload management strategies, and the use of learning technologies can help lecturers provide timely and high-

quality feedback. Additionally, fostering a culture where feedback is viewed as a dialogue rather than a one-way process can create a more interactive and supportive learning environment.

Students are more likely to succeed academically and develop critical thinking abilities when professors provide them timely, constructive, and well-structured feedback. Overall, feedback is a potent instrument for learning and growth in addition to being an assessment tool. When properly applied, it may change students' educational experiences, encourage lifelong learning, and set them up for future success in the workplace. Lecturers may guarantee that feedback stays a significant and influential component of the learning process by addressing current issues and consistently enhancing feedback procedures.

**References**

Abde, R. P., B., J., Balala, R. A., Bandiwan, M. A. L., Deang, J. V., Losnong, G. A., Quinio, M. R., Salbino, J. C., Velasco, J. B., & Eguia, M. L. G. (2024). Teacher's feedback on students motivation and academic engagement. *Cognizance Journal of Multidisciplinary Studies, 4*(7), 1–8. https://doi.org/10.47760/cognizance.2024.v04i07.001.

Al Maharma, H., & Abusa'aleek, R. (2022). Teachers' feedback and students' academic achievement. *International Education Studies*, *15*(6), 65. https://doi.org/10.5539/ies.v15n6p65.

Forsythe, A., & Johnson, S. (2016). Thanks, but no-thanks for the feedback. Assessment & Evaluation in Higher Education, 42(6), 850–859. https://doi.org/10.1080/02602938.2016.1202190.

Lipnevich, A. A., & Panadero, E. (2021). A review of feedback models and theories: Descriptions, definitions, and conclusions. *In Frontiers in Education, 6*. Frontiers Media S.A. https://doi.org/10.3389/feduc.2021.720195.

Paris, B. M. (2022). Instructors' perspectives of challenges and barriers to providing effective Feedback. *Teaching and Learning Inquiry, 10*. https://doi.org/10.20343/teachlearninqu.10.3.

Williams, A. (2024). Delivering effective student feedback in higher education: An evaluation of the challenges and best practice. *International Journal of Research in Education and Science (IJRES), 10*(2), 473-501. https://doi.org/10.46328/ijres.3404.

*2-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# ENVIRONMENTAL AND ECONOMIC IMPLICATIONS OF ELECTRONIC WASTE (E-WASTE) IN MALAYSIA

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**ABSTRACT**

As one of the fastest-growing waste streams globally, e-waste presents significant challenges and opportunities for developing economies. The research highlights how Malaysia's rapid technological advancement and urbanization have contributed to increased e-waste generation, while regulatory frameworks remain inadequately implemented. The environmental implications include soil and water contamination, air pollution, increased carbon footprint, and threats to biodiversity due to hazardous substances like heavy metals. From an economic perspective, e-waste contains valuable recoverable materials that could contribute to resource security and economic resilience. The study also discusses how proper e-waste management creates employment opportunities and stimulates entrepreneurship. However, low recycling rates persist due to inadequate infrastructure and limited public awareness. The paper concludes that improving regulatory enforcement, enhancing public education, and investing in sustainable recycling infrastructure are essential steps toward creating an e-waste management system that effectively balances environmental protection with economic development.

***Keywords: Electronic waste, Environmental contamination, Hazardous materials, Sustainable recycling, Economic opportunities***

## Introduction

Electronic waste (e-waste) has emerged as a significant global environmental and economic issue due to the increasing consumption and disposal of electronic products. The rapid pace of technological advancement, urbanization, and population growth has led to an unprecedented surge in e-waste generation worldwide. The World Health Organization (WHO) has reported that e-waste is one of the fastest-growing waste streams worldwide, with an estimated 53.6 million metric tons generated in 2019 alone, a figure projected to rise to 74 million metric tons by 2030 (Razali et al., 2019). According to the Global E-Waste Monitor, an estimated 53.6 million metric tons of e-waste were generated globally in 2019, with only 17.4% being properly collected and recycled (Forti et al., 2020). This rapid growth in e-waste generation is driven by several intersecting factors: accelerating technological innovation, decreasing product lifespans, expanding digital access in developing economies, and changing consumer preferences that favor frequent device upgrades. The resulting waste stream creates complex management challenges, as e-waste contains both valuable materials worth recovering (precious metals, rare earth elements, and base metals) and hazardous substances requiring careful handling to prevent

environmental contamination. The improper disposal of e-waste results in severe environmental hazards due to toxic materials such as heavy metals, lead, mercury, and cadmium.

In Malaysia, the situation is similarly alarming, with e-waste generation increasing significantly due to rapid urbanization and technological advancement (Sujá et al., 2014). The Malaysian government has classified e-waste as scheduled waste under the Environmental Quality Regulations, emphasizing the need for regulated management to mitigate its hazardous impacts (Noor et al., 2023; El-Gawhari et al., 2024). These regulations mandate that e-waste must be handled, transported, and treated by licensed facilities. Additionally, the government introduced the Environmental Quality (Prescribed Premises) (Treatment and Disposal Facilities) Order 1989, which establishes requirements for waste treatment and disposal facilities. Despite these regulatory efforts, implementation and enforcement challenges persist, resulting in a significant portion of e-waste being managed through informal channels or improperly disposed of with general waste (Yuan et al., 2019). The difference between formal and informal e-waste management systems creates a dual set of challenges. The informal sector, while providing economic livelihoods, often employs primitive recycling techniques that pose environmental and health risks. Meanwhile, the formal sector struggles to capture sufficient e-waste volumes to achieve economic viability, despite offering superior environmental performance. This dynamic creates a complex policy landscape requiring interventions that address both environmental protection and economic development objectives.

This paper investigates the environmental and economic implications of e-waste in Malaysia, highlighting the associated risks and potential opportunities.

**Environmental Implications of e-waste**

E-waste poses substantial environmental risks due to the presence of hazardous substances. The primary environmental concerns associated with e-waste include soil and water contamination, air pollution, and adverse effects on biodiversity. These impacts are particularly reflected in areas with informal recycling operations, where inadequate technological capacity and limited regulatory oversight result in ineffective waste management practices. Improper disposal of e-waste leads to the leaching of toxic substances into the soil and water bodies. The toxic effects of e-waste pollutants on wildlife, particularly in aquatic environments, have been well documented. E-waste contains hazardous materials such as heavy metals (lead, mercury, cadmium) and toxic substances posing significant risks to human health and the environment (Sujá et al., 2014). Uncontrolled disposal methods, particularly in informal recycling sectors, exacerbate these risks, leading to soil and water contamination (Sujá et al., 2014; Ohajinwa et al., 2019).

The improper disposal and management of e-waste contribute to Malaysia's carbon footprint. Burning e-waste to extract valuable metals is a common practice, especially in informal recycling

sectors. This process releases harmful dioxins and furans, contributing to air pollution and respiratory issues among local populations. When electronic devices are disposed of in landfills instead of being recycled, valuable resources are wasted, necessitating the extraction and processing of virgin materials, which is energy-intensive and generates significant greenhouse gas emissions. Furthermore, certain electronic components, particularly refrigerants in cooling devices, contain potent greenhouse gases that can be released into the atmosphere when improperly handled, exacerbating climate change impacts (Tukimin et al., 2019). Research highlights that unregulated e-waste processing in Malaysia exacerbates air pollution, leading to increased health risks in affected communities. The improper handling of e-waste not only threatens local ecosystems but also affects public health, with studies indicating that workers in informal recycling operations are often unaware of the health risks associated with exposure to these hazardous materials (Aja et al., 2016). Exposure to e-waste-derived pollutants has been associated with various health issues, including neurological damage, respiratory problems, skin disorders, and increased risk of certain cancers (Sujá et al., 2014; Ohajinwa et al., 2019). Particularly vulnerable are informal recyclers and communities living near unregulated e-waste processing sites, who face heightened exposure to hazardous substances through direct contact, inhalation of toxic fumes, or consumption of contaminated water and food.

Furthermore, Malaysia's rapid urbanization has resulted in increased e-waste generation, which, if not managed properly, could lead to severe environmental degradation (Tiep et al., 2015). The Malaysian government has recognized these challenges and has implemented regulations to manage e-waste. However, despite the legal framework, the actual recycling rates remain dismally low, with a significant portion of e-waste ending up in landfills (Yuan et al., 2019; El-Gawhari et al., 2024). E-waste disposal has been linked to declining biodiversity in water bodies near urban landfills. This situation highlights the urgent need for improved waste management practices and public awareness campaigns to promote responsible disposal and recycling of e-waste (Noor et al., 2023).

**Economic Implications of e-Waste**

The economic implications of e-waste management in Malaysia are equally significant. If managed properly, e-waste can serve as a valuable resource for recovering precious metals and fostering economic growth. Valuable materials such as gold, silver, and palladium are embedded in electronic devices, and proper recycling can recover these resources (Sujá et al., 2014). For instance, a ton of mobile phones contains approximately 300 times more gold than a ton of gold ore, highlighting the economic potential of urban mining (Sofian et al., 2023). Effective e-waste recycling could reduce Malaysia's dependence on imported raw materials, contributing to resource security and economic resilience. The development of a robust e-waste recycling industry in Malaysia presents significant opportunities for job creation and economic growth.

Studies suggest that formal e-waste recycling creates more employment opportunities than landfilling, with jobs spanning collection, transportation, dismantling, processing, and material recovery (Afroz et al., 2020). Additionally, the sector can stimulate entrepreneurship through the establishment of collection centers, recycling facilities, and refurbishment businesses. Research indicates that effective e-waste management could create thousands of jobs in Malaysia while generating substantial revenue from recovered materials (Sofian et al., 2023; Afroz et al., 2020).For instance, effective e-waste management can lead to the creation of green jobs in recycling facilities and related sectors, thereby enhancing local economies (Sofian et al., 2023).

However, the current e-waste recycling rate in Malaysia remains low due to inadequate infrastructure and limited public awareness. (Azlan et al., 2021; Hussin et al., 2023). Public attitudes and behaviors significantly influence e-waste management outcomes in Malaysia. Research indicates that while awareness of e-waste hazards is increasing, this knowledge does not consistently translate into appropriate disposal practices (Akhtar et al., 2014; Azlan et al., 2021). Many consumers continue to store obsolete devices at home, sell them to informal collectors, or dispose of them with general waste due to convenience, lack of accessible recycling options, or insufficient incentives for proper disposal. Understanding these behavioral patterns is crucial for developing effective interventions to enhance participation in formal e-waste recycling programs (Hussin et al., 2023). Educational initiatives play a critical role in fostering responsible e-waste management behaviors. Studies suggest that increased awareness and knowledge about e-waste can lead to more proactive recycling behaviors among residents (Akhtar et al., 2014; Azlan et al., 2021). However, many individuals still lack a comprehensive understanding of the e-waste management systems in place, which can lead to improper disposal practices (Yuan et al., 2019; Tukimin et al., 2019). Targeted awareness campaigns, educational programs in schools, and community engagement initiatives are essential for cultivating a culture of responsible e-waste management in Malaysia. By fostering a culture of recycling, Malaysia can not only mitigate the environmental impacts of e-waste but also harness its economic potential.

**Conclusion**

The environmental and economic implications of e-waste in Malaysia underscore the urgent need for improved management strategies. While e-waste poses significant environmental risks, it also presents opportunities for resource recovery and economic growth. Strengthening regulatory frameworks, increasing public awareness, and investing in sustainable recycling infrastructure are crucial steps toward mitigating the negative impacts of e-waste. By addressing these challenges, Malaysia can transition towards a more sustainable e-waste management system that balances economic benefits with environmental protection.

**References:**

Afroz, R., Muhibbullah, M., Farhana, P., & Morshed, M. (2020). *Analyzing the intention of the households to drop off mobile phones to the collection boxes: empirical study in malaysia*. Ecofeminism and Climate Change, 1(1), 3-20. https://doi.org/10.1108/efcc-03-2020-0004

Aja, O. C., Al-Kayiem, H. H., Zewge, M. G., & Joo, M. S. (2016). Overview of Hazardous Waste Management Status in Malaysia. InTech. doi: 10.5772/63682

Akhtar, R., Masud, M., & Afroz, R. (2014). *Household perception and recycling behaviour on electronic waste management: a case study of kuala-lumpur, malaysia*. Malaysian Journal of Science, 33(1), 34-41. https://doi.org/10.22452/mjs.vol33no1.5

Azlan, R., Razak, S., & Indıran, L. (2021). *Knowledge, attitude and practices on e-waste management among business students in a public university*. International Journal of Academic Research in Business and Social Sciences, 11(8). https://doi.org/10.6007/ijarbss/v11-i8/10609

El-Gawhari, I., Hameed, I., & Sami, F. (2024). *Strategies to manage electronic-wastes in malaysia: a review study*. Zagazig Journal of Agricultural Research, 51(2), 157-169. https://doi.org/10.21608/zjar.2024.353639

Forti, V., Balde, C. P., Kuehr, R., & Bel, G. (2020). The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential.

Hussin, N., Ali, N., & Khalil, N. (2023). *E-waste management systems in shah alam city: household awareness and behavior*. International Journal of Academic Research in Business and Social Sciences, 13(4). https://doi.org/10.6007/ijarbss/v13-i4/16320

Noor, N., Soleman, N., & Azuan, A. (2023). *To recycle or not to recycle? factors affecting malaysian residents' intention for recycling e-waste*. Malaysian Journal of Social Sciences and Humanities (Mjssh), 8(2), e002102. https://doi.org/10.47405/mjssh.v8i2.2102

Ohajinwa, C., Bodegom, P., Osibanjo, O., Xie, Q., Chen, J., Vijver, M., … & Peijnenburg, W. (2019). *Health risks of polybrominated diphenyl ethers (pbdes) and metals at informal electronic waste*

*recycling sites.* International Journal of Environmental Research and Public Health, 16(6), 906. https://doi.org/10.3390/ijerph16060906

Razali, F., & Wai, C. W. (2019). A review of Malaysia solid waste management policies to improve recycling practice and waste separation among households. International Journal of Built Environment and Sustainability, 6(1-2), 39-45.

Sofian, D., Hanafiah, ., Woon, K., & Hassan, F. (2023). *Characteristics of consumer towards development of sustainable e-waste management in malaysia*. Iop Conference Series Earth and Environmental Science, 1167(1), 012043. https://doi.org/10.1088/1755-1315/1167/1/012043

Sujá, F., Rahman, R., Yusof, A., & Masdar, M. (2014). *E-waste management scenarios in malaysia*. Journal of Waste Management, 2014, 1-7. https://doi.org/10.1155/2014/609169

Tiep, H. S., Kin, T. D. Y., Ahmed, E. M., & Teck, L. C. (2015). E-waste management practices of households in Melaka. International Journal of Environmental Science and Development, 6(11), 811. doi:10.7763/ijesd. 2015.v6.704

Tukimin, M., Anwar, R., & Latif, A. (2019). *A performance on awareness of e-waste management among university students*. International Journal of Engineering and Advanced Technology, 9(1), 3510-3414. https://doi.org/10.35940/ijeat.a2677.109119

Yuan, P., Mun, N., & Rajendran, S. (2019). *A study on barriers to implement e-waste management*. E3s Web of Conferences, 136, 02026. https://doi.org/10.1051/e3sconf/201913602026

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# ANALYZING STUDENTS' CONFUSION IN INTEGRATION AND DIFFERENTIATION TECHNIQUES IN CALCULUS

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**ABSTRACT**

*This study investigates engineering students' confusion in mastering integration and differentiation techniques in calculus and its impact on their academic performance. A quantitative approach is employed, analyzing students' final examination responses to identify misconceptions and recurring errors. The study aims to determine the extent of confusion, examine its effect on students' mathematical competency, and propose pedagogical strategies for improvement. The findings highlight key difficulties in selecting appropriate techniques, applying differentiation rules, and handling algebraic manipulations. Addressing these challenges is crucial in enhancing students' comprehension and problem-solving skills in calculus.*

***Keywords: Calculus, Integration, Differentiation, Student Confusion***

## Introduction

Calculus serves as a fundamental component in engineering education, essential for mathematical modeling and technical problem-solving. Despite its significance, many students struggle with integration and differentiation due to conceptual misunderstandings, leading to persistent academic challenges. Research suggests that confusion arises from weak foundational knowledge, ineffective pedagogical approaches, and difficulty in contextualizing calculus within real-world engineering applications (Engelbrecht et al., 2020; Clements et al., 2019).

This study aims to explore the sources of confusion in integration and differentiation, assess its impact on academic performance, and propose targeted strategies for pedagogical enhancement. Addressing these issues can refine instructional methodologies, equipping students with stronger analytical skills necessary for success in engineering disciplines.

Research on students' confusion in mastering integration and differentiation techniques in calculus has gained considerable attention in higher education. This literature review aims to critically identify similarities, differences, gaps, and strengths of previous studies and their implications for engineering students. A study by Solfitri et al. (2019) found that students experience significant confusion in understanding and interpreting integration problems, leading to failure in solving calculus problems accurately. The strength of this study lies in its use of Newman's classification, which systematically analyzes student errors. However, it does not thoroughly explore the direct impact of confusion on the long-term academic performance of engineering students.

Similar to Solfitri et al. (2019), Kairuddin (2017) also found that the biggest confusion among students occurs in understanding basic mathematical concepts. This study makes a significant contribution by providing strong empirical evidence on the primary cause of students' confusion. However, it does not directly emphasize the long-term implications for engineering students, which is its major limitation.

On the other hand, Prakitipong and Nakamura (2006) focused more on errors in algebraic processes and the transformation of mathematical information. Their research highlights the importance of mastering algebraic processes, which serve as a crucial foundation in understanding calculus. However, this study does not sufficiently address the affective aspects of students, which also influence the learning process.

Meanwhile, Clements et al. (2019) examined the impact of confusion in learning calculus specifically on engineering students. They concluded that engineering students often struggle to apply calculus concepts in real engineering situations due to fundamental confusion in integration and differentiation techniques. The key strength of this study is its specific focus on the academic and professional implications for engineering students.

Additionally, the study by Engelbrecht et al. (2020) highlighted the advantages of using technology in calculus teaching to address student confusion. However, a significant limitation of this study is the lack of strong empirical evidence on the long-term effectiveness of technology in overcoming confusion in integration and differentiation techniques.

Overall, there are several similarities and differences among previous studies. The main similarity is that student confusion primarily stems from weak fundamental mathematical concepts. However, a key difference lies in the focus of each study some emphasize problem interpretation, while others focus on algebraic processes and technical skills. The most apparent gap is the absence of a comprehensive study that integrates affective factors, pedagogy, and the long-term implications of confusion for engineering students.

Therefore, this study aims to fill this gap by focusing on engineering students' mastery of integration and differentiation techniques and identifying the impact of this confusion on their academic performance and professional competence. his study is designed to achieve three primary objectives. First, it seeks to identify the most common sources of confusion experienced by engineering students in integration and differentiation. Second, it aims to analyze how these difficulties impact students' academic performance and problem-solving abilities. Finally, it proposes pedagogical interventions that can help mitigate these issues and enhance conceptual understanding, ultimately leading to better learning outcomes in calculus.

**Methodology**

This study employs a quantitative approach to analyze the confusion experienced by first-year engineering students in applying integration and differentiation techniques in calculus. A sample of 40 students from a public university was selected, and data were collected from their final semester examination answers, specifically focusing on questions related to these techniques. The primary objective is to identify the most common errors and misconceptions that hinder students' understanding and application of integration and differentiation in problem-solving.

The data is analyzed through a structured process. Firstly, errors are categorized based on mathematical concepts, including issues related to integration technique selection, algebraic manipulation, and notation inaccuracies. Descriptive statistical analysis is then applied to determine the frequency and severity of each error type. Lastly, a comparative assessment is conducted by relating the findings to existing literature to contextualize students' difficulties and establish a more comprehensive understanding of the problem.

**Result and Discussion**

The analysis revealed common error patterns among students, as summarized in Table 1. The descriptive statistical analysis of students' errors in calculus revealed that the most common confusion was choosing the appropriate integration technique, affecting 45% of students (18 out of 40). This suggests that students struggle to differentiate between various integration methods, such as substitution, integration by parts, and partial fractions. The second most prevalent issue was a lack of understanding of fundamental differentiation concepts, with 35% (14 students) making errors in applying basic differentiation principles.

Furthermore, 30% (12 students) encountered difficulties in algebraic manipulation during both differentiation and integration processes. This indicates that a weak foundation in algebra contributes to miscalculations and incorrect steps in problem-solving. Additionally, 25% (10 students) struggled with the application of the chain rule, a crucial differentiation technique used in composite functions. Lastly, 20% (8 students) faced errors in mathematical notation, which could lead to misunderstandings and misinterpretation of problems.

Table 1: Percentage of Common Student Confusions in Integration and Differentiation

| Type of Confusion | Number of Students | Percentage (%) |
|---|---|---|
| Error in Choosing Integration Technique | 18 | 45% |
| Error in Differentiation | 14 | 35% |
| Algebraic Errors in Calculus | 12 | 30% |
| Transformation Function Errors | 10 | 25% |
| Mathematical Notation Errors | 8 | 20% |

These findings align with previous studies that suggest integration is a major challenge among engineering students due to their struggle in selecting appropriate techniques (Solfitri et al., 2019). Similarly, differentiation errors are often linked to a lack of understanding of the chain rule, a crucial concept in advanced calculus (Engelbrecht et al., 2020). The following Table 2 presents examples of errors, their causes, and their impact on learning.

Table 2: Error Categories and Their Impact

| Type of Confusion | Example of Error | Cause of Confusion | Impact on Learning |
|---|---|---|---|
| Error in Choosing Integration Technique | Student uses integration by parts for $\int e^{x^2}/x\,dx$, while the more appropriate technique is direct integration | Lack of understanding in identifying appropriate function forms | Students need more practice in recognizing the correct integration technique |
| Error in Differentiation | Student writes $d/dx(\sin x) = \cos x$ but makes a mistake in differentiating composite functions such as $d/dx(\sin 2x) = \cos 2x$ instead of the correct answer, $2\cos 2x$ | Lack of understanding of the chain rule | This error leads to mistakes in solving differential equations |
| Algebraic Errors in Calculus | Incorrectly expands $(x+2)(x-2)$ as $x^2+4$ | Weak algebraic foundations before proceeding with integration or differentiation | Leads to incorrect final solutions, reducing accuracy |
| Transformation Function Errors | Student writes $\ln(1+x/1-x)$ as $(1-x)/(1+x)$ in differentiation | Confusion in derivative rules and problem-solving methods | Results in significant errors in differentiation and problem-solving |
| Mathematical Notation Errors | Student writes $\int \sqrt[3]{(x^2+5)^2}\,dx$ but provides the answer as $\int (x^2+5)^{3/2}\,dx$ | Inaccuracy in writing the final notation | This mistake can affect the entire final solution |

The results of this study underscore the need for targeted instructional interventions to address students' confusion in integration and differentiation. One effective strategy is active learning, where

problem-based learning and real-world applications are integrated into the curriculum. Clements et al. (2019) emphasize that engaging students in contextualized problem-solving tasks enhances their conceptual understanding. Another crucial approach is technology integration, such as utilizing digital simulations and step-by-step software guidance to reinforce learning through visualization (Engelbrecht et al., 2020). Furthermore, targeted remediation programs should be introduced, focusing on structured algebraic reinforcement and guided differentiation exercises to strengthen students' proficiency in fundamental mathematical concepts (Kairuddin, 2017). By implementing these strategies, educators can significantly improve students' comprehension and reduce persistent errors in calculus.

**Conclusion**

This study highlights the significant confusion that engineering students face in integration and differentiation techniques, with notable deficiencies in selecting appropriate methods, applying differentiation rules, and performing algebraic manipulations. The findings suggest that these difficulties stem from weak foundational knowledge and insufficient pedagogical reinforcement in core mathematical principles.

To address these issues, educators should focus on strengthening students' conceptual understanding through targeted interventions, including interactive learning, continuous formative assessment, and reinforcement of algebraic skills. By incorporating structured teaching methodologies that emphasize conceptual clarity and problem-solving skills, students' competency in calculus can be significantly improved, ultimately enhancing their ability to apply mathematical techniques in engineering contexts.

Future research should explore the effectiveness of various teaching methodologies in mitigating student confusion in calculus. A longitudinal study tracking students' improvement over time could provide deeper insights into the long-term benefits of specific pedagogical strategies. Additionally, qualitative approaches such as student interviews and focus group discussions could be employed to further understand the cognitive barriers affecting student learning in integration and differentiation.

**References:**

Clements, D. H., Sarama, J., & Germeroth, C. (2019). *Learning trajectories in mathematics education: Perspectives of psychology, curriculum, instruction, and assessment*. Educational Researcher, 48(2), 95–105.

Engelbrecht, J., Bergsten, C., & Kågesten, O. (2020). *Mathematics education in the digital age: Learning and teaching in a changing world*. Routledge.

Kairuddin, K. (2017). *Students' conceptual understanding of basic mathematics and its impact on calculus performance*. Journal of Mathematics Education, **11**(1), 45–60.

Prakitipong, N., & Nakamura, S. (2006). *Analysis of students' mathematical errors in learning fractions.* International Journal of Mathematics Education, **38**(3), 181–190.

Solfitri, T., Yusuf, M., & Rahayu, S. (2019). *Students' difficulties in solving integral calculus problems: An error analysis using Newman's theory*. Journal of Mathematics and Science Education, **7**(2), 102–115.

*e-ISBN :978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# THE EFFECT OF ONLINE LEARNING ON STUDENT INVOLVEMENT AND ACHIEVEMENT IN PERMATANG PAUH CAMPUS, UiTM CAWANGAN PULAU PINANG (UiTMCPP)

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**ABSTRACT**

*This study investigates the effects of online learning on student engagement and academic achievement at the Permatang Pauh Campus of Universiti Teknologi MARA Cawangan Pulau Pinang (UiTMCPP). As the institution transitioned from traditional face-to-face learning to online education during the COVID-19 pandemic, students faced both opportunities and challenges. The study employed a questionnaire-based survey targeting 82 students from Culinary Arts Management, Mechanical Engineering, and Electrical Engineering programs. A sample of 34 students was selected using simple random sampling, and data were analyzed using descriptive and inferential statistics, including ANOVA and chi-square tests. The findings revealed that while online learning provided flexibility and accessibility, it also led to varying levels of student engagement and academic performance. Some students reported increased participation, while others struggled with motivation and concentration. The ANOVA results indicated significant differences in GPA among the three academic programs, suggesting that the effectiveness of online learning varied by field of study. The study highlights the need for enhanced online learning strategies, including interactive course designs and real-time feedback mechanisms, to improve student engagement and academic outcomes. Future research should explore long-term trends in online education to further refine instructional practices.*

***Keywords: Online Learning, Student Engagement, Academic Achievement, Higher Education***

## Background of Study

The COVID-19 pandemic created an unforeseen period of limited opportunities, forcing an extended disruption of face-to-face education. Its worldwide impact affected over 850 million students, leading to the suspension of in-person learning (Ulum, 2022). Permatang Pauh Campus of Universiti Teknologi MARA Cawangan Pulau Pinang (UiTMCPP) is also moving from face-to-face classes or traditional classroom learning to online learning during the COVID-19 pandemic. This change brought both opportunities and challenges. Online learning offers flexibility and convenience but concerns about its impact on student engagement and academic performance exist (Akpen et.al, 2024). The study focuses on understanding on how online learning has influenced student involvement and achievement at UiTMCPP. By comparing students' experiences and performance in

online learning versus traditional classroom learning, this research will provide insights to help students improve their future teaching strategies at the university.

The study will target students at the Permatang Pauh Campus of UiTMCPP and aim to understand their level of engagement in online classes and how it affects their academic performance. The findings will help to identify strategies to enhance the online learning experience at the university. The sampling frame, which consists of 82 students, was chosen as respondents in this study. They are students from the Culinary Arts Management, Mechanical Engineering and Electrical Engineering programs. The data for this study will be collected through an online survey. The survey will include multiple-choice and open-ended questions to capture quantitative and qualitative data from the students. The questions will cover how often students participate in online classes, their engagement during lessons, and their perceived academic performance.

**Methodology**

This study uses a questionnaire approach to analyse the engagement and academic performance of the Permatang Pauh Campus of UiTMCPP students in online and traditional learning environments. The data was gathered using an online questionnaire survey, which was shared via online group chats with 82 students from the Culinary Arts Management, Mechanical Engineering, and Electrical Engineering programs. This simple random sampling method was selected to ensure an equal selection of respondents. The survey contained closed-ended and open-ended questions suggested by Survey Planet (2025), allowing qualitative and quantitative data. The questionnaire has been modified to be suitable for this study. Descriptive and inferential statistical methods, including ANOVA and chi-square tests, were applied to analyse the data and ensure it complies with the study's objectives.

***Data Exploration***

The study focused on a population of 82 students from the Culinary Arts Management, Mechanical Engineering, and Electrical Engineering programs in the Permatang Pauh Campus of UiTMCPP. A sample of 34 students was selected using simple random sampling, ensuring a representative mix from the three programs. Data was collected via a questionnaire survey distributed through Google Forms, with the survey link shared on online platforms such as Telegram and WhatsApp to facilitate easy access for the participants.

***Steps of Simple Random Sampling***

Below are the steps of applying simple random sampling to choose the sample in this study.

1) Define the population for this study, consisting of 82 students from the Culinary Arts, Electrical Engineering, and Mechanical Engineering programs.

2) Determine the required sample size using an online sample size calculator.
3) Create a sampling frame by preparing a complete list of all 82 students in the population.
4) Assign a unique number for each individual in the sampling frame, starting from one.
5) Then, select 34 numbers randomly from the sampling frame using a random number generator to ensure fairness.
6) Cross-check the selected number with the sampling frame to identify the individual by their names.
7) Lastly, data from the selected sample will be collected and recorded by distributing the survey online.

***Method Analysis***

Table 1 below are the details of the research objectives, variable (s) involved, and the analysis method used in this study.

Table 1. Research objectives, variable (s) involved, and analysis method

| Objective | Variable (s) | Analysis Method |
|---|---|---|
| 1. To describe students' learning engagement in online classes and traditional classroom settings in the Permatang Pauh Campus of UiTMCPP. | Student engagement | Bar-chart |
| 2. To determine whether there is a significant difference in academic performance between different programs. | Current GPA<br>Field of Study | One-way ANOVA |

**Finding**

The main goal of this study was to find out how online learning at the Permatang Pauh Campus of UiTMCPP affected student participation and performance. Many new ideas were found by gathering information from 34 students in the Culinary Arts Management, Mechanical Engineering, and Electrical Engineering programs. For this study, the questionnaire was sent out through Google Forms, and students who filled it out were chosen randomly. The results examine how online learning platforms have affected student engagement and academic success, pointing out both the good things that have happened and the problems that students have had to deal with during this change.

The information from 34 students who answered the questionnaire how online learning affects student participation and success on their studies at the Permatang Pauh Campus, UiTMCPP. The results from Figure 1 shows that most of the students in the Culinary Arts Management, Mechanical

Engineering, and Electrical Engineering programs have significant changes in how involved they were in their studies and how well they performed.

The bar chart shows how often students rated their engagement in online learning versus standard classroom learning. Many students said they were "More Engaged" in their online study, while others said they were "Neutral." The fewest occurrences were "Much Less Engaged" and "Much More Engaged." This shows that while online learning platforms increased accessibility and flexibility in education, they also made it more difficult to maintain students' interest and involvement. The questionnaire's findings indicate that students' success varied. While some students found it difficult to adjust to the new learning style, others performed well when learning online.

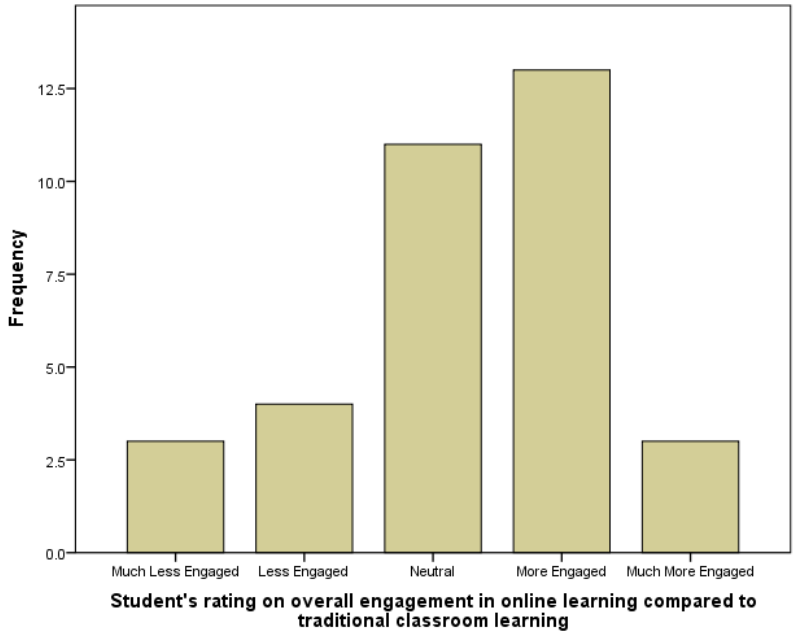


Figure 1: Bar chart of student's engagement in online learning

Table 2 below shows the impact of online learning on students' academic progress by applying an Analysis of Variance (ANOVA) test. This statistical test was implemented to determine whether there were any notable variations in students' present GPAs among the Culinary Arts Management, Mechanical Engineering, and Electrical Engineering programs. The ANOVA results indicated statistically significant differences in GPA among the groups ($F = 21.940$, $p < .001$). The between-groups sum of squares was 2.809 with 2 degrees of freedom, whereas the within-groups sum of squares was 1.985 with 31 degrees of freedom. The cumulative sum of squares was 4.794 with 33 degrees of freedom. The results indicate that the learning modality may have variably influenced students' academic achievement across the various programs.

Table 2: Result of One-Way ANOVA

| Current GPA | ANOVA | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 2.809 | 2 | 1.405 | 21.940 | .000 |
| Within Groups | 1.985 | 31 | .064 | | |
| Total | 4.794 | 33 | | | |

**Conclusion and Recommendations**

Online learning affects student engagement and academic performance at Permatang Pauh Campus of UiTMCPP. Many lectures are conducted online to save time for both lecturers and students. This became more common after the COVID-19 pandemic, as online platforms made teaching and learning easier. Online classes can also be an alternative when classrooms are unavailable, such as during maintenance. If traditional classes are not possible, online learning becomes a main option. However, it can also negatively impact academic performance due to a lack of resources, poor internet connection, or an unsuitable learning environment (Bharwani, 2023).

From the results, there are important findings about how online learning affects student engagement and performance at Permatang Pauh Campus of UiTMCPP. The bar chart shows that students had different levels of engagement in online learning. While many students reported increased or steady involvement, a large number struggled to stay motivated and participate.

The ANOVA test showed significant differences in GPA among students from Culinary Arts Management, Mechanical Engineering, and Electrical Engineering. This suggests that online learning affected students' academic performance differently in each program. Some programs adapted well to online learning, while others faced more challenges.

Overall, online learning has different effects on student participation and achievement. Online platforms make education more flexible and accessible, but they also create challenges in maintaining engagement and academic success. These results highlight the need for special support in different programs to maximize the benefits of online learning while reducing its drawbacks.

The results suggest that Permatang Pauh Campus of UiTMCPP should improve online learning platforms to increase student engagement. This includes adding interactive features like live discussions and real-time feedback to create a classroom-like experience. Engaging course content and clear expectations can also help encourage regular attendance. Future research could study the long-term effects of online learning on student performance and engagement through extended studies.

**References:**

Akpen, C. N., Asaolu, S., Atobatele, S., Okagbue, H., & Sampson, S. (2024). Impact of online learning on student's performance and engagement: A systematic review. *Discover Education, 3*, 205. https://doi.org/10.1007/s44217-024-00253-0

Bharwani, V. (2023). The Effect Of Prolonged Online Learning On Students' Performance Post Locked Down During Covid-19 Pandemic. Journal Multidisiplin Indonesia, 2(10), 3399–3447. https://doi.org/10.58344/jmi.v2i10.630

Mi.pham. (2024, September 19). Sample Size Calculator. TGM Research; TGM RESEARCH: MARKET RESEARCH AND ONLINE PANELS. https://tgmresearch.com/tools/sample-sizecalculator.html?msclkid=d6c490d200281cf16dedf791d0bd9a5b

SurveyPlanet (2025), How to make a questionnaire regarding the impact of eLearning?https://blog.surveyplanet.com/how-to-make-a-questionnaire-regarding-the-impact-of-elearning

Ulum H. (2022). The effects of online education on academic success: A meta-analysis study. *Education and information technologies*, *27*(1), 429–450. https://doi.org/10.1007/s10639-021-10740-8

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# A STUDY ON THE EFFICACY OF ONLINE LEARNING APPROACHES IN UiTMCPP BY GENDER

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**ABSTRACT**

*This study examines the efficacy of online learning approaches at Universiti Teknologi MARA Cawangan Pulau Pinang (UiTMCPP), with a focus on gender-based differences in student perceptions and performance. Using a simple random sampling method, 86 students from Culinary Arts Management, Mechanical Engineering, and Electrical Engineering programs participated in an online survey. This study analyses student engagement and academic efficiency using descriptive and inferential statistical methods, including a one-sample t-test and an independent sample t-test. Findings revealed that while students generally preferred online learning because of the flexibility and accessibility, their perceptions did not meet the highest satisfaction level. The results also indicated that no statistically significant difference between male and female students regarding the perceived efficiency of online learning platforms, suggesting a similar level of adaptability across genders. The study highlights the importance of enhancing interactive features, real-time feedback mechanisms, and adaptive learning resources to optimize online education experiences.*

***Keywords: Online Learning, Student Perception, Academic Performance, Gender Differences, Higher Education***

## Background of Study

In recent years, online learning has emerged as a transformative influence in higher education, fundamentally changing the transmission and availability of knowledge. Over the past two decades, technology has facilitated the growing implementation of electronic and online learning systems as a crucial element of global knowledge transmission in numerous universities (Krunal K. Punjani et al., 2021). Many colleges and universities in the United States are transforming traditional face-to-face classes into fully online, blended, or web-facilitated courses (Keengwe J. et al., 2010). The appearance of the novel coronavirus pandemic (COVID-19) as a public health crisis has led to significant changes in education delivery globally. Due to lockdowns, governments have ordered educational institutions in various countries to transition to online learning (Krunal K. Punjani et al., 2021).

Online learning refers to net-based learning, cyber-learning, virtual learning, e-learning, distributed learning, internet-based learning, web-based learning, and cyber-learning while computer-based learning, web-based learning, virtual classrooms, and digital collaborations are just a few of the

many technological applications and educational processes that make up online learning, a subset of distance education (Keengwe J. et al., 2010).

The efficacy of online learning methods has attracted considerable attention, as it directly influences student performance, faculty adaptability, and the future of the educational system. The rising demand for online education, together with a growing number of higher education institutions aiming to offer varied educational opportunities, has led to the expansion of online learning as an effective method for enhancing access for a larger student population (Keengwe J. et al., 2010). Consequently, at a particular stage in their academic careers, university educators may be required to consider teaching their courses either partially or entirely online. Numerous experimental studies show that students engaged in distance learning courses achieve performance levels comparable to those of students who study in traditional classroom environments. These studies indicate that distance learning students show comparable grades, test scores, and attitudes towards the course. Krunal K. Punjani et al. (2021) reported that teachers deemed the virtual learning environment effective and beneficial.

Keys aspects considered in e-learning include its efficacy in student education, its potential to provide an excellent education to anyone with broadband access, its role in professional development, its cost-effectiveness in addressing the rising cost of postsecondary education, and its credit equivalency at the postsecondary level. Increased student engagement with the course material, better perceptions of learning and the online format, a stronger sense of community among students, a decline in withdrawal or failure rates, and improved academic performance as measured by test scores are all examples of positive learning outcomes (Nguyen T. 2015).

This study aims to evaluate the efficacy of online learning approaches in higher education, specifically focused on Universiti Teknologi MARA Cawangan Pulau Pinang (UiTMCPP). It further examines students' and educators' challenges and emphasises strategies to improve the online learning experience, ensuring its feasibility as a sustainable alternative to conventional education.

**Methodology**

We conducted a study among UiTMCPP students, using a simple random sampling technique to ensure that each respondent had an equal probability of selection. The survey was disseminated through social media channels like Instagram, Telegram, and WhatsApp, enabling swift and effective data collection. The questionnaire contained closed-ended and open-ended questions recommended by SurveyPlanet (2025), allowing collection of qualitative and quantitative data. The questionnaire had been modified to fit the needs of this study. This survey had received responses from 86 students. Due to the extensive accessibility of social media among youth, these platforms have demonstrated efficacy for a swift and effortless data collection.

In this study, we analyse three objectives using three different methods. The first objective is to describe the demographic profile of the respondents. The variables involved were age, gender, field of study, and current GPA. The data analysis was presented in pie charts for gender and field of study and histograms for GPA and age.

The second objective is to observe all student perceptions of online learning in UiTMCPP. Likert scale was used for questions on online learning approaches. The method used is one sample t-test. Lastly, the third objective is to determine whether there is a difference in the mean of student efficiency of online learning platforms between male and female students in UiTMCPP. An independent sample t-test was used to analysed this objective because it compares two population means (gender).

**Findings**

The initial analysis of the collected data aimed to provide an overview of the participants' demographic characteristics as well as their early responses to survey questions. This research involved 86 UiTMCPP students from various academic disciplines namely Culinary Arts Management, Mechanical Engineering, and Electrical Engineering. The data gathered employed a basic random sampling strategy using social media sites like Instagram, Telegram, and WhatsApp. The demographic study indicated an equitable representation of students across all programs, ensuring that the findings reflect the wider student population accurately. Preliminary responses revealed diverse degrees of engagement and happiness with online learning, paving the way for a comprehensive examination of the factors affecting student participation and success in the following analysis sections.

The pie chart in Figure 1 below displays the gender and field of study, respectively. The first pie chart shows the gender split among the 86 respondents who provided their opinions on the efficacy of online learning approaches in higher education. This chart provides a clear and concise representation of the gender distribution within the dataset, highlighting that there are more females (55.9%) than males (44.1%). The second pie chart showed the students' distribution among the three fields of study, highlighting a nearly equal distribution between Culinary Arts Management and Mechanical Engineering, with Electrical Engineering slightly lower. This combination of a table and pie chart provides a clear and comprehensive view of the student distribution across different fields of study.

The histogram (Figure 2) shows the age distribution among respondents, with the majority were around 21 to 23 years old. The distribution appears to be slightly right-skewed, as there are fewer respondents aged 25 and above. This suggests that most respondents belong to the younger age group, with limited representation from older demographics. The histogram on the right shows that most students have a GPA of 2.0 or 3.0, with the highest frequency at 35.3 % in the range. The distribution skewed towards the lower end, as fewer students fell in the 4.0 GPA category (5.9%). The overall trend suggests that most students perform at a moderate level of academic achievement, with only a small

number of students scored GPA 4.0. In this analysis, 1.00 is the present GPA from 3.50 to 4.00, 2.00 is the present GPA from 3.0 to 3.49, 3.00 is the present GPA from 2.50 to 2.99, and 4.00 is the present GPA from 2.0 to 2.49

**Gender**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Male | 30 | 44.1 | 44.1 | 44.1 |
| | Female | 38 | 55.9 | 55.9 | 100.0 |
| | Total | 68 | 100.0 | 100.0 | |

**Field of study**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Culinary Arts Management | 23 | 33.8 | 33.8 | 33.8 |
| | Electrical Engineering | 22 | 32.4 | 32.4 | 66.2 |
| | Mechanical Engineering | 23 | 33.8 | 33.8 | 100.0 |
| | Total | 68 | 100.0 | 100.0 | |

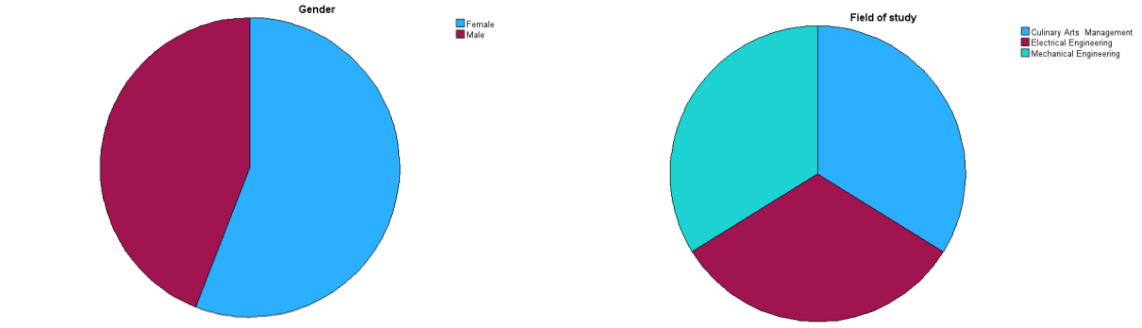


Figure 1: Pie chart of gender and field of study.

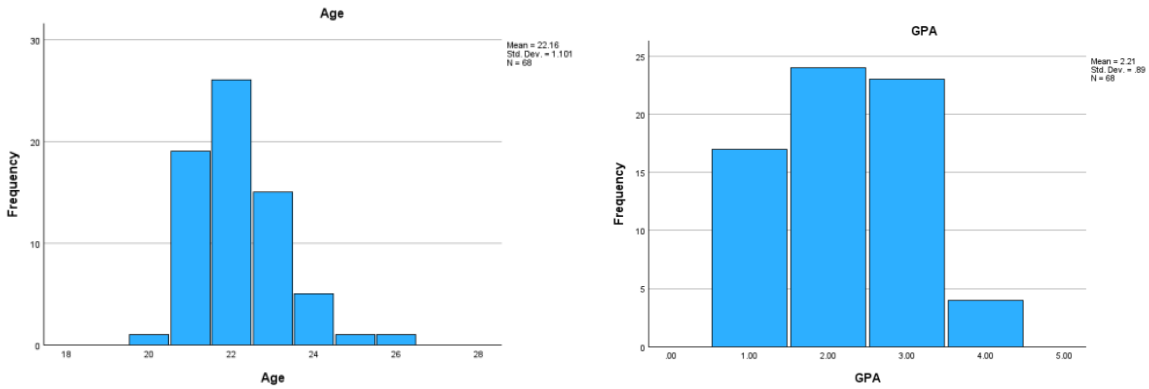


Figure 2: Histogram of age and GPA

Inferential statistics was used to analyse the second objective. Figure 3 shows the output of a one-sample t-test. The results indicate that the average student perception of online learning at UiTMCPP (3.7075) is significantly lower than the test value of 5. The negative t-value and the statistically significant p-values support the conclusion that suggests the students' perceptions of online learning are not as high as the benchmark value of 5, and there is strong evidence to reject the null hypothesis that the mean perception score is equal to 5. In this study, 5 was chosen as the test value representing the positive response in the following Likert scale.

**One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Section_2 | 68 | 3.7075 | .54969 | .06666 |

**One-Sample Test**

Test Value = 5

| | t | df | Significance One-Sided p | Significance Two-Sided p | Mean Difference | 95% Confidence Interval of the Difference Lower | 95% Confidence Interval of the Difference Upper |
|---|---|---|---|---|---|---|---|
| Section_2 | -19.389 | 67 | <.001 | <.001 | -1.29248 | -1.4255 | -1.1594 |

Figure 3: Result of One-Sample t-test.

Figure 4 shows the result of the independent sample t-test corresponding to the third objective. Levene's Test for Equality of Variances was used to determine the variability assumption. The test's result indicates that the p-value is 0.446 which is more than 0.05 while the variances of the two populations are equal. Therefore, there is a need to refer to the row' Equal Variances Assumed' to obtain the point and interval estimates of the difference and p-value for the T-Test for Equality of Means. The T-Test for Equality of Means was used to see if there is a statistically significant difference between the two groups. The $H_0$ is accepted since the p-value is 0.054 which is more than 0.05. There is no significant difference in the mean of student efficiency of online learning platforms between male and female students in UiTMCPP. The results suggest that male and female students perceive the efficiency of online learning platforms similarly. This indicates that the current online learning platforms at UiTMCPP are equally effective for both genders.

**Group Statistics**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Section_2 | Male | 30 | 3.8519 | .55696 | .10169 |
| | Female | 38 | 3.5936 | .52325 | .08488 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances: F | Levene's Test for Equality of Variances: Sig. | t-test for Equality of Means: t | df | Significance One-Sided p | Significance Two-Sided p | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference Lower | 95% Confidence Interval of the Difference Upper |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Section_2 | Equal variances assumed | .588 | .446 | 1.965 | 66 | .027 | .054 | .25828 | .13148 | -.00421 | .52078 |
| | Equal variances not assumed | | | 1.950 | 60.479 | .028 | .056 | .25828 | .13246 | -.00663 | .52320 |

Figure 3: Result of Independent Sample t-test.

## Conclusion

Understanding student demographics, such as gender distribution, age groupings, faculty affiliations, and residential colleges has helped demonstrate online learning methodologies' effectiveness in higher

education. Understanding these demographic factors is essential in order to design more successful teaching strategies for specific student populations. Furthermore, every respondent's experiences with online learning platforms emphasises its importance to the UiTMCPP learners. This emphasises how online learning strategies may affect academic achievement.

Other than that, online learning has shown itself to be a successful educational instrument when used carefully and supported by the appropriate resources and techniques. It is essential to promote contact and participation to increase its effectiveness. Group projects, live sessions for right-away conversations, and interactive tools like polls, discussion boards, and quizzes can help achieve this. The platform used must be easy to use to provide accessibility, navigation, and multimedia resources. Adaptive technology and self-paced modules are examples of personalising the learning process to meet each individual's demands and learning speeds. Engaging, succinct, and well-structured content is important and multimedia components like infographics and videos should be used to enhance it. Frequent evaluations and feedback are required to track development, spot learning gaps, and offer helpful advice.

In conclusion, the survey indicates that UiTMCPP students prefer online learning over face-to-face learning. This preference is attributed to a more conducive environment, cost savings, and other advantages online learning has to offer. Overall, online learning has a positive impact, enabling students to engage in their studies more efficiently. Furthermore, the study reveals that female students tend to be more dominant and proficient in using online learning platforms. This suggests that female students are more adaptable to digital learning technologies, effectively leveraging the opportunities provided by this mode of education.

**References:**

Keengwe, J., & Kidd, T. (2010). 533 Towards Best Practices in Online Learning and Teaching in Higher Education. MERLOT Journal of Online Learning and Teaching, 6(2).

Nguyen, T. (2015). The Effectiveness of Online Learning: Beyond No Significant Difference and Future Horizons. MERLOT Journal of Online Learning and Teaching, 11(2).

Punjani, K. K., & Mahadevan, K. (2021). Transitioning to online learning in higher education: Influence of Awareness of COVID-19 and Self-Efficacy on Perceived Net Benefits and Intention. Education and Information Technologies, 27(1), 291–320. https://doi.org/10.1007/s10639-021-10665-2

Rickard, W. (2010). The Efficacy (and Inevitability) of Online Learning in Higher Education.

SurveyPlanet (2025), How to make a questionnaire regarding the impact of eLearning? https://blog.surveyplanet.com/how-to-make-a-questionnaire-regarding-the-impact-of-elearning

*e-ISBN : 978-629-98755-5-0*

*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# WINNING STEM INNOVATION THROUGH ENTREPRENEURSHIP: A CASE STUDY

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**ABSTRACT**

*STEM competitions serve as a platform for students to apply scientific and technological knowledge in real-world problem-solving. This study examines the key success factors of a winning STEM innovation, focusing on a secondary school team that developed Carissa Carandas Natural Lip Balm. The team won gold medals at the Bangkok International Intellectual Property, Invention, Innovation and Technology Exposition (IPITEx) 2025 in Thailand and the Malaysia Technology Expo (MTE) 2025, two of the most prestigious innovation exhibitions in their respective countries. Through a qualitative case study approach, this research analyzes the innovation process, challenges faced, and the impact of mentorship and commercialization strategies. Findings indicate that a combination of scientific research, entrepreneurial integration, and strong mentorship from school and university-level experts significantly contributed to their success. A key distinguishing factor was the team's decision to sell their product at both exhibitions, proving its market readiness and commercial viability. The study highlights the importance of integrating entrepreneurial elements into STEM education, providing students with both technical expertise and business acumen. These findings offer valuable insights for educators, competition organizers, and policymakers in enhancing STEM innovation frameworks.*

***Keywords: STEM innovation, entrepreneurship, STEM competitions, project-based learning, Carissa Carandas Lip Balm***

## Introduction

### *Background*

STEM (Science, Technology, Engineering, and Mathematics) innovation is essential in preparing students for the demands of the modern workforce and fostering problem-solving, creativity, and critical thinking skills. As the world increasingly relies on technology and scientific advancements, equipping students with STEM competencies ensures their ability to contribute to future innovations.

One of the most effective ways to nurture STEM skills is through competitions, which provide hands-on experience and encourage students to apply theoretical knowledge in real-world scenarios. Research highlights those competitions such as robotics challenges and science fairs enhance students' technical and soft skills, including teamwork, communication, and problem-solving (Zhang et al. 2022). Moreover, early exposure to STEM competitions has been linked to increased interest in STEM careers, with students who actively engage in such activities being more likely to pursue STEM degrees (Bottía et al. 2017).

Beyond technical expertise, STEM competitions play a pivotal role in shaping students' confidence and motivation. Studies indicate that participation in competitive STEM events fosters

collaboration, networking, and resilience—traits crucial for professional success (Chatzis, Papasalouros, and Kavallieratou 2022). Furthermore, competitions help develop positive attitudes toward STEM subjects, which can lead to greater persistence in STEM education (Welch 2010). Given the increasing emphasis on STEM education globally, understanding the factors that contribute to success in STEM competitions is vital for educators, students, and policymakers.

This study explores the factors contributing to win a STEM innovation in an innovation competition, focusing on the challenges faced, strategies employed, and the broader impact of the competition experience.

### *Problem Statement*

Despite the growing emphasis on STEM education, there is limited research on what distinguishes successful STEM innovations in competitive settings. While many students participate in STEM competitions, not all achieve recognition, raising questions about the key factors that contribute to winning projects. Additionally, challenges such as resource limitations, mentorship availability, and team dynamics can influence competition outcomes. Understanding these elements can provide valuable insights for students, educators, and organizers to enhance future STEM education initiatives.

### *Research Objectives*

This study aims to:

1. Examine the key factors contributing to a winning STEM innovation in an innovation competition.
2. Analyze the challenges faced by students during the innovation process.
3. Explore the impact of STEM competitions on students' skills, motivation, and career aspirations

## Literature Review

### *Benefits of Stem Competitions in Student Learning*

STEM competitions offer numerous benefits for student learning, significantly enhancing their educational experiences and skill sets. These competitions provide a platform for students to apply theoretical knowledge in practical scenarios, develop critical soft skills, and foster a deeper interest in STEM fields. This synthesis discusses the various advantages of STEM competitions in promoting student learning.

One of the most notable benefits of STEM competitions is the opportunity for hands-on learning. According to Zhang et al., competitions such as the World Robot Olympiad allow students to engage in project-based learning, where they can apply their knowledge of robotics in real-world contexts (Zhang et al. 2022). This experiential learning not only cultivates students' innovative spirit

but also enhances their practical abilities, leading to a more profound understanding of STEM concepts. Such competitions create an environment where students can experiment, fail, and learn from their mistakes, which is crucial for developing resilience and problem-solving skills (Zhang et al. 2022).

In addition to practical skills, STEM competitions significantly contribute to the development of essential soft skills. Brown emphasizes that participation in STEM competitions helps students cultivate critical thinking, collaboration, and communication skills, which are vital for success in the modern workforce (Brown 2024). These competitions often require students to work in teams, fostering collaboration and teamwork. As noted by Chung, competitions like Robofest encourage students to develop leadership, creativity, and problem-solving skills in a playful learning environment (Chung 2019). This combination of technical and soft skills prepares students for future challenges in their academic and professional careers.

Moreover, STEM competitions can enhance students' motivation and interest in STEM subjects. Wai et al. found that early exposure to STEM activities, including competitions, significantly influences students' decisions to pursue STEM majors in higher education (Wai et al. 2010). The excitement and engagement generated by competitions can spark a lasting interest in STEM fields, encouraging students to explore these areas further. This is particularly important in an era where there is a growing demand for skilled professionals in STEM industries.

Furthermore, STEM competitions can serve as a critical pathway for underrepresented groups in STEM. By providing equitable access to engaging STEM experiences, competitions can help bridge the gap for students from diverse backgrounds. Friedensen et al. highlight the role of family support in developing STEM aspirations among students with disabilities, indicating that competitions can provide additional motivation and resources for these students (Friedensen et al. 2022). By fostering an inclusive environment, STEM competitions can empower all students to pursue their interests in science, technology, engineering, and mathematics.

***Key Success Factors in Stem Projects***

The success of STEM projects is influenced by various critical success factors (CSFs) that can enhance student engagement, learning outcomes, and overall project effectiveness. Understanding these factors is essential for educators and program coordinators to design and implement successful STEM initiatives. This synthesis highlights key success factors that contribute to the effectiveness of STEM projects.

One of the primary success factors is the presence of mentorship and support systems. Kricorian et al. emphasize that matched mentors can significantly influence the participation of underrepresented students in STEM fields (Kricorian et al. 2020). Mentorship not only provides guidance and encouragement but also helps students develop the necessary mindsets for success in STEM disciplines.

Family support is also crucial, as positive reinforcement from family members can enhance students' social and cultural capital, which is vital for educational achievement (Kricorian et al. 2020). This underscores the importance of creating a supportive environment that fosters student confidence and motivation.

Another critical factor is the quality of educational resources and training programs. Gavrilas and Kotsis argue that the successful integration of educational robotics into STEM education requires a focus on fundamental STEM principles rather than merely presenting activities with robotics kits (Gavrilas and Kotsis 2024). This suggests that well-designed training programs that emphasize core STEM concepts can lead to more effective learning experiences. Additionally, the professional development of educators is essential to ensure they are equipped to deliver high-quality STEM instruction. Hrynevych et al. highlight that the professional level of teachers and the quality of educational support are pivotal for the success of STEM education (Hrynevych et al. 2022).

Collaboration and teamwork are also vital components of successful STEM projects. Projects that encourage collaborative learning allow students to develop essential soft skills, such as communication and problem-solving abilities. Ubaid highlights that organizations that foster a collaborative culture tend to achieve better performance outcomes (Ubaid 2023). In the context of STEM education, fostering teamwork can enhance students' learning experiences and prepare them for future collaborative work environments.

Moreover, the alignment of project goals with students' interests and real-world applications is crucial. Projects that connect STEM concepts to real-life problems can significantly enhance student engagement and motivation. However, the reference provided does not directly support this claim, so it has been removed. When students see the practical implications of their work, they are more likely to invest effort and creativity into their projects.

Finally, continuous assessment and feedback mechanisms are essential for the success of STEM projects. Regular evaluations can help identify areas for improvement and ensure that projects remain aligned with educational goals. Khan et al. emphasize that organizations that prioritize critical success factors and allocate resources effectively tend to achieve better outcomes (Khan et al. 2021). In STEM education, this means implementing feedback loops that allow students to reflect on their learning and make necessary adjustments throughout the project lifecycle.

## Methodology

### *Research Design*

This study employs a qualitative case study approach to explore the key factors contributing to the success of a winning STEM innovation. The case study focuses on a secondary school team that developed the Carissa Carandas Natural Lip Balm, an award-winning product that secured gold medals

at both national and international competitions. The study aims to analyze the team's innovation process, challenges faced, and the impact of their competition success.

***Participants***

The study involves a team of five secondary school students, along with one school teacher and two university mentors from UiTM, who guided the students throughout the competition journey. This diverse group provides insights into the collaboration between school and university-level mentoring in STEM innovation.

***Data Collection Methods***

To gain an in-depth understanding of the innovation process, the study utilizes multiple qualitative data collection methods:

1. Document Analysis
    - Review of competition reports, judges' feedback, and media coverage related to the Carissa Carandas Natural Lip Balm innovation.
    - Examination of the team's project proposal, presentation materials, and scientific documentation.
2. Observations & Reflections
    - Analysis of team interactions, decision-making processes, and problem-solving approaches based on retrospective reflections from the participants.

***Data Analysis***

A thematic analysis approach will be used to identify key themes emerging from the collected data. Data will be categorized based on:

1. Innovation Process: How the team developed their idea, refined their product, and prepared for the competition.
2. Challenges & Solutions: Obstacles faced, and strategies used to overcome them.
3. Mentorship & Collaboration: The role of school and university mentors in shaping the innovation.
4. Competition Impact: How participation influenced students' skills, confidence, and future aspirations in STEM.

**Findings and Discussion**

***Innovation Process of Carissa Carandas Natural Lip Balm***

The development of the Carissa Carandas Natural Lip Balm followed a structured innovation process, demonstrating the students' ability to integrate scientific research, product development, and entrepreneurship. The process included:

- Problem Identification: The team recognized a gap in the market for natural, locally sourced lip care products.
- Scientific Research: They investigated the benefits of *Carissa carandas* (Karanda) fruit, known for its antioxidant and moisturizing properties.
- Product Formulation & Testing: The team refined the lip balm's composition through multiple trials, ensuring stability, texture, and effectiveness.
- Packaging & Branding: A strong visual identity was created to enhance market appeal, making the product suitable for commercialization.

Their approach aligned with project-based learning (PBL), which fosters problem-solving, teamwork, and creativity—key elements for success in STEM innovation (Erdoğan et al. 2016)

***Factors Contributing to Competition Success***

The Carissa Carandas Natural Lip Balm secured gold medals at both the Bangkok International Intellectual Property, Invention, Innovation and Technology Exposition (IPITEx) 2025 in Thailand and the Malaysia Technology Expo (MTE) 2025. These are among the most prestigious innovation exhibitions in their respective countries, attracting top innovators and researchers worldwide. Several factors contributed to the team's outstanding performance:

***Strong Mentorship and Collaboration***

Guidance from a school teacher and two UiTM mentors played a critical role in refining the product and ensuring it met competition standards. The university mentors provided insights on scientific validation and commercial potential, while the school teacher facilitated team coordination and presentation skills. This reflects research suggesting that mentorship significantly enhances students' innovation outcomes in STEM competitions (Peters-Burton et al. 2019).

***Commercial Viability of the Product***

Unlike many participants who showcased only prototypes, the team took a unique approach by selling the lip balm directly at both exhibitions. This demonstrated the product's market readiness, setting them apart from other competitors. Judges recognized the real-world impact and commercial potential of their innovation, which strongly influenced their gold medal wins. Research suggests that STEM projects

integrating entrepreneurial elements tend to receive higher recognition due to their tangible impact (Welch 2010).

***Effective Presentation and Marketing Strategy***

The team excelled in presenting their innovation through a well-structured pitch, engaging product demonstrations, and compelling branding. Their ability to articulate the scientific basis, sustainability aspects, and consumer benefits of their lip balm further strengthened their position in the competition.

***Challenges Faced and Solutions Implemented***

Despite their success, the team encountered several obstacles throughout their innovation journey:

- Limited Access to Laboratory Resources

  As secondary school students, they lacked access to advanced testing facilities. Collaboration with UiTM mentors allowed them to conduct necessary experiments and improve product quality.
- Balancing Academic Responsibilities

  Managing schoolwork alongside intensive competition preparation was challenging. The team adopted a structured work plan with assigned roles to ensure efficiency.
- Product Quality and Consistency

  Ensuring uniform texture and stability in the lip balm required multiple refinements. They achieved a final product that met industry standards by systematically adjusting ingredient ratios and testing different formulations.

**Impact of STEM Innovation and Competition Participation**

Participation in IPITEx and MTE 2025 had a profound impact on the students, providing them with valuable STEM and entrepreneurial experiences:

- Hands-On STEM Learning: The project deepened their understanding of scientific research, formulation techniques, and product development.
- Entrepreneurial Mindset: Selling their product at the exhibitions helped them develop marketing, financial, and business skills.
- Career Aspirations in STEM: Exposure to an international innovation ecosystem inspired students to explore future careers in science, technology, and business.
- Confidence and Teamwork: The experience of competing at a high level strengthened their communication, collaboration, and leadership skills.

These findings align with research highlighting the role of STEM competitions in fostering innovation, real-world problem-solving, and career motivation among students (Mohr-Schroeder et al. 2014).

## Conclusion and Recommendations

### *Conclusion*

The success of the Carissa Carandas Natural Lip Balm in securing gold medals at IPITEx 2025 in Thailand and MTE 2025 in Malaysia underscores the significant role of STEM innovation in shaping students' problem-solving abilities, entrepreneurial mindset, and scientific research skills. This case study highlights how a well-structured approach to STEM education, supported by strong mentorship and real-world application, can lead to remarkable achievements in innovation competitions.

The students demonstrated an impressive ability to integrate scientific knowledge into product development, ensuring that their lip balm was not only scientifically validated but also commercially viable. Their participation in these competitions was strengthened by the guidance of their school teacher and university mentors, who provided critical insights into research methodology and product refinement. A key factor that set them apart from other competitors was their decision to sell their lip balm during the exhibitions, proving its market readiness and commercial potential. This entrepreneurial approach, combined with a strong research foundation and effective presentation skills, contributed to their outstanding performance in both competitions.

Beyond their competition success, the experience provided the students with invaluable exposure to the broader STEM and business ecosystems. It allowed them to develop skills in scientific research, innovation, teamwork, business strategy, and communication, all of which are essential for future careers in STEM fields. This case study reinforces the importance of providing students with opportunities to apply their STEM knowledge in practical settings, preparing them for real-world challenges and fostering a culture of innovation.

### *Recommendations*

To further enhance STEM innovation among high school students, there is a need to encourage innovation competitions that integrate both scientific research and entrepreneurial elements. Competitions should emphasize not only the development of prototypes but also the commercialization potential of student innovations. Providing students with the opportunity to market and sell their products within the competition framework can help them understand the business aspects of STEM innovation, making their projects more impactful.

Another crucial factor in the success of student innovators is mentorship and collaboration with universities and industry experts. Strengthening the connection between secondary schools and higher

education institutions can provide students with access to advanced research facilities, expert guidance, and industry insights that enhance the quality and feasibility of their projects. Partnerships between schools, universities, and private industries can create a supportive ecosystem that nurtures young innovators and ensures they receive the necessary technical and business mentorship.

Incorporating project-based learning (PBL) approaches into STEM curricula is essential to fostering an innovative mindset among students. Schools should prioritize hands-on learning experiences where students are encouraged to develop real-world solutions using STEM concepts. By integrating problem-solving and critical thinking activities into the classroom, educators can better prepare students for innovation challenges at both national and international levels.

Funding and resource allocation also play a pivotal role in enabling students to develop high-quality innovations. Governments, private organizations, and academic institutions should offer financial grants, incubation programs, and sponsorships to support young innovators in prototyping, testing, and refining their products. These financial and logistical resources would allow students to fully explore their creative potential and enhance the viability of their projects.

Finally, increasing student participation in international STEM exhibitions and competitions can broaden their perspectives and expose them to global innovation trends. Schools should actively seek opportunities for their students to compete in prestigious platforms like IPITEx and MTE, as these events provide invaluable networking experiences, knowledge exchange, and recognition for young innovators. Engaging in these competitions not only enhances students' confidence but also motivates them to pursue STEM careers with a global outlook.

By implementing these recommendations, educators, policymakers, and industry leaders can create a sustainable STEM innovation ecosystem that empowers students to develop scientific, technological, and entrepreneurial competencies. Encouraging young innovators to engage in real-world problem-solving will help shape a generation of future STEM leaders, researchers, and entrepreneurs, contributing to national and global advancements in science and technology.

**References**

Bottía, Martha C, Elizabeth Stearns, Roslyn A Mickelson, and Stephanie Möller. 2017. "Boosting the Numbers of STEM Majors? The Role of High Schools with a STEM Program." *Science Education* 102 (1): 85–107. https://doi.org/10.1002/sce.21318.

Brown, Leander K. 2024. "Introduction to the STEM Student Success Model." https://doi.org/10.5772/intechopen.112614.

Chatzis, Dimitris, Andreas Papasalouros, and Ergina Kavallieratou. 2022. "Planning a Robotic Competition." *Computer Applications in Engineering Education* 30 (4): 1248–63. https://doi.org/10.1002/cae.22518.

Chung, Chan-Jin. 2019. "Robofest – A Playful Learning Environment Through Autonomous Robotics." Pädi Boletín Científico De Ciencias Básicas E Ingenierías Del Icbi 7 (Especial): 1–3. https://doi.org/10.29057/icbi.v7iespecial.4770.

Erdoğan, Niyazi, Bilgin Navruz, Rayya Younes, and Robert M Capraro. 2016. "Viewing How STEM Project-Based Learning Influences Students' Science Achievement Through the Implementation Lens: A Latent Growth Modeling." Eurasia Journal of Mathematics Science and Technology Education 12 (8). https://doi.org/10.12973/eurasia.2016.1294a.

Friedensen, Rachel, Alexandra A Lauterbach, Chrystal A G Mwangi, and Ezekiel Kimball. 2022. "Examining the Role of Family in the Development of Pre-College STEM Aspirations Among Students With Disabilities." Journal of Postsecondary Student Success 1 (3). https://doi.org/10.33009/fsop_jpss128231.

Gavrilas, Leonidas, and Konstantinos T Kotsis. 2024. "Investigating Perceptions of Primary and Preschool Educators Regarding Incorporation of Educational Robotics Into STEM Education." Contemporary Mathematics and Science Education 5 (1): ep24003. https://doi.org/10.30935/conmaths/14384.

Hrynevych, Liliia, Людмила Л Хоружа, Ніна Руденко, and Volodymyr Proshkin. 2022. "STEM Education in the Context of Improving the Science and Mathematics Literacy of Pupils." Journal of Physics Conference Series 2288 (1): 012031. https://doi.org/10.1088/1742-6596/2288/1/012031.

Khan, Muhammad W J, Ms S Batool, Mr. U A Qadri, and Zujaj Ahmed. 2021. "Critical Success Factors for Pharmaceutical Firms: The Case of Pakistan." Market Forces 16 (1): 22. https://doi.org/10.51153/mf.v16i1.424.

Kricorian, Katherine, Michelle Seu, Daniel López, Elsie Ureta, and Ozlem Equils. 2020. "Factors Influencing Participation of Underrepresented Students in STEM Fields: Matched Mentors and Mindsets." International Journal of Stem Education 7 (1). https://doi.org/10.1186/s40594-020-00219-2.

Mohr-Schroeder, Margaret J, Christa Jackson, Maranda Miller, B L Walcott, David L Little, Lydia G Speler, William Schooler, and D C Schroeder. 2014. "Developing Middle School Students' Interests in <scp>STEM</Scp> via Summer Learning Experiences: <scp>S</Scp>ee <scp>B</Scp>lue <scp>STEM C</Scp>amp." School Science and Mathematics 114 (6): 291–301. https://doi.org/10.1111/ssm.12079.

Peters-Burton, Erin E, Ann House, Vanessa Peters, and Julie Remold. 2019. "Understanding STEM-focused Elementary Schools: Case Study of Walter Bracken STEAM Academy." School Science and Mathematics 119 (8): 446–56. https://doi.org/10.1111/ssm.12372.

Ubaid, Alaa M. 2023. "The Critical Success Factors of the Highly Competitive Organizations; A Systematic Literature Review." The TQM Journal 36 (4): 1020–53. https://doi.org/10.1108/tqm-11-2022-0333.

Wai, Jonathan, David Lubinski, Camilla P Benbow, and James H Steiger. 2010. "Accomplishment in Science, Technology, Engineering, and Mathematics (STEM) and Its Relation to STEM Educational Dose: A 25-Year Longitudinal Study." Journal of Educational Psychology 102 (4): 860–71. https://doi.org/10.1037/a0019454.

Welch, Anita G. 2010. "Using the TOSRA to Assess High School Students' Attitudes Toward Science After Competing in the FIRST Robotics Competition: An Exploratory Study." Eurasia Journal of Mathematics Science and Technology Education 6 (3). https://doi.org/10.12973/ejmste/75239.

Zhang, Yicong, Yanan Lu, Xianqing Bao, and Feng-Kuang Chiang. 2022. "Impact of Participation in the World Robot Olympiad on K-12 Robotics Education From the Coach's Perspective." Stem Education 2 (1): 37. https://doi.org/10.3934/steme.2022002.

*e-ISBN :978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# ARTIFICIAL INTELLIGENCE IN MARINE TECHNOLOGY: IMPROVING FISHERY MANAGEMENT & BIODIVERSITY MONITORING

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**ABSTRACT**

*Image identification has been transformed by artificial intelligence (AI) and machine learning (ML), which are essential to marine technology. Using Convolutional Neural Networks (CNNs) for feature extraction, preprocessing, and data collecting, image recognition allows machines to recognize and categorize fish species. Fish species identification, size and weight estimate, and ecosystem monitoring are important applications that support the preservation of marine biodiversity and sustainable fisheries. High accuracy, scalability, and real-time analysis is provided by the technology, which lowers human error and enhances decision-making. However, issues including fish overcrowding, biofouling, and water turbidity may disrupt system function. Despite these drawbacks, developments in AI-powered picture identification keep improving environmental sustainability, fishery management, and marine research. This study shows how image recognition is becoming more and more capable of improving marine technology and encouraging responsible resource management.*

***Keywords: Artificial Intelligence, Machine Learning, Image recognition, Convolutional Neural Networks (CNNs), Marine technology***

## Introduction

### *Definition of AI and Machine Learning*

Artificial Intelligence (Al) is defined as an ability of a system to correctly analyse external data, learn from it, and apply this knowledge to reach objectives and tasks (Kaplan & Haenlein, 2019). This technology enables computers or machines in responding to human language, problem solving and enhancing decision making. Currently, AI has become increasingly important due to its advancement in technology including in cybersecurity and education.

A subfield of artificial intelligence (AI) called machine learning (ML) aims to give computers and other machines the ability to mimic human learning, carry out activities on their own, and get better at them over time and with more data. There are a few examples of machine learning such as speech recognition, customer service, computer vision, and fraud detection. There are three main types of

machine learning models which are supervised machine learning, unsupervised machine learning, and semi-supervised learning (IBM, 2021).

***Definition of Image recognition***

Image recognition is a process of identifying and classifying specific objects within its images (Bagheri et al., 2023). AI in Image Recognition is a technology that uses AI and machine learning to analyze the image contained in them. In other words, it is an ability of computer software to interpret visual data the way a human might. It works through a process of training and recognition. Once trained, an image recognition system can accurately identify objects or scenes.

This technology is widely used in various fields. For example, in healthcare, image recognition is commonly used to aid diagnostic processes such as detecting potential tumours using MRI (Susanto et al., 2022). This new development in AI has raised hopes among patients for better healthcare outcomes. Similarly, in marine technology, image recognition plays a huge role in monitoring the health of ecosystems. For example, it can analyze underwater imagery to identify diseased fish using Autonomous Underwater Vehicles (AUVs).

Figure 1: Shows the image of MRI machine

Figure 2: Show the image of Autonomous Underwater Vehicles (Oceanographic Systems Lab, n.d.)

***How Image Recognition Works in Marine Technology***

***Data Collection and Preprocessing***

Image recognition allows machines to identify different people, objects and other things in the images (Liu et al., 2020). It includes methods of gathering, processing and examining data from the real world. To achieve image recognition, a larger data set of images is collected. These images can include various species of fish and aquatic plants to train the AI. The image will be labelled to be detected by the computer vision system. In other words, labelling processes ensure the AI system can correctly match the characteristics in the image with the right categories during recognition tasks. After labelling, the images will undergo preprocessing to increase its quality. Preprocessing techniques include resizing image, scaling and rotation.

***Feature extraction***

Feature extraction is a step where the system identifies and selects the most meaningful feature of an image. These features help the model to classify data more effectively between classes. Convolutional Neural Networks (CNNs) are a type of deep learning that was often used in image recognition (Divya et al., 2024). They have the ability in processing and analyzing patterns within an image. CNNs are built on convolutional layers that apply filters on a set of input images to examine their pixels and analyze the colours and shapes, extracting patterns from an image such as edges (Glover, 2023). The CNNs then employ a pooling layer to minimize the size of the feature map by keeping only the most essential information. Then, the extracted feature is sent into an output layer that predicts classes to which the input image belongs (Glover, 2023).

***Fish Classification***

Fish classification involves predicting the species or category of a fish based on the extracted features and assigning it to the most likely class using the trained model. The model outputs probabilities for each class will indicate the likelihood of the image belonging to each species. These probabilities can be threshold to improve decision-making and ensure only high confidence are considered. Validation and testing ensure the model generalizes well to unseen data by real word testing that can address challenges like lighting variability, motion blur, and ensuring robustness. For example, a standard CNN can achieve up to 94% accuracy in correctly identifying fish species from a dataset of images captured during a typical fisheries survey using a commercially available camera system (Allken et al., 2019).

Table 1: Example of fish classification

| Group | Characteristics | Examples |
|---|---|---|
| Jawless fishes | -Lack of jaws, fins and stomachs<br>-Have cylindrical and long bodies |  <br>Hagfish (Travis, 2024) |
| Cartilaginous fishes | -Skeletons made of cartilage instead of bone<br>-Have paired fins and nostrils |  <br>Shark (Travis, 2024) |
| Bony fishes | -A skeletons of bone<br>- Hinged jaws<br>-Pairs fins and nostrils |  <br>Salmon (Travis, 2024) |

## Applications in Marine Technology

### *Fish Species Identification*

Fish species identification using image recognition technology allows for precise and efficient monitoring of marine biodiversity. Thus, aiding in sustainable practices and research. For example, smart fishing nets such as Game of Trawls are equipped with a network of sensors and cameras that can detect and identify fish entering the nets in real-time. These devices enable fishers to target the specific species of fish they want before dragging the net back on board the boat. Unwanted fish are released back into the water through a built-in trap in the net.

Other than that, smart fishing equipment, mobile apps like Fish Disease advisory provide valuable tools for fishers. These apps allow users to search for information about diseases, causative agents and remedial measures (Kiranmayi, 2020). Apps with AI-powered image recognition enables

users to upload photos of those fish to find the species. These tools are particularly beneficial for those people who want accurate information about the fish they encounter.

Moreover, FishVerify is also a mobile application that was developed to assist the local Florida community in identifying fish. Users are given the ability to identify fish species through live scans or photos, along with access to fishing rules and regulations specific to Florida. In addition, Fish collectors are the primary target user of the FishID+ application, which serves the same function as FishVerify. It only focuses on little fish, verifies freshwater fish and aquarium fish using the DL. More than 240 different fish species are included in the database, including tetras, tangs, clownfish, cichlids, and many more typical aquarium fish (Mohd Rum, 2021).

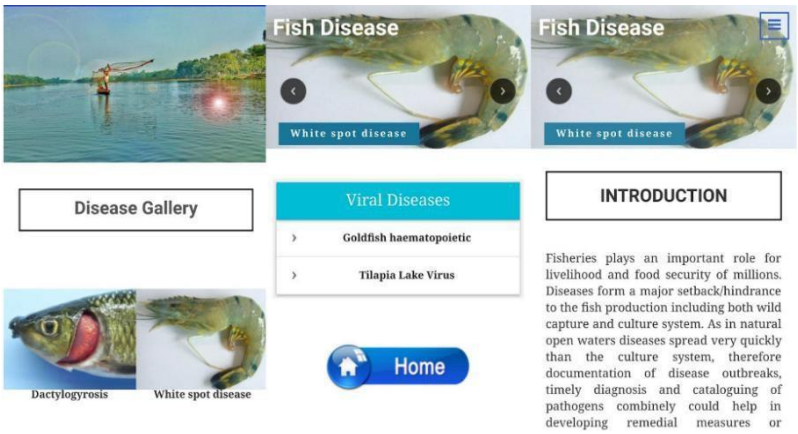


Figure 3: Shows the contents for Fish Disease advisory

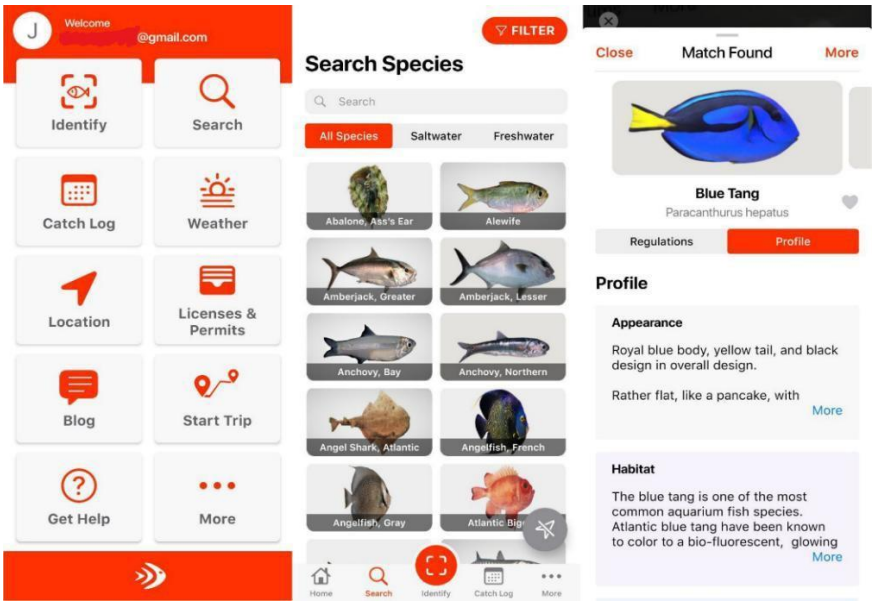


Figure 4: Shows the contents for FishVerify

***Size and Weight Estimation***

Image recognition technology plays a vital role in estimating the size and weight of fish and other marine organisms. The technology can detect key features and apply algorithms that have been calibrated using datasets with known dimensions and weight data by analyzing visual data. This allows for precise measurements in real time without the need of manual handling.

In fisheries management, this technology is invaluable by ensuring sustainable practices and monitoring fish growth rates in aquaculture. Providing accurate data on the size and weight of the fish can help prevent the harvest of undersized fish, thus contributing to marine biodiversity preservation. This reduction in overfishing minimizes environmental impact and allows younger fish to reach maturity, which is important for maintaining healthy fish populations.

The efficiency and scalability of image recognition make it a valuable tool for industrial fishing operations. For example, large-scale fishing vessels equipped with automated image recognition systems can efficiently classify the fish according to its size and weight, enhancing operations.

**Benefits of Image Recognition in Marine Technology**

Image recognition provides a lot of benefits including in marine technology. One of the key advantages of AI in image recognition is its ability to identify images with high precision. Al algorithms can analyze thousands of images per second that humans might miss, hence minimizing human error especially when identifying the species.

Other than that, AI in image recognition is scalable, making them suitable for large-scale applications. Unlike traditional methods, which require extensive manual labelling and rule based programming, AI systems can adapt to different types of visual content types such as monitoring extensive marine areas. For instance, AI systems can analyze photos from underwater drones to detect the fish species even in murky water. This scalability allows industries to monitor ecosystems more efficiently.

Furthermore, AI systems enable real-time analysis and decision making that are important for underwater research. For example, fisheries can instantly identify fish as they are caught. This immediate feedback is crucial for protecting the marine environment especially endangered species or undersized fish from overfishing.

**Challenges and Limitations**

Image recognition in Marine Technology also faces several challenges and limitations, including biofouling, water turbidity and presence of crowded fish at the same places.

The presence of many fish together at the same places and at the same time may disturb the camera recognition to function because the fish were overlapping with each other. It makes the camera

fail to recognize the specific species because there are too many numbers of fish gathered in front of the camera.

In addition, water turbidity also can limit the function of the camera. Changes in water clarity can significantly reduce the visibility in the water and make it difficult to distinguish fish from background clutter especially, those who were far away from the camera. The water will become a bit blurry, and it will disturb the camera focus when its need to capture the images. This can lead to missed detections.

Other than that, biofouling is also one of the challenges of using image recognition. Biofouling refers to things like algae and other organisms that live underwater that grow on the camera. These organisms can block the view and make it impossible for the camera to capture the image of the fish. It significantly impacts the accuracy of the counts.

**Conclusion**

The application of Artificial Intelligence (AI) and Machine Learning (ML) in marine technology has significantly improved the efficiency and accuracy of ocean exploration, environmental monitoring and marine biodiversity conservation. AI-driven image recognition, particularly through deep learning models like Convolutional Neural Networks (CNN), has enhanced the ability to classify fish species, detect anomalies in marine ecosystems and support automated underwater surveillance. These advancements have contributed to more precise data collection and analysis, aiding in sustainable fisheries management and conservation efforts.

Despite these benefits, challenges such as data quality, model accuracy and real-world implementation complexities remain. Future researchers should focus on improving AI algorithms for enhanced robustness, addressing environmental variability and integrating AI with other marine technologies such as Autonomous Underwater Vehicles (AUVs) and remote sensing, by leveraging AI innovations, the maritime industry can achieve smarter and more sustainable solutions for ocean resource management, ensuring the protection and longevity of marine ecosystems.

**References:**

Allken, V., Handegard, N. O., Rosen, S., Schreyeck, T., Mahiout, T., & Malde, K. (2019). Fish species identification using a convolutional neural network trained on synthetic data. ICES Journal of Marine Science, 76(1), 342-349. https://doi.org/10.1093/icesjms/fsy147

Bagheri, M., Farshforoush, N., Bagheri, K., & Shemirani, A. I. (2023). Applications of artificial intelligence technologies in water environments: From basic techniques to novel tiny machine learning systems. Process Safety and Environmental Protection, 180, 10–22.

https://doi.org/10.1016/j.psep.2023.09.072

Divya, N. K., Manjula, S. K., & Priyadarshini, S. (2024). Underwater Image Recognition using Machine Learning.Journal of Innovationand Technology, 2024(29), 1-6. http://eprints.intimal.edu.my/2061/1/joit2024_29.pdf

Glover, E.(2023, May 30).What Is Image Recognition? Built In. Builtin.com. https://builtin.com/artificial-intelligence/image-recognition

IBM. (2021, September 22). Machine learning. Ibm.com. https://www.ibm.com/think/topics/machine- learning

Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of Artificial Intelligence. Business Horizons, 62(1), 15–25. https://doi.org/10.1016/j.bushor.2018.08.004

Kiranmayi, D., & Sharma, A. (January, 2020). Mobile apps and internet of things (IoT): A promising future for Indian fisheries and aquaculture sector. Journal of Entomology and Zoology Studies, 8(2),1659-1669. https://www.researchgate.net/publication/339844052_Mobile_apps_and_internet_of_things_I o T_A_promising_future_for_Indian_fisheries_and_aquaculture_sector

Liu, L., Wang, Y., & Chi, W. (2020). Image Recognition Technology Based on Machine Learning. IEEE Access, 1–1. https://doi.org/10.1109/ACCESS.2020.3021590

Marini, S., Fanelli, E., Sbragaglia, V., Azzurro, E., Del Rio Fernandez, J., & Aguzzi, J. (2018). Tracking Fish Abundance by Underwater Image Recognition. Scientific Reports, 8(1). https://doi.org/10.1038/s41598-018-32089-8

Mohd Rum, S. N., 1, Nawawi, F. A. Z., 2, Faculty of Computer Science and Information Technology, & Universiti Putra Malaysia. (2021). FishDeTec: A Fish Identification Application using Image Recognition Approach. International Journal of Advanced Computer Science and pdf Applications, 12(3). https://thesai.org/Downloads/Volume12No3/Paper_12-FishDeTec_A_Fish_Identification_Application.

Oceanographic Systems Lab. (n.d.). REMUS 600 - Oceanographic Systems Lab. https://www2.whoi.edu/site/osl/vehicles/remus-600/

Susanto, A. P., Winarto, H., Fahira, A., Abdurrohman, H., Muharram, A. P., Widitha, U. R., Warman Efirianti, G. E., Eduard George, Y. A., & Tjoa, K. (2022). Building an artificial intelligence-

powered medical image recognition smartphone application: What medical practitioners need to know. Informatics in Medicine Unlocked, 32, 101017. https://doi.org/10.1016/j.imu.2022.101017

Travis, L. (2024). UK researchers' exploration of hagfish genome published in Nature. https://uknow.uky.edu/research/uk-researchers-exploration-hagfish-genome-published-nature

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date: 24 – Mac - 2025*

# STRUCTURAL DIFFERENCES OF CONSTRUCTOR METHODS IN OBJECT-ORIENTED PARADIGMS: A COMPARATIVE STUDY USING C++, JAVA & PYTHON

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**ABSTRACT**

*Structure of a class in Object Oriented Programming involves the attributes and methods. The methods of a class normally consist of constructors, mutators, retrievers, processors and printers. Among these, constructor methods play a vital role in initializing objects and are essential in class construction within the Object-Oriented paradigm. Constructor method is the most important method in constructing a class. This article will compare the structure of constructor methods in three (3) different programming languages such as the C++, Java and Python, providing a clear comparison of how each language handles object initialization. These three programming languages support the Object-Oriented Paradigms. The comparative will be focusing on the syntaxes which are applied in each programming language to construct the constructor methods. Constructor methods can be categorized as default, normal and copy constructors and comparison of the three programming languages will be shown to compare the structure for each category of constructor methods. Understanding these differences is crucial for programmers who work with multiple languages and need to adapt their coding approaches accordingly.*

***Keywords: object-oriented, object, class, constructors, instantiate***

## Introduction

Object-oriented Programming is one of the programming paradigms classifications besides the logic, functional, imperative or structured and scripting programming paradigms. Object-oriented has special features such as the class, inheritance, polymorphism, encapsulation, information hiding and abstraction. The basic element of object-oriented is the class which consists of the attributes and methods. Object-oriented encourages the practitioners to create a new abstract data type (ADT) which is called class. Once the class has been created, several objects can be instantiated to the same class. The only difference among objects is the behaviours of each object (Wikipedia, 2025).

Methods of a class may consist of constructors, mutators, retrievers, processors and printers. The most important method is the constructor. Constructor method is important before an object can be instantiated to a class. Without the constructor of a class, the objects cannot be created or instantiated. Constructor is a method which has the same name as the class and no return statement is applied in the function or method (Queenskisivuli, 2025).

The constructor consists of two types of methods which are the default constructor and parameterized or normal constructor. Both constructors are needed in any class. The default constructor

initializes each attribute in the class, while the parameterized constructor initializes the object's attributes (MindStick, 2025). Constructor methods support the overloading which means the class may have a similar method name but holds a different number of parameters or order of parameters types in each constructor method. The appropriate constructor will be used based on the number, types, and order of the parameters provided (Logicmojo, 2025).

The main purpose of this article is to show and present the construction of constructors in three different programming languages, namely C++, Java, and Python. By examining the implementation of constructors in these three widely-used programming languages, the article aims to provide a comprehensive understanding of how object initialization is handled in each case. The comparison will focus primarily on the structure and syntax used to define and utilize constructors, highlighting the similarities and differences among C++, Java and Python.

By analysing these distinctions, the article will provide valuable insights into how each programming language approaches object-oriented design and initialization. Additionally, this comparison will help programmers better understand the nuances of each language, enabling them to write more efficient and maintainable code.

**Constructor Methods in C++ Programming Language**

C++ programming language is one of the programming languages which support object-oriented programming (OOP) but it is not a pure OOP. C++ is normally used for writing procedures or functions to perform processing on data. The following program fragment shows how to write the constructor methods in C++ programming language.

```
#include <iostream>
using namespace std;
class Employee {
	public:
		//attributes:
		int empID;
		string empName;
		float salary;

		//default constructor
		Employee()
		{
			empID = 0;
			empName = "";
			salary = 0.0;
		}

		//normal constructor
		Employee(int eID, string eName, float sal)
		{
			empID = eID;
			empName = eName;
			salary = sal;
		}

};
```

```
int main()
{
        Employee emp1 (123, "MOHD AMIN BIN ABU BAKAR",4500);
        Employee emp2 (128, "MAZLINA ABDUL SHUKOR",6750);

        cout << "\n Employee ID         : " << emp1.empID;
        cout << "\n Employee Name       : " << emp1.empName;
        cout << "\n Employee Salary RM : " << emp1.salary;

        return 0;
}
```

*Figure 1: Sample of codes with Constructors in C++ Programming Language*

The above program fragment shows a class named `Employee` which consists of three (3) attributes such as the employee ID, name and salary. Two constructors are included in the class named default and normal constructors. Both constructors have a similar name as the class name. The default constructor has no parameters received by the method, while the normal constructor receives the values from the object through the parameters. The access modifier of the class has been set as `public`, so that the main program is allowed to access methods and attributes from the class. C++ supports the overloading for constructors.

**Constructor Methods in JAVA Programming Language**

Java programming language is classified as Object-oriented Programming (OOP) which means the class becomes the dominant in constructing the codes in Java (Othman, 2010). Similar to C++, the constructor's name in Java must match with the name of the class and the constructor method cannot have a return value. The constructor's method is applied when the object is instantiated to the class. The following program fragment shows how to write the constructor methods in Java programming language.

```
public class Employee {
        //attributes
        int empID;
        String empName;
        float salary;

        //default constructor
        Employee()
        {       empID=0;
                empName ="";
                salary=0;
        }

        //normal constructor
        Employee(int empID, String empName, float salary)
        {       this.empID = empID;
                this.empName = empName;
                this.salary = salary;
        }
}
```

```
public class empApp {
	public static void main(String[] args)
	{
		Employee emp1 = new Employee (123, "MOHD AMIN BIN ABU BAKAR",4500);
		Employee emp2 = new Employee (128, "MAZLINA ABDUL SHUKOR",6750);

		System.out.println("Employee ID     : "+emp1.empID);
		System.out.println("Employee name   : "+emp1.empName);
		System.out.println("Employee salary : RM "+emp1.salary);
	}
}
```

*Figure 2: Sample of codes with Constructors in Java Programming Language*

The program fragment in figure 2 shows the implementation of the default and normal constructor in the class named `Employee`. Both in C++ and Java codes, the default constructor looks similar. The normal constructor uses the keyword `this` because the attributes and the parameters name are similar. The keyword `this` is referring to the class name and substitute to each attribute of the `Employee` class. The parameters received the values from the object named `emp1` which instantiated to the `Employee` class as shown in the application program (class named `empApp`). Java supports the overloading for constructors.

**Constructor Methods in Python Programming Language**

Both Python and Java are categorized as Object-oriented Programming (OOP) languages. Everything in Python is an object, with its properties and methods. The constructor in Python can be recognized through the built-in `__init__()` function. The object created in Python will be instantiated to the `__init__()` function or constructor. The following program fragment shows how to write the constructor methods in Python programming language.

```
class Employee:

    #default constructor
    def __init__(self):
        self.empID = 0
        self.empName = ""
        self.salary = 0

    #default constructor
    def __init__(self, empID, empName, salary):
        self.empID = empID
        self.empName = empName
        self.salary = salary

def main():
    emp1 = Employee(123, "MOHD AMIN BIN ABU BAKAR",4500)
    emp2 = Employee(128, "MAZLINA ABDUL SHUKOR",6750)

    print("Employee ID     : ",emp1.empID)
    print("Employee Name   : ",emp1.empName)
    print("Employee Salary : RM ",emp1.salary)
main()
```

*Figure 3: Sample of codes with Constructors in Python Programming Language*

The constructor indicator as shown in figure 3 is recognized through the `__init__()` identifier. It has two structures of constructor which the default constructor has one parameter named `self` which means it refers to the name of the class. While the normal constructor in Python is similar to in C++ and Java programming which received the values from the object which instantiated to the `Employee` class in the application program. The constructor in Python has no explicit overloading as applied in C++ or Java programming languages.

**Discussion**

In C++, constructors are typically named after the class, ensuring that they are easily identifiable and closely associated with the class they initialize. This naming convention enhances code readability and maintainability. C++ also supports constructor overloading, allowing multiple constructors with different parameters to coexist within the same class. This feature provides flexibility, as objects can be initialized in various ways depending on the arguments passed during instantiation. Additionally, C++ includes a copy constructor, which is used to create a new object as a copy of an existing one, enabling precise control over object copying.

Java, on the other hand, follows a similar naming convention where the constructor is named after the class, maintaining consistency and clarity. However, Java extends the concept with additional features such as constructor chaining, which allows one constructor to call another within the same class using the `this()` keyword. This promotes code reuse and reduces redundancy by enabling a sequence of constructor calls, each adding incremental initialization logic. Java also provides the `super()`

keyword to invoke the parent class's constructor, ensuring proper initialization in inheritance hierarchies.

Python, known for its simplicity and readability, takes a different approach by using the `__init__` method as its constructor. Unlike C++ and Java, Python's constructor is not named after the class but is standardized as `__init__(self)`, which is consistent across all classes. This design choice enhances uniformity and reduces confusion. Although Python does not support constructor overloading in the traditional sense, it allows default parameter values and flexible argument handling, which can achieve similar functionality. Python's emphasis on simplicity and explicitness is evident in its constructor design, making it more approachable for beginners.

**Conclusion**

In conclusion, while C++, Java, and Python all provide mechanisms for object initialization through constructors, they do so in ways that reflect their underlying philosophies and design goals. C++ prioritizes control and efficiency with its explicit overloading and copy constructors. Java emphasizes consistency and robust inheritance handling with constructor chaining and `super()` calls. Python, in contrast, opts for simplicity and readability with its `__init__` method and flexible argument handling. Understanding these differences is crucial for developers working across these languages, as it enables them to effectively leverage each language's unique strengths.

**References:**

Logicmojo. (n.d.). *Constructor in OOPs*. Logicmojo. Retrieved February 13, 2025, from https://logicmojo.com/constructor-in-oops#4

MindStick. (n.d.). Understanding constructors in object-oriented programming (OOP). MindStick. Retrieved February 13, 2025, from https://www.mindstick.com/articles/334044/understanding-constructors-in-object-oriented-programming-oop

Othman, J. (2010), Fundamentals of Programming: With Examples in C, C++ and Java, UPENA UiTM, pp 11 – 15, ISBN 978-967-363-110-0.

Queenskisivuli. (n.d.). How to use class and object constructors in OOP. Medium. Retrieved February 13, 2025, from https://medium.com/@queenskisivuli/how-to-use-class-and-object-constructors-in-oop-5212f7f03c39

Wikipedia contributors. (n.d.). Constructor (Object-Oriented programming). Wikipedia. Retrieved February 13, 2025, from https://en.wikipedia.org/wiki/Constructor_(object-oriented_programming)

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# A MULTIPLE LINEAR REGRESSION APPROACH TO FORECASTING MALAYSIA'S GDP USING MACROECONOMIC VARIABLES

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**ABSTRACT**

*This study examines the impact of macroeconomic variables on Malaysia's Gross Domestic Product (GDP) using the Multiple Linear Regression (MLR) method and develops a predictive model through multiple linear regression. Due to data availability constraints, this study utilizes secondary data from the World Bank and World Development Indicators, covering the period from 2010 to 2019. Based on a review of previous literature, six macroeconomic variables were selected: inflation, exports, imports, Foreign Direct Investment (FDI), population growth, and unemployment rate. Using EViews 12 Student Lite software, the findings reveal that only exports have a statistically significant positive impact on GDP growth, while inflation, imports, FDI, population growth, and unemployment rates are found to be insignificant. These results provide valuable insights for policymakers in formulating strategies to enhance economic growth, identifying key economic trends, and mitigating potential risks. Additionally, the findings contribute to improved decision-making for firms, investors, and government agencies by supporting risk management and strategic economic planning.*

***Keywords: GDP, Multiple Linear Regression, Macroeconomic Variables, World Development Indicators***

## Introduction

Gross Domestic Product (GDP) measures the monetary value of goods and services produced within a country over a given period, such as a quarter or a year (OECD, 2009). It includes both market-driven and non-market output, such as government services. GDP is widely used to assess economic size, growth, and performance, but it has limitations, such as not accounting for environmental sustainability or wealth distribution (OECD, 2024). Alternative indices are thus needed for a more comprehensive evaluation of economic progress.

In Asia, GDP growth remains a key driver of global economic expansion, but its pace is slowing. The IMF estimates that in 2023, Asia contributed nearly two-thirds of global growth. However, while GDP in the Asia-Pacific region grew from 4.2% in 2022 to 4.6% in 2023, concerns remain over declining investment in Southeast Asia and Japan, as well as China's real estate slump. Malaysia's GDP outperformed expectations in Q1 2023 with a 5.6% growth rate but slowed to 2.9% in Q2 before

improving slightly to 3.3% in Q3, reflecting global economic challenges and declining external demand (Goh, 2023).

Multiple linear regression is a statistical method used to assess the impact of multiple independent variables on a single dependent variable. This approach estimates coefficients that minimize prediction errors, commonly using the Ordinary Least Squares (OLS) method, which minimizes the total squared differences between actual and predicted values (Gujarati & Porter, 2009; Pohlmann & Leitner, 2003).

In this study, macroeconomic indicators such as population growth, FDI, unemployment rate, inflation rate, imports, and exports are used as independent variables (Agalega & Antwi, 2013). Population growth is measured as the exponential rate of midyear population increase. FDI refers to net inflows aimed at acquiring a long-term managerial stake in a foreign enterprise. The unemployment rate represents the percentage of the labour force actively seeking jobs. Inflation is calculated using the consumer price index (CPI) as an annual percentage change in consumer costs. Exports and imports denote the total value of goods and services traded internationally (World Bank, 2024).

As a rapidly growing economy, Malaysia faces ongoing challenges in accurately predicting GDP to guide policy decisions, strategic planning, and sustainable economic growth. The interplay of various macroeconomic factors complicates economic forecasting, highlighting the need for a robust predictive model. While previous studies have attempted to forecast GDP, a more comprehensive approach incorporating multiple macroeconomic variables is necessary for improving accuracy (Omar & Nor, 2020). For instance, studies on Pakistan's GDP by Irshad et al. (2022) and Memon et al. (2021) yielded differing results regarding the impact of exports. This discrepancy arose due to variations in methodology—both studies conducted the Augmented Dickey-Fuller (ADF) test, but only Irshad et al. (2022) performed additional multicollinearity, heteroscedasticity, and autocorrelation tests to refine their model. Such methodological differences can lead to conflicting conclusions, making it difficult for firms and policymakers to evaluate risks and predict economic trends accurately.

Given these challenges, this study proposes a model that identifies key factors influencing Malaysia's GDP using a more appropriate econometric approach. By improving GDP prediction accuracy, this model aims to assist policymakers in making informed decisions that support long-term economic stability and growth.

**Literature Review**

Stani´c and Ra˘ci´c (2019) used the multiple linear regression model to investigate the macroeconomic variables influencing Bosnia and Herzegovina's GDP from 2005 until 2018. From the study, growth rate, unemployment rate, and inflation rate are shown to have a negative association with GDP, whereas imports, exports, and FDI are shown to have a positive relationship. In other study investigating whether

US' GDP can be predicted annually using multiple linear regression using macroeconomic variables, three models have been proposed (Samiyu, 2021). The first one is called the basic model. In this model, population, maturity rate, disposable income, and housing price index are positively associated to GDP. Next, in the second model, corporate profit has been included. This is called model 1. The result shows that it has a positive and significant correlation with GDP. In the third model, 10-year breakeven inflation rate was added as an extended to the model 1. However, the result revealed that inflation rate has a negative correlation with GDP.

Omar and Nor (2020) study the linkage between macroeconomic variables (population, unemployment and export) with the economic growth in Malaysia based on time series quarterly data from 2006 until 2016 using multiple linear regressions (MLR) analysis. The study revealed that population is significant and negatively related to economic growth, while export is significant but positively related to economic growth. However, this study stated that the unemployment is insignificant towards economic growth. In a similar study to examine the impact of macroeconomic variables on the expansion of Pakistan's economy from 1991 to 2020, the results of the Ordinary Least Square (OLS) method show that, while the inflation rate has a negative association with GDP, household consumption, government spending, the investment rate, and net exports have positive relationships (Memon et al., 2021).

Using four machine learning techniques — principal component regression (PCR), ridge regression (RR), lasso regression (LR), and OLS — Agu et al. (2022) conducted a study to predict Nigeria's GDP based on macroeconomic indicators and identify the most likely major macroeconomic variables that could affect GDP growth. The study's data set spans from 1981 to 2019. The first approach, PCR, is a PCA-based regression analysis methodology. However, PCA cannot be used to forecast GDP since it does not offer an economic interpretation of the data. Other than that, the RR, LR, and OLS approaches result in the same outcome: population, federal government expenditure, import rate, and exports have a positive connection with GDP, whereas the foreign exchange rate, FDI, and oil revenue have a negative link with GDP. When comparing MSE, PCR outperformed OLS, LR, and RR in terms of predictive accuracy. However, since PCA does not offer economic interpretation, hence PCR unable to impose any relationship between dependant and independent variables. Due to that issue, RR model is utilized for predicting accuracy since it has second highest predictive accuracy.

**Methodology**

Data of GDP and other macroeconomic variables from 2010 to 2019 were retrieved from World Development Indicator (WDI), The World Bank (2024). Regarding the macroeconomic variables, the dependent variable GDP would be predicted using the following independent variables; population growth (POP), imports (IMP), exports (EXP), unemployment rate (UNEMP), inflation rate (INF), and

foreign direct investment (FDI). Next, all the data are checked for stationarity test. It is a method used to identify whether a time series statistical properties hold true over time. In this study, Augmented Dickey-Fuller (ADF) test is used to determine whether the data is stationary or non-stationary. All the analysis were executed using EViews 12 Student Lite software.

Multicollinearity in a multiple regression model is the presence of strong intercorrelations between two or more independent variables. If there is multicollinearity in the data, the common solution would be to identify and remove those variables from the regression (Tan et al., 2021). This problem can be tested using Variance Inflation Factor (VIF). The degree to which multicollinearity increases the variances in the regression estimates is shown by the linear regression's VIFs. A VIF value of 5 to 10 will mean that variables are highly correlated, a VIF between 1 and 5 indicates that variables are moderately correlated, and a VIF of 1 show that the variables are not correlated (Statistics, 2013).

Multiple linear regression (MLR) is used to explain the impact of GDP on the dependent variable. MLR is a linear regression model in which only one dependent variable (Y) and two or more independent variables (X) are regressed. The purpose of using this model is to create a linear equation that best fits the data by estimating the coefficients of the independent variables that minimize the error in predicting the dependent variable (Gujarati & Porter, 2009). The general form of multiple linear regression equation is:

$$GDP_t = B_0 + B_1POP_t + B_2IMP_t + B_3EXP_t + B_4UNEMP_t + B_5INF_t + B_6FDI_t + \xi_t$$

Where;

$GDP_t$ = the dependent variable, GDP, at time t .

$B_0$ = the intercept, representing the value of GDP when all the independent variables are zero.

$B_1, B_2, ..., B_n$ = the coefficients for the independent variables representing how much the dependent variable changes for a one-unit change in each respective independent variable, while holding other variables constant.

$\xi$ = the error term, representing the difference between the predicted and actual values of the dependent variable.

**Result and Discussion**

The study examined the relationship between GDP and macroeconomic variables; inflation, exports, imports, FDI, population growth, and unemployment using multiple linear regression. After conducting Multicollinearity Tests, no multicollinearity was detected, and the data was homoscedastic.

Table 1: Variance Inflation Factor (VIF) result

| Variables | VIF values |
|---|---|
| Inflation | 2.096297 |
| Export | 2.230797 |
| Import | 1.902861 |
| FDI | 1.230503 |
| Population growth | 1.933110 |
| Unemployment | 1.995800 |

The result for F-statistics for heteroscedasticity test is 1.508703 with p-value of 0.3955 indicating that the data is homoscedasticity. Initially, all six independent variables were included, but only variable exports (EXP) were found to be statistically significant in influencing GDP.

Table 2: Multiple Linear Regression result

| Variables | Coefficient | p-values |
|---|---|---|
| Intercept | 4.982692 | 0.0032 |
| Inflation | -0.074520 | 0.8030 |
| Export | 0.228831 | 0.0472* |
| Import | -0.000685 | 0.9860 |
| FDI | -0.167898 | 0.4640 |
| Population growth | 3.969650 | 0.5438 |
| Unemployment | 1.065465 | 0.3628 |

From the result, only export data is significant variables and F-statistic shown to have value of 3.2080 with p-value of 0.1833. With p-value (F-statistic) more than 0.05, the whole regression proves to be insignificant. Hence, to achieve model that is significant, insignificant variables need to be excluded starting from highest p-value. After few steps execution in finding the good model, finally, only export variable is left with statistically significant p-value (F-statistics=15.23762, p-value=0.004522). Other variables were excluded due to high p-values. Therefore, the final regression model obtained was:

$$GDP = 4.824162 + 0.179571EXP$$

This indicates that a 1% increase in exports is associated with a 0.18% increase in GDP. The model was statistically significant, aligning with previous studies that support the positive relationship between exports and GDP. However, the study's small sample size (10 years) may have contributed to the insignificance of other variables.

Overall, the findings highlight the strong impact of exports on GDP, while other factors like inflation, FDI, and population growth were not significant in this dataset. These results align with previous studies, such as Omar and Nor (2020), which also found exports to be a key driver of Malaysia’s GDP. The insignificance of unemployment and FDI is consistent with findings by Assaf (2014) and Memon

et al. (2021), suggesting that these factors may have a weaker direct influence on economic growth within the selected time frame. Moreover, in the study on Nigeria's GDP of data set spans from 1981 to 2019 has identified exports as a major factor positively affecting GDP, while FDI had a negative relationship (Agu et al., 2022).

**Conclusion**

This study aimed to examine the impact of macroeconomic variables (inflation, exports, imports, FDI, population growth, and unemployment) on GDP using a multiple linear regression model. The analysis covered data from [years] to determine which factors significantly influence economic growth. The regression results revealed that among the six independent variables, only exports (EXP) had a significant positive relationship with GDP. A 1% increase in exports was associated with a 0.18% increase in GDP, indicating a strong linkage between international trade and economic growth. In contrast, inflation, imports, FDI, population growth, and unemployment were found to be statistically insignificant in this study.

The findings underscore the crucial role of exports in driving economic growth. Policymakers should focus on enhancing trade policies, strengthening export-oriented industries, and expanding international market access to sustain GDP growth. Meanwhile, further investigation into the role of other macroeconomic factors may be needed to understand their long-term impact on economic performance. This study is limited by its relatively small sample size of 10 years, which may have influenced the statistical significance of certain variables. Future research could extend the dataset to include a longer period or explore additional macroeconomic indicators to provide a more comprehensive analysis. Furthermore, alternative econometric techniques, such as time-series modelling, could be applied to enhance the robustness of the findings.

Overall, this study highlights exports as a vital contributor to GDP growth. As globalization continues to shape economic trends, further research into trade dynamics and macroeconomic policies will be essential in ensuring sustainable economic development.

**References:**

Agalega, E., & Antwi, S. (2013). *The impact of macroeconomic variables on gross domestic product: Empirical evidence from Ghana*. International Business Research, 6(5), 108–116.

Agu, S. C., Onu, F. U., Ezemagu, U. K., & Oden, D. (2022). *Predicting Gross Domestic Product to macroeconomic indicators*. Intelligent Systems with Applications, 14, 200082.

Goh, N. (2023). *Malaysia's GDP growth inches up to 3.3% but remains lacklustre* [Accessed: 2024-04-20]. https://asia.nikkei.com/Economy/Malaysia-s-GDP-growth-inchesup-to%203.3-but-remains-lackluster

Gujarati, D. N., & Porter, D. C. (2009). Basic econometrics. McGraw-hill.

Irshad, M., Hussain, M., & Baig, M. A. (2022). *Macroeconomic variables the indicators for the economic growth of Pakistan*. Pakistan Social Sciences Review, 6(2), 58–72.

Memon, A. W., Phul, M. H., & Kanhar, N. A. (2021). *The impact of macroeconomic variables on economic growth of Pakistan*. Turkish Online Journal of Qualitative Inquiry, 12(8), 7802–7830.

OECD. (2009). National accounts of OECD countries 2009, volume 1, main aggregates. https://doi.org/10.1787/na vol 1-2009-en-fr

OECD. (2024). Gross Domestic Product (GDP) (indicator) [Accessed: 2024-05-26]. https://doi.org/10.1787/dc2f7aec-en

Omar, M. S., & Nor, A. M. (2020). *Macroeconomic variables and economic growth: The Malaysian perspectives.* International Journal of Academic Research in Business and Social Sciences, 10(3), 272–280.

Pohlmann, J. T., & Leitner, D. W. (2003). *A comparison of Ordinary Least Squares and Logistic Regression (1)*. The Ohio journal of science, 103(5), 118–126.

Samiyu, M. (2021). *Multiple regression model for predicting GDP using macroeconomic variables (part 1)*. Available at SSRN 3895177.

Stani´c, S., & Raˇci´c, ˇ Z. V. (2019). *Analysis of macroeconomic factors effect to Gross Domestic Product of Bosnia and Herzegovina using the multiple linear regression model.* Economics, 7(2), 91–97.

Statistics, L. (2013). Multiple regression analysis using SPSS statistics. Laerd Research Ltd.

Tan, V. N., Md Yusof, Z., Misiran, M., & Supadi, S. S. (2021). *Assessing youth unemployment rate in malaysia using multiple linear regression*. Journal of Mathematics and Computing Science (JMCS), 7(1), 23–34.

The World Bank. (2024). World development indicators [Accessed: 2024-01-08]. https://databank.worldbank.org/source/world-development-indicators

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# STUDENT PERSPECTIVES ON ONLINE LEARNING COMPARED TO CONVENTIONAL CLASSROOM LEARNING BETWEEN FIELDS OF STUDY

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**ABSTRACT**

*Transitioning from traditional classroom instruction to online education has ignited extensive discourse among students, educators, and politicians. This study examines student perceptions of online learning versus traditional classroom instruction among Culinary Arts Management and Engineering students at Kampus Permatang Pauh, UiTM Cawangan Pulau Pinang. A survey was administered to a sample of 55 students, chosen using systematic sampling. Data collection was conducted using an online questionnaire, and statistical analysis was executed using SPSS, incorporating an independent sample t-test to evaluate variations in student preferences. Research reveals that although both cohorts acknowledge the benefits of online education, Culinary Arts Management students have a pronounced inclination for conventional in-person instruction owing to the tactile demands of their field. Conversely, Engineering students demonstrate a greater propensity for online learning, appreciating its flexibility and accessibility. The study emphasises the necessity of a balanced blended learning approach that amalgamates the advantages of both techniques to improve student engagement and academic performance.*

***Keywords: Online learning, conventional classroom learning, student perspectives, blended learning, education***

## Introduction

The transition from conventional classroom instruction to online learning has generated much debate among students, teachers, and legislators (Karp, 2025). Students now have access to a more adaptable and technologically advanced learning environment because of the growth of digital education. However, students now have differing views on how effective this shift is compared to conventional classroom instruction. Some students love the dynamic, structured and collaborative character of traditional classrooms, while others value the ease, independence and accessibility of online learning. Examining how students view these two learning modalities offers important insights into their preferences and difficulties and how each affects their learning experience and academic achievement.

In this study, we are conducting a survey on Student Perspectives on Online Learning Compared to Conventional Classroom Learning in Kampus Permatang Pauh, UiTM Cawangan Pulau Pinang. This survey involved Culinary Arts Management and Engineering Students; our survey population was 82. The sample for this study is 55 students from the Culinary Arts Management and Engineering Students retrieved from the Sample Size Calculator. For the data collection, we used a questionnaire distributed through Google Forms using social media platforms such as WhatsApp and Telegram. The questionnaire was adopted from SurveyPlanet (2025) and restructured to be relevant to our survey. Next, we used systematic sampling to collect the sample. Systematic sampling is a probability sampling technique in which a population chooses components regularly. After randomly selecting a beginning point, each k -th member from the list – where k is the sample interval – is chosen. The intended sample size (n) divided by the overall population size (N) yields the interval k. Data were analysed using SPSS.

The primary purpose of this survey was to examine students' preferences between online and face-to-face classes. The key finding revealed that Culinary Arts Management and Engineering program students were more inclined toward online than face-to-face classes. This study addresses the students' perspectives on online learning compared to conventional classroom learning. The objectives are (1) To identify courses that prefer online learning compared to conventional classroom learning and (2) To investigate whether a significant difference exists between courses that prefer online learning compared to conventional classroom learning.

**Methodology**

For this study, the method used to collect the data for us to achieve the objectives is "Two Population Mean". Two population means are measured from two sets of independent samples. In this study, our samples were Culinary Arts students and Engineering students. Furthermore, for the sampling technique, in order for us to collect the data, we used a probability sampling technique called systematic sampling, which involves the selection of every 2nd, 5th or 10th, or any ordinal number that is suitable to be used on the person on a list. The sample that we would sample was 55 people, a mix of Culinary Arts students and Engineering students. Therefore, we will choose the fifth person from the list to be in our sample for this study.

*Steps of Systematic Sampling*

- First, the sampling interval, which is symbolised by "k" or can also be defined as the population size divided by the desired sample size, is determined.
- Secondly, randomly select a number between 1 and k, then include the chosen person in the sample. 3. Thirdly, include each fifth element in the sample.

- Lastly, at the end of the sampling frame, we will have all the people to be included in the sample.

*Descriptive of Data*

- Population: 82 students from the Faculty of Culinary Arts Management and the Faculty of Engineering at Permatang Pauh Campus of UiTMCPP.
- Sample: 55 students from the Faculty of Culinary Arts Management and the Faculty of Engineering Sampling Technique: Systematic or probability sampling. Students were selected by choosing every fifth person from a list of students from both fields of study.
- Data Collection Method: The data was collected using a questionnaire shared via Google Forms. The survey link was distributed through WhatsApp, making it easy for participants to access and complete the form.

**Finding**

To comprehend student preferences for diverse learning modalities, we conducted research comparing online learning with traditional classroom instruction across multiple disciplines. This study elucidates the changing educational landscape and the determinants affecting students' decisions. Through analysing these preferences, we aim to offer insights that might guide academic institutions and instructors regarding contemporary trends and prospective areas for enhancement in educational content delivery. The analysis will assist in discovering patterns and preferences that can inform the creation of more effective and customised learning experiences for students.

This bar chart (Figure 1) illustrates a distinct preference for traditional classroom instruction over online education in both disciplines. The disparity in satisfaction levels suggests that students enrolled in Culinary Arts Management and Engineering programs exhibit more contentment with in-person instruction than online learning settings (Cook, 2024). This may result from the experiential aspect of these disciplines, where practical engagement and direct contact are essential to the learning process.

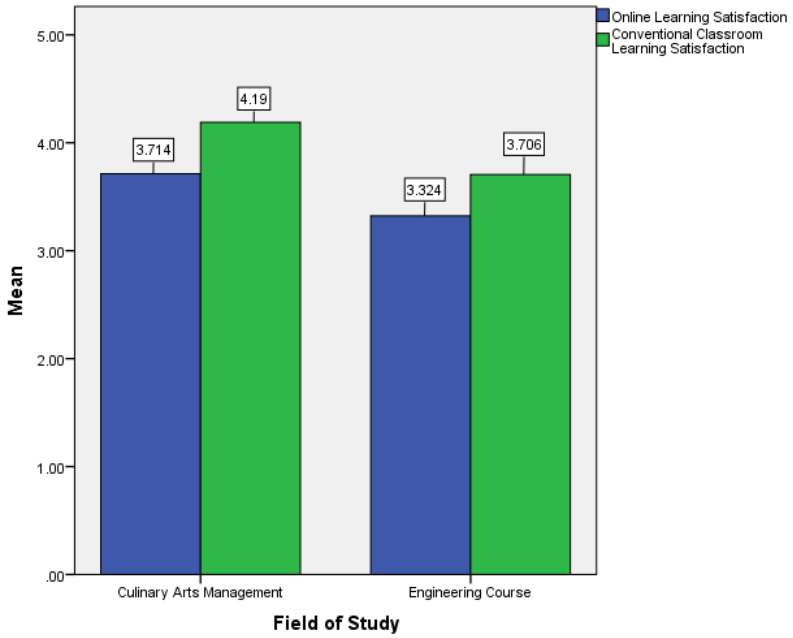


Figure 1: Satisfaction Levels in Different Learning Environments for Culinary Arts and Engineering Students

We performed an independent sample t-test (Table 1) to examine the disparities in student preferences for online learning compared to traditional classroom learning across several disciplines of study. This statistical test seeks to ascertain if a substantial disparity exists between the average satisfaction levels of students in Culinary Arts Management and Engineering courses across both learning contexts. Analysing the t-test results allows us to determine the degree to which the observed differences in satisfaction are statistically significant rather than coincidental. This analysis offers significant insights into the influence of learning modalities on student satisfaction across these specific academic fields.

Table 1: Result of Independent Sample t-Test

| | | Mean of Online Learning | | Mean of Conventional Classroom Learning | |
|---|---|---|---|---|---|
| | | Equal variances assumed | Equal variances not assumed | Equal variances assumed | Equal variances not assumed |
| Levene's Test for Equality of Variances | F | .145 | | 4.369 | |
| | Sig. | .705 | | .041 | |
| t-test for Equality of Means | t | 1.963 | 2.108 | 2.062 | 2.285 |
| | df | 53 | 51.203 | 53 | 52.927 |
| | Sig. (2-tailed) | .055 | .040 | .044 | .026 |

Levene's Test for Equality of Variances: The significance level (Sig.) of 0.705 is greater than 0.05, showing that the assumption of equal variances is not violated. This means we can assume that the two groups' variances are equivalent. When identical variances are assumed, the t-value is 1.963, with a 2-tailed significance level of 0.055. This p-value is slightly higher than the customary threshold of 0.05, indicating that the satisfaction gap of online learning is marginally non-significant between the two courses. The analysis suggests that these two courses have an equal preference for online learning.

On the other hand, in Levene's Test for Equality of Variances for conventional classroom learning, The significance value (Sig.) of 0.041 is less than 0.05, indicating that the assumption of equal variances is violated. We should use the "equal variances not assumed" t-test results for a more accurate interpretation. When equal variances are not assumed, the t-value is 2.285 with 52.927 degrees of freedom (df), and the significance value (Sig. 2-tailed) is 0.026. This value is also less than 0.05, indicating a statistically significant difference in conventional classroom learning between these two courses. The Culinary Arts Management student prefers conventional classroom learning to online learning.

**Conclusion and Recommendations**

As for the recommendation, by fusing the advantages of conventional classroom learning and online learning, universities can successfully adopt blended learning in the future. With this method, students may take advantage of the accessibility and flexibility of online learning, which lets them access many digital materials, learn at their own pace, and engage in engaging online conversations and activities.

Simultaneously, traditional in-person programs offer structure, instant feedback, practical learning opportunities, and beneficial social connections critical for developing specific skills and subjects. By combining these two approaches, universities can accommodate a range of learning styles, boost student motivation and engagement, and raise academic achievement overall (Houston, 2024). Besides encouraging efficient two-way contact with students, instructors can improve their educational experience. This method entails establishing a lively and engaging learning environment where students can easily share their thoughts, pose queries, and participate in class discussions. Then, two-way communication fosters collaboration and reduces monotony in the learning process. It keeps students interested. Instructors can facilitate this using various techniques, including interactive exercises in in-person seminars, group discussions, and live Q&A sessions. Online platforms can also be used for video calls, discussion boards, and real-time conversations, letting students interact with peers and teachers outside the conventional classroom. Instructors may resolve any issues or misunderstandings, give prompt feedback, and modify their teaching methods to fit the various requirements of their pupils by

keeping lines of communication open. In addition to avoiding boredom, this guarantees that the learning process proceeds efficiently, eventually improving educational results.

In a nutshell, both traditional classroom instruction and online learning have advantages and disadvantages of their own. Unmatched accessibility and flexibility are provided by online learning, enabling students to access a wealth of digital resources and learn quickly and from anywhere. However, it can occasionally result in loneliness and a lack of face-to-face interaction and practical experiences essential for specific subjects. Traditional classroom instruction fosters community and involvement by offering structured settings, instant feedback, and beneficial social connections. However, because of the cost of transportation and lodging, it may be less flexible and more expensive. The benefits of online and in-person learning can be combined in a blended learning strategy, which offers a thorough and well-rounded educational experience that accommodates a range of learning styles and enhances academic performance. By carefully combining these strategies, educational institutions can design future learning environments that are more effective, flexible, and engaging.

**References:**

Cook, J. (2024, November 15). The boom in home schooling. Financial Times. https://www.ft.com/content/364a65cf-4ec1-4f65-ba17-d7cf7ebb4b1a

Houston, K. (2024, December 30). 7 benefits of blended learning. The Jotform Blog. https://www.jotform.com/blog/benefits-of-blended-learning

Karp, P. (2025, February 19). Teaching to an empty hall: Is the changing face of universities eroding standards of learning? The Guardian. https://www.theguardian.com/australia-news/2025/feb/19/teaching-to-an-empty-hall-is-the-changing-face-of-universities-eroding-standards-of-learning

Mi.pham. (2024, September 19). Sample Size Calculator. tgm research; tgm research: market research and online panels https://tgmresearch.com/tools/sample-size calculator.html?msclkid=d6c490d200281cf16dedf791d0bd9a5b

SurveyPlanet (2025), How to make a questionnaire regarding the impact of eLearning? https://blog.surveyplanet.com/how-to-make-a-questionnaire-regarding-the-impact-of-elearning

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mac - 2025*

# PENDEKATAN PEMBELAJARAN KOLABORATIF: MENGHUBUNGKAN MATEMATIK PERNIAGAAN DENGAN APLIKASI DUNIA SEBENAR MELALUI PERKONGSIAN INDUSTRI

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**ABSTRAK**

*Pendidikan moden menekankan pendekatan pengajaran yang lebih kolaboratif, di mana akademia dan industri bekerjasama untuk memperkayakan pengalaman pembelajaran pelajar. Kajian ini bertujuan untuk menganalisis pemahaman dan persepsi pelajar terhadap Matematik Perniagaan serta mengenal pasti cabaran dalam penggunaannya dalam kehidupan sebenar. Dengan mengambil kira kepentingan pembelajaran kolaboratif, pembelajaran melalui perkongsian industri berpotensi membantu pelajar menghubungkan konsep teori dengan aplikasi dunia sebenar. Dapatan kajian menunjukkan bahawa majoriti pelajar memahami konsep asas Matematik Perniagaan, namun masih menghadapi kesukaran dalam mengaplikasikannya secara praktikal. Antara cabaran utama adalah kesukaran menghubungkan teori dengan amalan dan kekurangan pendedahan kepada situasi industri sebenar. Oleh itu, kaedah pengajaran yang melibatkan perkongsian daripada industri boleh menjadi pendekatan yang berkesan untuk meningkatkan kefahaman dan kemahiran pelajar dalam bidang ini.*

***Keywords: Asas matematik, matematik perniagaan, pengajaran kolaboratif***

## Pengenalan

Matematik Perniagaan merupakan satu komponen penting dalam dunia perniagaan kerana ia membantu dalam membuat keputusan kewangan, analisis keuntungan, serta pengurusan risiko. Walau bagaimanapun, terdapat cabaran dalam memastikan pelajar bukan sahaja memahami konsep secara teori tetapi juga dapat mengaplikasikannya dalam situasi sebenar (Sabtu & Mohamad, 2023). Dalam usaha untuk merapatkan jurang ini, konsep Pembelajaran kolaboratif melalui perkongsian industri semakin mendapat perhatian (Misra,2020).

Pembelajaran kolaboratif melibatkan kerjasama antara akademik dan profesional industri untuk memberikan perspektif dunia sebenar kepada pelajar (Dewi et al., 2025). Kaedah ini bukan sahaja meningkatkan pemahaman pelajar terhadap konsep Matematik Perniagaan tetapi juga membolehkan mereka melihat aplikasi praktikal dalam sektor seperti peruncitan, perkilangan, dan perkhidmatan (Haj-Yahya & Klieger, 2023). Melalui sesi perkongsian industri, pelajar dapat memahami bagaimana teori yang dipelajari di bilik darjah digunakan dalam dunia pekerjaan sebenar, sekali gus meningkatkan keupayaan mereka untuk berfikir secara analitikal dan menyelesaikan masalah (Wang et al., 2019).

Kajian ini bertujuan untuk mengenal pasti trend dan corak dalam pemahaman serta persepsi pelajar terhadap Matematik Perniagaan, serta meneroka sejauh mana pembelajaran kolaboratif melalui perkongsian industri dapat membantu mengatasi cabaran yang dihadapi dalam pembelajaran subjek ini.

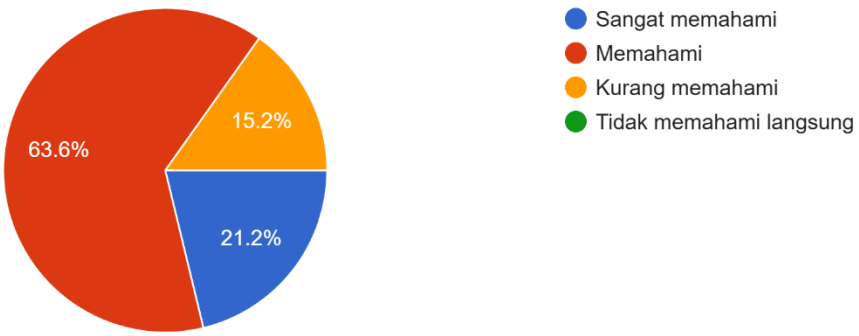
## Metodologi

Kajian ini menggunakan pendekatan kuantitatif melalui kaedah tinjauan bagi menganalisis pemahaman dan persepsi pelajar terhadap Matematik Perniagaan serta cabaran yang mereka hadapi dalam mengaplikasikan konsep tersebut. Sampel kajian terdiri daripada pelajar pra-perdagangan yang mengambil subjek Matematik Intensif (MAT037) di UiTM Cawangan Pulau Pinang. Data dikumpulkan menggunakan borang soal selidik yang diedarkan secara atas talian semasa sesi perkongsian bersama wakil industri. Soal selidik ini terbahagi kepada beberapa bahagian utama, tahap pemahaman pelajar mengenai Matematik Perniagaan, penggunaan konsep ini dalam kehidupan seharian, kesedaran terhadap kepentingannya dalam industri, serta cabaran dan cadangan penambahbaikan. Data yang dikumpulkan dianalisis menggunakan perisian statistik bagi mendapatkan peratusan, purata, serta taburan frekuensi bagi setiap kategori jawapan. Analisis ini membolehkan pengenalpastian corak dan trend dalam pemahaman serta persepsi pelajar terhadap Matematik Perniagaan, sekali gus memberikan gambaran yang lebih jelas mengenai cabaran yang dihadapi dan langkah-langkah penambahbaikan yang boleh diambil.

## Dapatan Kajian

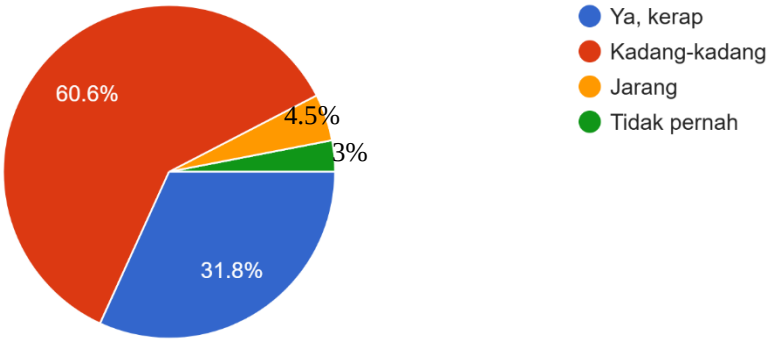
### *Pemahaman dan Persepsi Pelajar terhadap Matematik Perniagaan*

Hasil kajian menunjukkan bahawa majoriti pelajar mempunyai pemahaman yang baik terhadap Matematik Perniagaan, dengan kebanyakan mereka melaporkan bahawa mereka “Sangat memahami” (21.2%) atau “Memahami”(63.6%) konsep asas seperti keuntungan, diskaun, dan faedah. Walaupun begitu, terdapat sebilangan kecil pelajar yang masih “Kurang memahami”(15.2%), menunjukkan keperluan untuk pendekatan pengajaran yang lebih efektif (Rajah 1).




Rajah 1: Pemahaman terhadap konsep Matematik Perniagaan seperti keuntungan, diskaun, dan faedah

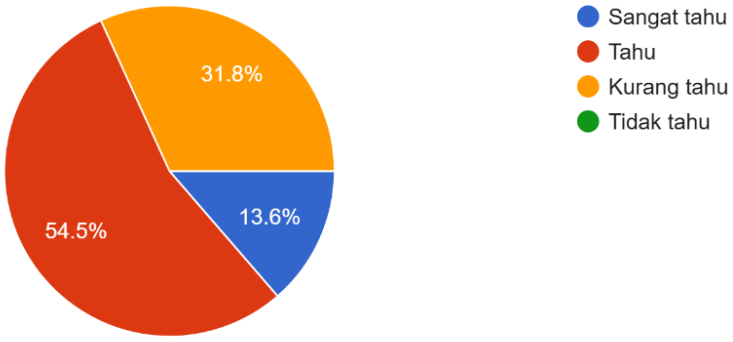
Selain itu, ramai pelajar menyatakan bahawa mereka sering menggunakan konsep Matematik Perniagaan dalam kehidupan harian mereka (Ya, kerap, 31.8%), terutamanya dalam membuat keputusan kewangan. Namun, masih terdapat pelajar yang hanya menggunakan konsep ini secara berkala dan kurang memahami kepentingannya dalam dunia sebenar (Rajah 2).




Rajah 2: Penggunaan konsep Matematik Perniagaan dalam kehidupan seharian

***Kesedaran terhadap Penggunaan dalam Industri Tempatan***

Dapatan kajian juga menunjukkan bahawa majoriti pelajar (Sangat tahu, 13.6% dan Tahu, 54.5%) menyedari bagaimana Matematik Perniagaan digunakan dalam industri tempatan seperti peruncitan dan perkilangan. Walau bagaimanapun, masih terdapat segelintir pelajar yang "Kurang tahu"(31.8%) mengenai penggunaannya dalam sektor industri tertentu, menandakan bahawa lebih banyak pendedahan dan latihan praktikal diperlukan (Rajah 3).

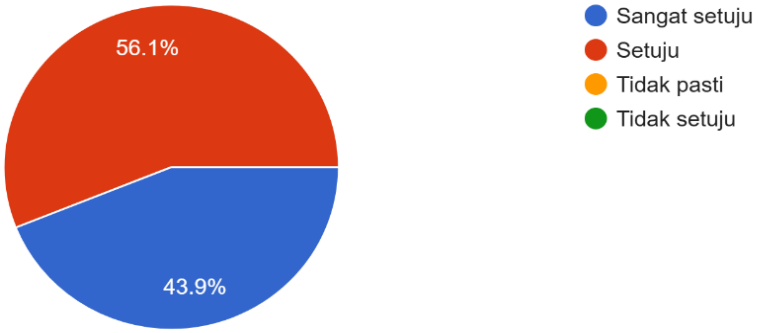



Rajah 3: Pengetahuan dalam Matematik Perniagaan yang digunakan dalam industri tempatan seperti peruncitan, perkilangan, atau perkhidmatan

***Persepsi terhadap Kepentingan Matematik Perniagaan dalam Kecekapan Perniagaan***

Sebilangan besar pelajar "Sangat setuju"(43.9%) atau "Setuju"(56.1%) bahawa Matematik Perniagaan membantu meningkatkan kecekapan dalam operasi perniagaan tempatan. Ini menunjukkan bahawa

mereka mengiktiraf kepentingan kemahiran ini dalam memastikan keberkesanan dan kejayaan dalam bidang perniagaan (Rajah 4).




Rajah 4: Kepercayaan bahawa Matematik Perniagaan membantu meningkatkan kecekapan dalam perniagaan tempatan

## Cabaran Dan Cadangan Penambahbaikan

### *Cabaran yang dihadapi pelajar*

Walaupun ramai pelajar memahami Matematik Perniagaan, mereka masih menghadapi beberapa cabaran utama, termasuk:

1. Kesukaran Menghubungkan Teori dengan Amalan

Ramai pelajar melaporkan bahawa mereka memahami teori Matematik Perniagaan tetapi sukar untuk mengaplikasikannya dalam situasi dunia sebenar. Ini menunjukkan bahawa pembelajaran lebih berfokus kepada teori tanpa contoh aplikasi dalam industri.

2. Kekurangan Pendedahan kepada Dunia Industri

Sebilangan pelajar menyatakan bahawa mereka kurang mendapat pendedahan tentang bagaimana Matematik Perniagaan digunakan dalam bidang pekerjaan. Ini menyebabkan mereka tidak dapat mengaitkan pembelajaran dengan keperluan industri sebenar (Anitha & Kavitha, 2022).

3. Kefahaman yang Berbeza dalam Kalangan Pelajar

Ada pelajar yang menunjukkan tahap pemahaman yang tinggi, tetapi ada juga yang masih kurang memahami konsep asas Matematik Perniagaan. Faktor seperti latar belakang pendidikan dan pengalaman mungkin mempengaruhi tahap pemahaman ini.

### *Cadangan Penambahbaikan*

Berdasarkan cabaran yang dikenal pasti, beberapa langkah boleh diambil untuk memperkukuhkan pemahaman pelajar, antaranya:

1. Meningkatkan Pendekatan Collaborative Teaching melalui Perkongsian Industri

Institusi pendidikan boleh mengundang pakar industri untuk berkongsi pengalaman mereka dalam sesi pembelajaran. Pelajar boleh diberikan tugasan atau projek berkaitan situasi sebenar dalam perniagaan (Membrillo-Hernández et al., 2019).

2. Menerapkan Kaedah Pembelajaran Berasaskan Projek (Project-Based Learning)

Pelajar boleh diberikan kajian kes perniagaan sebenar yang memerlukan mereka menggunakan konsep Matematik Perniagaan untuk menyelesaikan masalah. Ini membantu mereka memahami bagaimana teori boleh diaplikasikan secara praktikal.

3. Latihan Industri atau Lawatan ke Syarikat

Menggalakkan pelajar menjalani latihan industri jangka pendek atau lawatan ke syarikat yang berkaitan dengan bidang Matematik Perniagaan. Ini dapat memberi pendedahan langsung tentang bagaimana konsep Matematik Perniagaan digunakan dalam dunia pekerjaan (Watters & Christensen, 2014).

4. Membangunkan Modul Interaktif dan Digital

Menggunakan teknologi seperti simulasi perniagaan dan permainan interaktif yang melibatkan konsep Matematik Perniagaan. Pendekatan ini boleh meningkatkan minat pelajar dan membantu mereka memahami konsep dengan lebih baik.

**Kesimpulan**

Kajian ini mendapati bahawa pelajar secara umumnya mempunyai pemahaman yang baik terhadap Matematik Perniagaan dan mengakui kepentingannya dalam kecekapan perniagaan. Walau bagaimanapun, cabaran utama yang dihadapi ialah kesukaran menghubungkan teori dengan amalan serta kurangnya pendedahan kepada situasi industri sebenar. Oleh itu, pendekatan Pembelajaran kolaboratif melalui perkongsian industri boleh menjadi strategi yang berkesan dalam meningkatkan pemahaman dan kecekapan pelajar dalam Matematik Perniagaan. Dengan melaksanakan pembelajaran berasaskan projek, latihan industri, dan penggunaan teknologi interaktif, pelajar boleh memperoleh pengalaman yang lebih bermakna dan bersedia menghadapi cabaran dalam dunia perniagaan yang sebenar.

**Rujukan:**

Anitha, D., & Kavitha, D. (2022). Improving problem-solving skills through technology assisted collaborative learning in a first year engineering mathematics course. *Interactive Technology and Smart Education*, *20*(4), 534-553.

Dewi, Z. R., Ulfatin, N., & Timan, A. (2025). Kolaborasi Pendidikan dan Dunia Industri Melalui Program Teaching Factory: Strategi Sekolah dalam Penyelarasan Kompetensi Peserta Didik dengan Kebutuhan IDUKA. Proceedings Series of Educational Studies, 441-446.

Haj-Yahya, A., & Klieger, A. (2023). Collaborating with industry to highlight the relevance of mathematics. *Research in Mathematics Education*, 1-21.

Membrillo-Hernández, J., J Ramírez-Cadena, M., Martínez-Acosta, M., Cruz-Gómez, E., Muñoz-Díaz, E., & Elizalde, H. (2019). Challenge based learning: the importance of world-leading companies as training partners. *International Journal on Interactive Design and Manufacturing (IJIDeM), 13*, 1103-1113.

Misra, R. (2020). Industry-academia collaborative teaching–A journey. Journal of engineering education transformations, 33(4), 2349-2473.

Sabtu, M., & Mohamad, R. (2023). Keberkesanan Kolaborasi Politeknik Kuala Terengganu Dan Industri Terhadap Pencapaian Gred Lulus Kursus Matematik Di Kalangan Pelajar. *International Journal of Advanced Research in Education and Society*, *5*(2), 196-203.

Wang, S. L., Chen, H. P., Hu, S. L., & Lee, C. D. (2019). Analyzing student satisfaction in the technical and vocational education system through collaborative teaching. Sustainability, 11(18), 4856.

Watters, J. J., & Christensen, C. (2014). Vocational education in science, technology, engineering and maths (STEM): Curriculum innovation through school industry partnerships. In conference (pp. 89-110).

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# INNOVATIVE APPLICATION DEVELOPMENT: E-HISTORY APPLICATION FOR STPM CANDIDATES

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**ABSTRACT**

*The term "e-learning approach" refers to one type of formal education that uses electronic devices such as computers and smartphones. One of the most challenging subjects is history, which is still taught in schools using the conventional approach that requires students to study textbooks and modules. To accomplish this purpose, this study addressed a number of issue statements, such as the usage of formal vocabulary and sophisticated terminology, classroom boredom, and a lack of instructional tools. To address those issues, this E-History application was created especially for Form 6 students. Additionally, this e-history application can offer history teachers professional development opportunities that keep them abreast of the most recent findings in the area as well as innovative teaching techniques. To address those issues, the E-History application was created especially for Form 6 pupils. Additionally, this e-history application can offer history teachers professional development opportunities that keep them abreast of the most recent findings in the area as well as innovative teaching techniques. This application's primary goal is to create a comprehensive and user-friendly learning environment centered around historical subjects. Feedback from STPM History teachers and candidates from SMK Haji Ahmad Badawi was gathered through surveys, research, and interviews.*

***Keywords: eLearning, ADDIE model, history subject, application***

## Introduction

Electronic learning, or e-learning, is a teaching methodology that uses digital resources and technological innovations to make learning and knowledge acquisition easier. E-learning is the umbrella term for any educational initiatives that employ electronic technology to facilitate them. These initiatives can be implemented online or in conventional classroom settings (Coman et al., 2020; Rahayu & Wirza, 2020). E-learning is the use of electronic technologies to deliver educational content and activities. E-learning is frequently used to refer to a variety of different forms of digital learning, including online and virtual education (Alebeisat et al., 2022). E-learning is considered as the acquisition of knowledge in an electronic form using personal computers, smartphones, tablets (Bakanova & Javorcikova, 2020). Learners can gain numerous benefits from elearning, including customization, flexibility, simplicity, accessibility, and interaction. hand."

Technology is very important in e-learning because the letter "e" stands for "electronics." The learning activities are designed, delivered, and supported by software and technologies. One example that is frequently utilized in daily life, whether at home, at school, or at work, is mobile devices. Technology enables gamification, AI, mobile learning, and adaptive learning. As more sophisticated technologies are developed, more individuals are utilizing mobile devices in their daily lives. E-learning allows for personalized learning. Students can work and learn at their own speed using smartphones. E-learning is anticipated to increase learning effectiveness by enhancing the conventional teaching approach and provide a means of optimizing learning results (Najuah & Ricu Sidik, 2021).

The current practice of learning history subject is using textbooks provided by the Malaysian government, which is the standard procedure. One of the greatest advantages of using textbooks is that they are psychologically necessary for students because their growth and accomplishment can be tracked concretely when they are being used (Hycroft, 1998). However, textbooks can be challenging to understand, especially for those who are not enthusiastic readers. Besides that, it is lengthy and the explanations in the textbook make history tedious, leading to disinterest among students. The shortage of time forces the teachers to speed up the lesson in class, leaving little room for in-depth explanation or student engagement.

The use of formal language and complex vocabulary in the materials presents challenges for STPM pupils. The student struggles to visualize historical events. Students mostly study the past to pass tests because most institutions still use antiquated teaching methods. They can have a harder time understanding what happened as a result. Students may find it difficult to visualize the individuals and events being described in history books that are mostly text-based unless they are accompanied by visual aids such as maps, diagrams, or photographs. People may so struggle to visualize the historical events they have studied. Students may become bored with traditional history textbooks due to their extensive content and lack of visual assistance.

Therefore, e-History Mobile Application for STPM candidates will be developed to provide great possibilities and opportunities for students to be interested in the subject of History. This E-History program was created specifically for the STPM History course, with an emphasis on the first semester. To make history classes more interesting and fun, it includes an exam and exercises. The history form 6 semester 1 syllabus covers four topics: society, government and administration, growth and development, and nationalism and the establishment of the nation state. By offering additional options, diversity, and interaction in the learning process, it may also increase student interest and involvement

**Project Scope**

The scope of this project includes the syllabus for History Form 6 Semester 1. Society, Government and Administration, Progress and Development, and Nationalism and the Formation of the Nation State

are the four topics covered in the History Form 6 Semester 1 syllabus. The goal of this application is to develop a thorough and intuitive learning environment focused on this topic. There will be exercises for each topic. There will also be an abundance of engaging exercises, such as thought maps and tests. All sixth-grade students have access to this resource, which can aid in enhancing their historical understanding. Additionally, educators can use this program to gain access to extra resources for their classroom instruction.

## Methodology

A well-defined and appropriate methodology will guide how the project is executed and reduce the chance of failure. The ADDIE Model and Cognitive Learning was chosen as the technique.

### *ADDIE Model*

According to Holden (2015), one of the models that establishes a generic, systematic, dynamic, and adaptable instructional design approach that is commonly used in instructional design for effective learning is ADDIE. Figure 1 shows the steps in ADDIE Model.

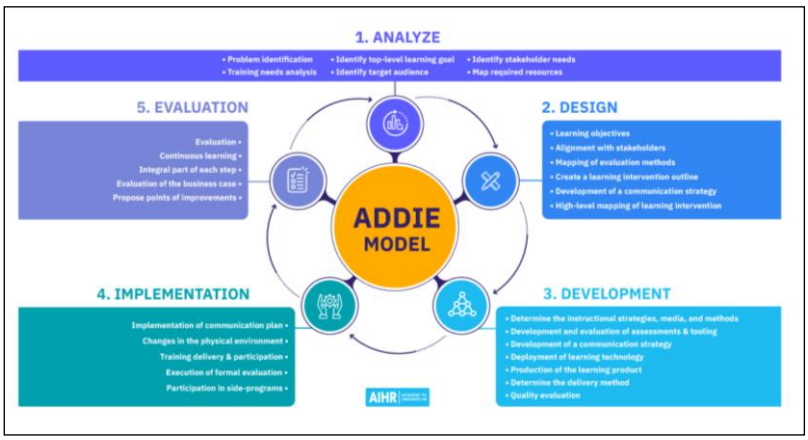


Figure 1: Steps in ADDIE Model

(Source: https://www.aihr.com/blog/addie-model/ )

### *Analysis*

The main objective is to assess the requirement for developing teaching purposes. Define the setting in the learning environment, as well as the educational requirements and objectives of the target audience. According to Adesfiana, Asturi and Enawaty (2022) there are two specific levels which is content needs analysis based on the syllabus (curriculum) and software requirements analysis (software).

### *Design*

The objective is based on research, to create a blueprint or storyboard for the course or instructional materials. The sitemap, storyboard, wireframe, and user interface were also created before the

development stage. Figure 2 below shows the Sitemap in E-History Application. Meanwhile figure 3 show the interface design and the wireframe proposed in the application.

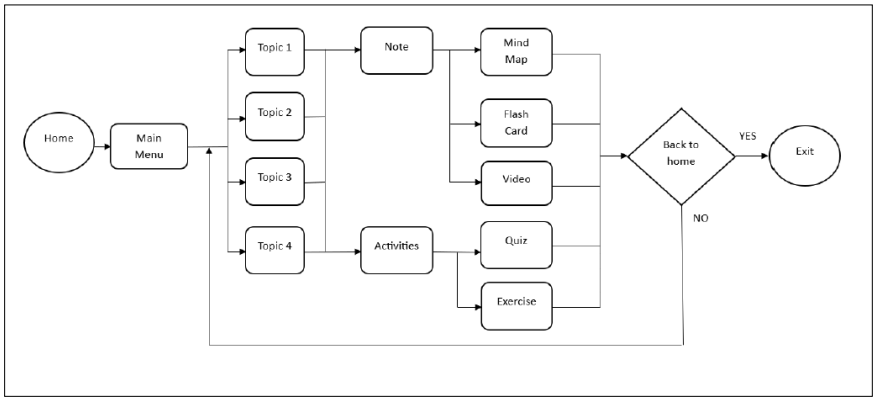


Figure 2: Sitemap in E-History Application

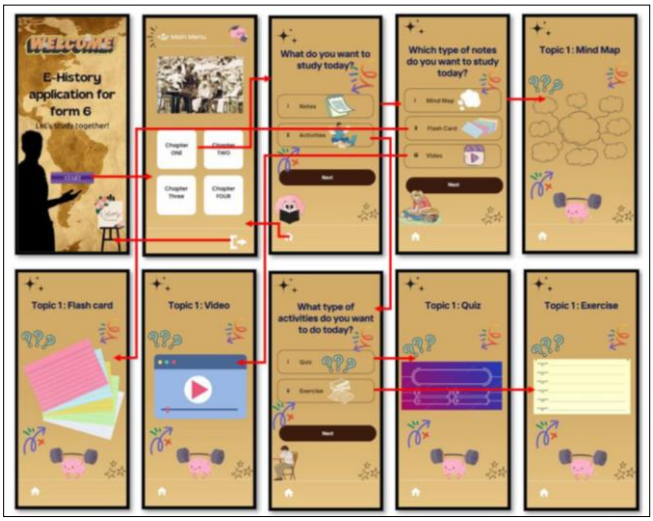


Figure 3: Interface Design and Wireframe Proposed in E-History Application

***Development***

According to the ADDIE model, the development phase is when the educational resources are made using the design specifications that were established in the design phase. The storyboard or prototype will serve as the project's template for creating the courses throughout this phase. The development stage concentrates on producing and refining those materials and experiences after the learning has been planned, (Downes, Andrew (2019). A digital development medium was used to convey the data acquired throughout the research and design stages. During this stage of development, the course material was changed to better accommodate user suggestions and demands. Multimedia components and computer software are combined in the design and development of e-history apps. The tools that

developers utilize throughout the development process must be identified. Table 1 and Table 2 and hardware below show the list of software used in developing the applications.

Table 1: Software used in E-History Application

| No | Software Requirements | Specification |
|---|---|---|
| 1 | Adobe audition | Utilised to combine text, audio, visuals, and videos |
| 2 | Adobe animates | Used to enhance the e-learning application's interactivity and include multimedia. |
| 3 | Adobe photoshop | Used for image and graphic design editing, enhancement, and manipulation |
| 4 | Play store | To publish apps. |

Table 2: Hardware used in E-History Application

| No | Hardware Necessities | Specification |
|---|---|---|
| 1 | Laptop Model | Dell Inspiron 15 3515 |
| 2 | Processor | AMD Ryzen 5 3500U with Radeon Vega Mobile Gfx 2.10 GHz |
| 3 | Memory (RAM) | 8.00 GB |
| 4 | Hard Disk Capacity | 458 GB |
| 5 | Hard Disk Capacity free | 216 GB |
| 6 | Window Edition | Windows 11 21H2 |

***Implementation***

The objective is to provide the course or training programme to the learners. By providing the learning environment that attracts individuals, the learning solution is completed. When a lesson has been established and set up, it is required to be pilot tested.

***Evaluation***

The ADDIE model's assessment phase, which came after all other phases, required examination to ascertain whether the e-learning application had been evaluated and whether its goals had been completely achieved. Users and specialists gave input on how the e-learning program affected them at this point, as well as whether any changes were required. During this stage, a number of respondents were given a questionnaire to complete in order to get their opinions. Finding out if the aforementioned goals satisfied user demands was the aim. In accordance with the development expectations prefix, evaluation is the procedure of figuring out the likelihood that the system is learning to develop effectively. Dick, Carey, and Carey (2015) state that formative and summative evaluations are the two forms of assessment used to assess the instructional design. Summative evaluation conducted at the end of a program, project, or instructional design to assess its overall efficacy and success, whereas formative evaluation concentrated on generating quick improvements.

**Conclusion**

The E-History application aims to support students and educators in the learning process. This e-learning application's ability to pique students' interest in studying history is one of its main advantages. Teachers don't have to work as hard to hold their students' attention in class because of the engaging and innovative method. New and interesting learning opportunities naturally appeal to students. Students may simply access the e-learning application on their phones because it is an application. The e-learning program is a flexible and useful tool for teaching history since it covers fundamental material, such as learning historical subjects and retaining key information.

**References:**

Adesfiana, Z. N., Astuti, I., & Enawaty, E. (2022). Pengembangan Chatbot Berbasis Web Menggunakan Model Addie. Jurnal Khatulistiwa Informatika, 10(2). https://doi.org/10.31294/jki.v10i2.14050

Alebeisat, F., Altarawneh, H., Alhalhouli, Z. T., Qatawneh, A., & Almahasne, M. (2022). The Impact of Human and Computer Interaction on eLearning Quality. International Journal of Interactive Mobile Technologies, 16(4). https://doi.org/10.3991/ijim.v16i04.27309

Andrew Downes. (2019, December 5). ADDIE: A 5-Step Process for Effective Training & Learning Evaluation.

Bakanova, I. G., & Javorcikova, J. (2020). Features of e-learning organization in a Modern University. Vestnik of Samara State Technical University Psychological and Pedagogical Sciences, 17(4). https://doi.org/10.17673/vsgtu-pps.2020.4.1

Brayadi, B., Supriadi, S., & Manora, H. (2022). Information Processing And Cognitive Theories Of Learning. Ej, 4(2). https://doi.org/10.37092/ej.v4i2.363

Dick, W., Carey, L., & Carey, J.O. (2015). The systematic design of instruction (8th ed.). Upper Saddle River, NJ: Pearson Publishing.

Holden, J. T. (2015). An introduction to the ADDIE instructional systems design model. FGDLA (1-17). US: fgdla. us.

Hycroft, J. 1998. An Introduction to English Language Teaching. New York & London: Longman

Najuah, Ricu Sidik &P. H. (2021). Analisis Pembelajaran Sejarah Berbasis E-Learning di Sumatera Utara pada Masa Pandemi Covid-19. Buddayah*: Jurnal Pendidikan Antropologi*, 3(1), 12–23. https://doi.org/10.24114/bdh.v3i1.23420.

*e-ISBN : 978-629-98755-5-0*
*SIG : e-Learning@CS*
*https://appspenang.uitm.edu.my/sigcs/*
*Publication Date : 24 – Mar - 2025*

# ANALYSIS USING DATA MINING TECHNIQUES: THE EXPLORATION AND REVIEW DATA OF DIABETES PATIENTS

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**ABSTRACT**

*Data mining is undergoing a transformative phase driven by advancements in Artificial Intelligence, statistics, database technology, real-time processing and integration of diverse data sources. These trends are not only enhancing the efficiency and accuracy of data mining but also expanding its applications across different industries. The subsequent step involves a comprehensive study of the dataset, incorporating both data exploration and analysis of data variables to achieve a structural and statistical understanding of the data. In this statistical summary procedure, the distribution of attributes and their interactions are crucial for accurately processing the data in accordance with the selected classification or data mining techniques to be performed. In examining the distribution of diabetes data, there are intricate interactions among the attributes. Therefore, it is advisable for future studies to implement robust classification algorithms, such as ensemble methods, to effectively manage and extract potential insights.*

***Keywords: data mining, classification, data interaction, attribute representation, data exploration***

## Introduction to fundamental concepts of data mining

In today's data-driven world, data mining has become an essential tool for organizations seeking to extract valuable insights from vast amounts of data. Data mining involves the process of discovering patterns, correlations, and anomalies within large datasets to predict outcomes and make informed decisions. As technology continues to evolve, several emerging trends are reshaping the landscape of data mining, making it more efficient, accurate, and impactful.

A prominent trend in data mining is the incorporation of artificial intelligence (AI) and machine learning (ML) to enhance algorithms derived from statistical methods and metaheuristic approaches. These technologies have revolutionized data mining by automating complex analysis processes and providing deeper, more actionable insights. AI-driven analytics enable organizations to process and analyze data at unprecedented speeds, uncovering hidden patterns and predicting future trends with greater accuracy (Current Trends & Future Scope of Data Mining, 2021). This has opened new avenues for innovation across various sectors, including finance, healthcare, retail, and manufacturing.

Figure 1 illustrates the relationship between AI and many fields of knowledge in the development of data mining technology, enhancing analytical outcomes. The descriptive analytics helps

organizations understand past events and trends by summarizing historical data. Next, predictive analytics uses this historical data to forecast future events and identify potential risks and opportunities. Afterwards, prescriptive analytics goes a step further by recommending actions to achieve desired outcomes based on these predictions (han et al., 2011). Together, these three types of analytics enable organizations to make informed, data-driven decisions that enhance their performance and strategic planning.

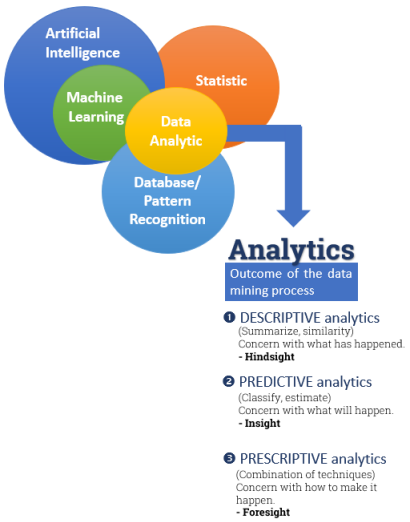



Figure 1: Data mining trends, disciplines and outcomes

Analytics starts upon the collection of data. This process has multiple steps or phases contingent upon the selected data mining techniques. Various techniques exist, including classification, clustering, association analysis, and text mining. The selected technique is reliant upon the expected outcomes of the research and the types of datasets employed. The most common technique is classification and Figure 2 illustrates the typical procedures involved in carrying out classification analysis on the utilized dataset. Initially, the acquisition of the dataset confronted certain issues that need a resolution. The subsequent step involves a comprehensive study of the dataset, incorporating both data exploration and analysis of data variables to achieve a structural and statistical understanding of the data. In this statistical summary procedure, the distribution of attributes and their interactions are crucial for accurately processing the data in accordance with the selected classification or data mining techniques to be performed. Afterwards, the data is prepared for pre-processing processes, which include addressing any missing data, outliers, and noise, as well as transforming or digitizing the data. Data is now prepared for classification analysis through the implementation of algorithms for training and testing prior to the generation of results (Shukri et al, 2024). Thus, this study intends to discuss thoroughly the phase of reviewing the data where the most fundamental statistical concept is established.

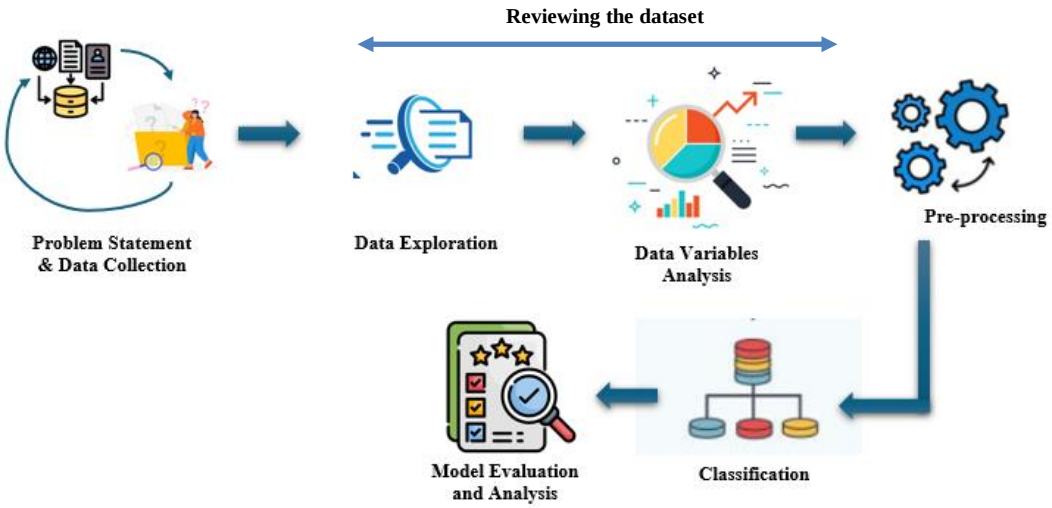



Figure 2: Six good reasons to take notes

**Data Exploration**

The diabetes patient dataset originally was taken through Kaggle website (TEBOUL, 2022) from Behavioral Risk Factor Surveillance System Overview 2015 of Centers for Disease Control and Prevention(.gov). The dataset consists of 13 attributes and a total of 253680 records or instances. Table 1 describes the detailed implementation of each attribute. Based on the description, the attributes were not limited to medical information only but consist of daily activities, diet and mental health record.

Table 1: Better life index 2024 description

| No | Attributes | Explanation |
|---|---|---|
| 1 | Diabetes_012 | 0 = no diabetes 1 = prediabetes 2 = diabetes |
| 2 | HighBP | 0 = no high, BP 1 = high BP |
| 3 | HighChol | 0 = no high cholesterol. 1 = high cholesterol |
| 4 | CholCheck | 0 = no cholesterol check in 5 years. 1 = yes cholesterol check in 5 years |
| 5 | BMI | Body Mass Index |
| 6 | Smoker | Have you smoked at least 100 cigarettes in your entire life? [Note: 5 packs = 100 cigarettes]. (0 = no 1 = yes) |
| 7 | Stroke | you ever had a stroke. (0 = no, 1 = yes) |
| 8 | HeartDiseaseorAttack | coronary heart disease (CHD) or myocardial infarction (MI). (0 = no 1 = yes) |
| 9 | PhysActivity | physical activity in past 30 days - not including job. (0 = no 1 = yes) |

| | | |
|---|---|---|
| 10 | Fruits | Consume Fruit 1 or more times per day. (0 = no 1 = yes) |
| 11 | Veggies | Consume Vegetables 1 or more times per day. (0 = no 1 = yes) |
| 12 | HvyAlcoholConsump | Adult men >=14 drinks per week and adult women>=7 drinks per week. (0 = no 1 = yes) |
| 13 | AnyHealthcare | Have any kind of health care coverage, including health insurance, prepaid plans such as HMO, etc. 0 = no 1 = yes |
| 14 | NoDocbcCost | Was there a time in the past 12 months when you needed to see a doctor but could not because of cost? 0 = no 1 = yes |
| 15 | GenHlth | Would you say that in general your health is: scale 1-5 (1 = excellent 2 = very good 3 = good 4 = fair 5 = poor) |
| 16 | MentHlth | Days of poor mental health scale 1-30 days |
| 17 | PhysHlth | Physical illness or injury days in past 30 days scale 1-30 days |
| 18 | DiffWalk | Do you have serious difficulty walking or climbing stairs? (0 = no 1 = yes) |
| 19 | Sex | Patient's gender (1: male; 0: female) |
| 20 | Age | 13-level age category<br>(1 = 18-24yrs / 2 = 25-29 yrs / 3 = 30-34 yrs / 4 = 35-39 yrs / 5 = 40-44 yrs / 6 = 45-49 yrs / 7 = 50-54 yrs / 8 = 55-59 yrs / 9 = 60-64 yrs / 10 = 65-69 yrs / 11 = 70-74 yrs / 12 = 75-79 yrs / 13 = 80 or older) |
| 21 | Education | Education level (EDUCA see codebook) scale 1-6<br>1 = Never attended school or only kindergarten<br>2 = Grades 1 - 8 (Elementary)<br>3 = Grades 9 - 11 (Some high school)<br>4 = Grade 12 or GED (High school graduate)<br>5 = College 1 year to 3 years (Some college or technical school)<br>6 = College 4 years or more (College graduate) |
| 22 | Income | Income scale (INCOME2 see codebook) scale 1-8<br>1 = less than $10,000, 2= $10,000 to less than $15,000, 3=$15,000 to less than $20,000, 4= $20,000 to less than $25,000, 5 = $25,000 to less than $35,000, 6= $35,000 to less than $50,000, 7= $50,000 to less than $75,000, 8 = $75,000 or more |

**Reviewing the content of the dataset**

The summary of variables's data types, range index, columns, non-values and memory usage were illustrated as in Figure 3, where we can recognize that dimensions of the dataset was 253680 x 22 indicates the total of records of person was 253680 and each share 22 attributes information varies from medical, diets and general health. Further, the presence of non-null values indicated that all attributes were devoid of null values, signifying the absence of missing data. Finally, the data types 'float64' indicate that all attributes consist of decimal numeric values.

In comparison to the information presented in Table 1, some attribute data types designated as objects signify categorical values meanwhile the data frame as illustrated in Figure 2 saved the data as continuous numeric type. Since different data types may require different statistical analyses in machine learning approaches, it was essential to re-assign the appropriate data types according to the original attributes.

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 253680 entries, 0 to 253679
Data columns (total 22 columns):
 #   Column                Non-Null Count   Dtype
---  ------                --------------   -----
 0   Diabetes_012          253680 non-null  float64
 1   HighBP                253680 non-null  float64
 2   HighChol              253680 non-null  float64
 3   CholCheck             253680 non-null  float64
 4   BMI                   253680 non-null  float64
 5   Smoker                253680 non-null  float64
 6   Stroke                253680 non-null  float64
 7   HeartDiseaseorAttack  253680 non-null  float64
 8   PhysActivity          253680 non-null  float64
 9   Fruits                253680 non-null  float64
 10  Veggies               253680 non-null  float64
 11  HvyAlcoholConsump     253680 non-null  float64
 12  AnyHealthcare         253680 non-null  float64
 13  NoDocbcCost           253680 non-null  float64
 14  GenHlth               253680 non-null  float64
 15  MentHlth              253680 non-null  float64
 16  PhysHlth              253680 non-null  float64
 17  DiffWalk              253680 non-null  float64
 18  Sex                   253680 non-null  float64
 19  Age                   253680 non-null  float64
 20  Education             253680 non-null  float64
 21  Income                253680 non-null  float64
dtypes: float64(22)
memory usage: 42.6 MB
```

Figure 3: Summary of the data in rows and columns of the diabetes dataset.

**Univariate Analysis**

Univariate analysis was employed to examine the distribution of data for each attribute and assess the significance of the data, determining whether it was suitable for further analysis or necessitated statistical correction. Figure 4 depicts the distribution of data for each attribute. As highlighted earlier the output attribute was Diabetes012 and other attributes were candidates of input attributes. Review the total of 21 attributes of input variables, some of the data poorly distributed and imbalance such as CholCheck, Stroke, HeartDiseaseorAttack, PhysActivity, veggies, HvyAlchoholConsump, AnyHealthcare, NoDocbcCost, DiffWalk. The distribution of each attribute in Figure 4 indicates they were categorized as float (represented automatically in the Python data frame in Figure 3) but nominal

data types, as originally described in Table 1. Therefore, the data types of each attribute except BMI will be changed to nominal as originally stated in Table 1 and in line with the distribution of the original data.


Figure 4: Frequency of each value from all attributes.

Next, the data transferred into WEKA application to make easier for further statistical exploration which at first all the suppose nominal attributes were converted using filter '*numerictonominal*' and attribute Diabetes_012 was assigned as class attribute (output attribute). Figure 5 depict the changes of the statistical properties of the attribute named PhysHlth, when the attribute's types was changed from numeric to nominal types. The figure shows that if the attribute's type was numeric, the statistical properties observation based on min, max, mean and standard deviation. Meanwhile if nominal the distribution based on count of each given value for the attribute which were 0 to 30 that indicate the number or patient that had experienced PhysHlth problem for last 30 days.

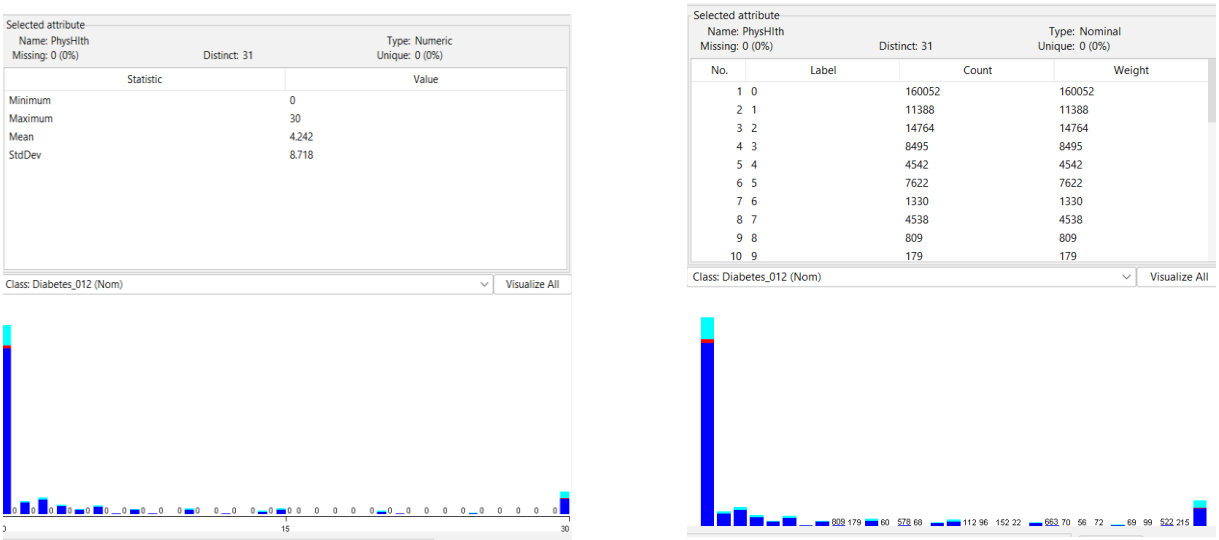



Figure 5: Comparison of statistical data distribution between numeric and nominal data.

The next Figure 6 illustrates the latest distribution of data for each attribute in relation to the class attribute. The blue color shows no diabetes patients, red color shows pre-diabetes patients and turquoise shows diabetes patients. From each visualization of the attribute, distribution of the data based on the three class easily being observed. Each attribute was dominate by blue class color and very minimal from turquoise and red classes. This indicates further learning analysis of machine learning will dominate by blue class since the model will learn too much from blue class data and overshadow the minimal classes of turquoise and red class (Wongvorachan et al, 2023). To resolve this issue, the imbalance in class distribution must be rectified.

Figure 7(a) illustrates the current distribution of class output consist of 84.24 percent of the data is from class no diabetes, 1.83 percent of pre-diabetes and 13.93 percent of the data is diabetes. This imbalance class distribution can be rectified in three ways which are; 1) Oversampling; 2) Undersampling; and 3) SMOTE (Synthetic Minority Over-Sampling Technique) (Liu et al, 2022). In overall all classes contain data that are more than 1000 which is adequate to run data mining analysis. Further, in comparing these 3 classes, the pre-diabetes class is disproportionately small, including just 1.83 percent. Hence, excluding this data appears more advantageous for facilitating a seamless and successful analysis.

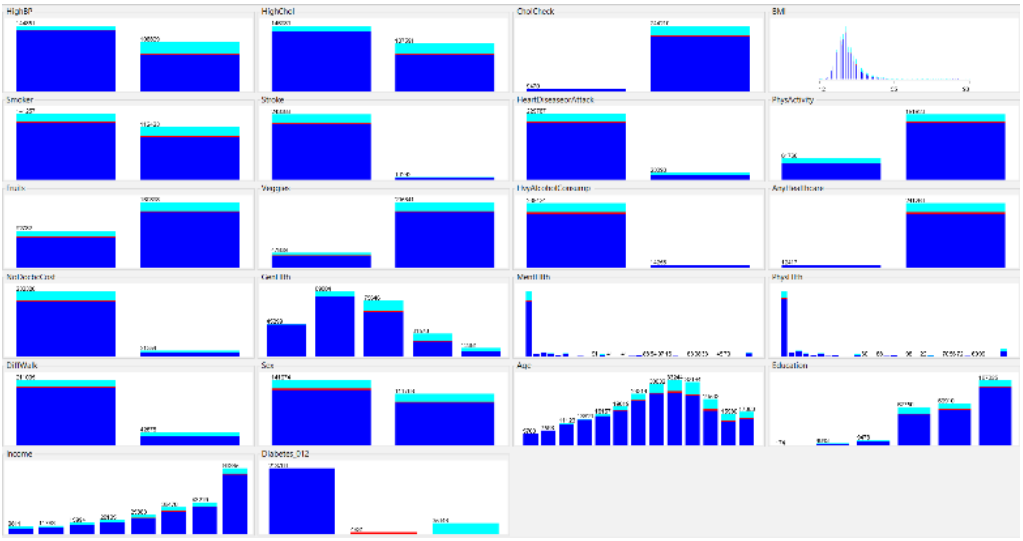
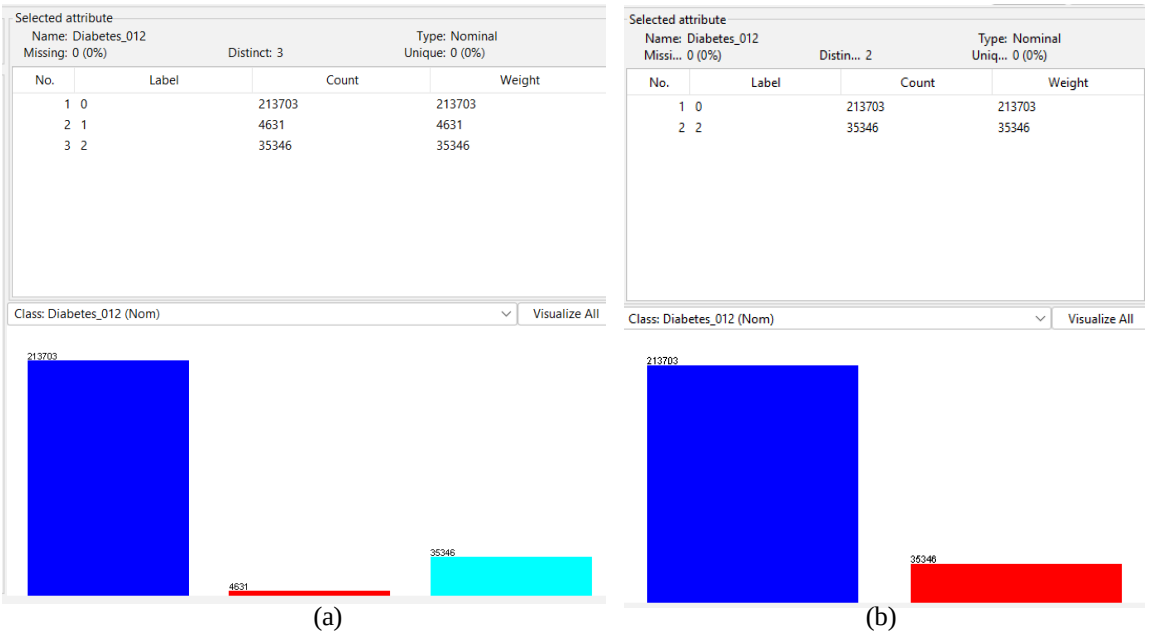


Figure 6: Distribution of the attributes with relation to class attribute Diabetes_012

Figure 7(b) shows the distribution of the class diabetes (red color) and no diabetes (blue color). To address the imbalance issue, the undersampling strategy was selected, which involves reducing the number of samples from the majority class to align with the minority class, after initially examining the whole data in both classes without generating new synthetic samples. Figure 8 shows both classes were balance in term of distribution of the data using undersampling approach. Nonetheless, there is no study indicating that any methods of undersampling, oversampling, or SMOTE are preferable to one another.




(a) (b)

Figure 7: Distribution of the attributes with relation to class attribute Diabetes_012

Next, Figure 9 illustrates overall data distribution of 70692 instances or observations among 21 input attributes and one output attribute of Diabetes_012. Following the aforementioned enhancements to the classes, the distribution of the data indicated by red and blue colors have significantly improved across all attributes.

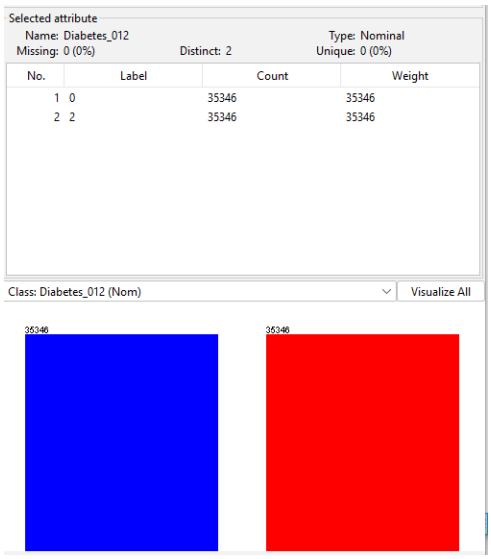



Figure 8: Balance data between two class using undersampling approach

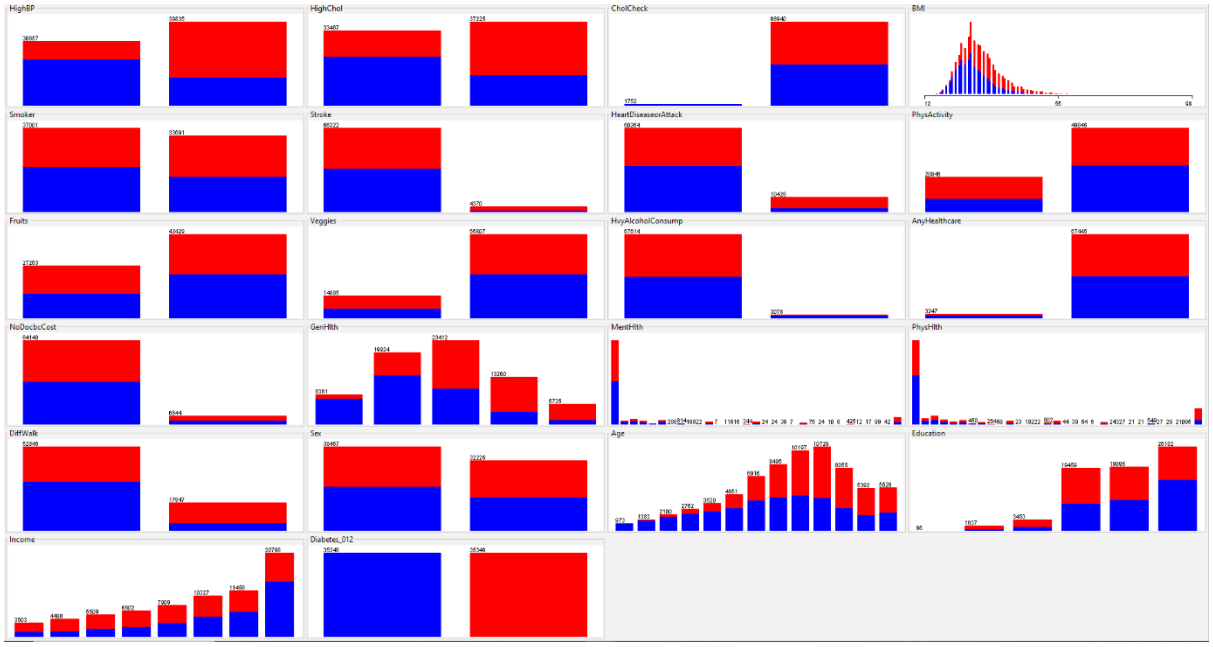



Figure 9: Distribution of all attributes in relation with class attribute Diabetes_012 after rectification.

**Attribute interaction**

The interaction among attributes, referred to as multivariate analysis, investigates the interplay between variables to comprehend complex relationships and facilitate classification, with an emphasis on the distribution across many classes. The distributions of nominal and numeric data types differ, as nominal data is segmented into distinct intervals, resulting in data clustering around those intervals, but numeric data is continuous, leading to variability across the scales.

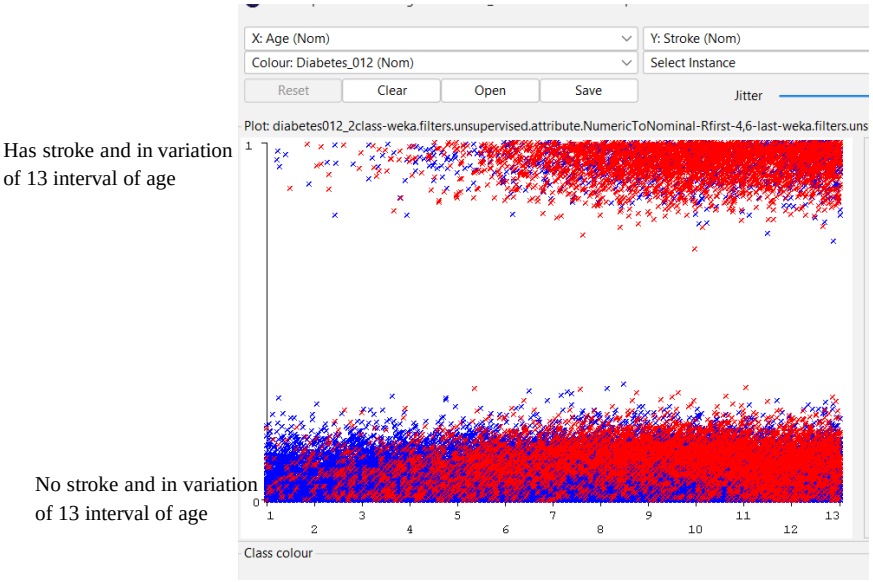
Figure 10(a) shows interaction among two nominal attributes of high cholesterol and heart disease attack. Meanwhile Figure 10(b) shows interaction among high cholesterol and another nominal attribute of stroke. Both figures show that diabetes patients indicated by red color are predominant on the upper level and less for no diabetes data. Consequently, this case highlights that high cholesterol, stroke incidents, and heart disease are significant contributors to the emergence of diabetes.

The interaction between 13 age categories and stroke incidence is depicted in Figure 11, emphasizing differences between diabetic and non-diabetic patients. This distribution indicates that no diabetes patients (shown in blue) dominate the no-stroke group; nevertheless, in the stroke group, the prevalence of diabetes patients increases from age level 6 to 13. According to Table 1, this level comprised a group of patients aged 54 and older than 80. The next Figure 12 illustrates the distribution of the data across numeric types of attribute of BMI in x-axis versus nominal data type of Diabetes_012 in y-axis which consist of no diabetes (label as 0) and diabetes (label as 2). The scatter distribution from the left to the right of the graph indicates a continuous data distribution for BMI, with a minimum of 12 and a maximum of 98. The majority of the sample data (patients) exhibit a BMI range of 12 to 55 for both diabetic and non-diabetic individuals. Therefore, there is no significant difference between these two attributes for further analysis.

Analyzing and comparing the interactions among attributes reveals that this is not a straightforward modeling problem, and there is no simple relationship among the attributes. Therefore, the tuning of the model requires careful consideration, employing advanced techniques like the ensemble method when classifying this dataset.


(a) (b)

Figure 10: Distribution of data across three different attributes of high cholesterol, heart disease attack and




stroke

Figure 11: Distribution of data across attribute age vs stroke for diabetes and no diabetes patient

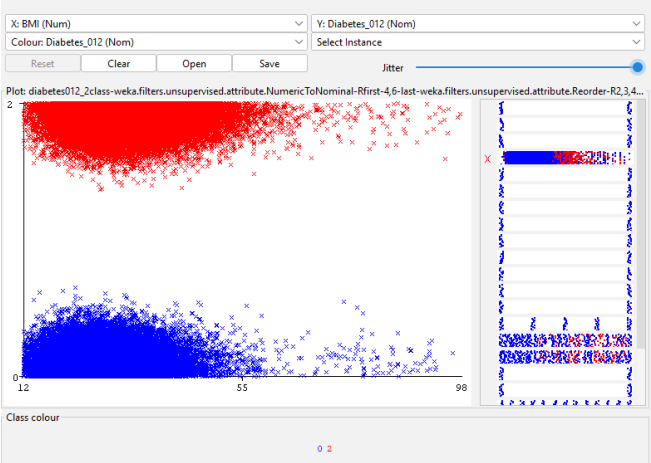



Figure 12: Distribution of data across attribute BMI vs Diabetes_012

## Conclusion

Originally this diabetes dataset consisted of 253680 samples of data known as observation and 22 attributes that might have a relation. The objective of the study which classification of diabetes patients with possible attributes that contribute to the disease. Thus, the target attribute selected was Diabetes_012 and the other 21 attributes remains as independent and predicted attributes. Statistical concepts play a crucial role in classification modeling, which is a fundamental technique in machine learning and data mining from the beginning of the data collected. Data distribution, which researchers require to review and understand the data, is essential for not only selecting appropriate classification algorithm but to make sure the data was accurately justified by the types and any possible constraint such as imbalance data. Diabetes list of predicted attributes originally dominance by nominal distribution except BMI. This justifies that there are several algorithms running well with nominal attributes for classification. The statistical analysis in this work elucidates the complex interplay among various attributes that necessitate advanced machine learning methods to differentiate insights between diabetic and non-diabetic patients. Additionally, there is a noteworthy connection among stroke, heart attack disease, and high cholesterol levels. Consequently, the future study will introduce a rigorous and robust machine learning algorithm to uncover predictive insights.

## References:

Ahmad Adib Baihaqi, S., Syarifah Adilah, M. Y., Saiful Nizam, W., Mohd Saifulnizam, A. B., & Rozita, K. (2024). Machine Learning Approach of Predicting Airline Flight Delay using Naïve Bayes Algorithm. *Journal of Computing Research and Innovation Machine*, *9*(2), 140–155. https://doi.org/10.24191/jcrinn.v9i2.460

*Current Trends & Future Scope of Data Mining*. (2021, July 30). Datamation. https://www.datamation.com/big-data/data-mining-trends/

Liu, L., Wu, X., Li, S., Li, Y., Tan, S., & Bai, Y. (2022). Solving the class imbalance problem using ensemble algorithm: application of screening for aortic dissection. *BMC Medical Informatics and Decision Making*, *22*(1), 1–16. https://doi.org/10.1186/s12911-022-01821-w

Han, Jiawei, Kamber, Micheline, & Pei, Jian. (2011). *Data Mining Third Edition*. https://myweb.sabanciuniv.edu/rdehkharghani/files/2016/02/The-Morgan-Kaufmann-Series-in-Data-Management-Systems-Jiawei-Han-Micheline-Kamber-Jian-Pei-Data-Mining.-Concepts-and-Techniques-3rd-Edition-Morgan-Kaufmann-2011.pdf

Rushdi Shams. (2013, December 12). *Weka Tutorial 33: Random Undersampling (Class Imbalance Problem)*. YouTube. https://www.youtube.com/watch?v=ocOlm73HeNs

Teboul, A. (2022). *Diabetes Health Indicators Dataset*. Www.kaggle.com. https://www.kaggle.com/datasets/alexteboul/diabetes-health-indicators-dataset

Wongvorachan, T., He, S., & Bulut, O. (2023). A Comparison of Undersampling, Oversampling, and SMOTE Methods for Dealing with Imbalanced Classification in Educational Data Mining. *Information (Switzerland)*, *14*(1). https://doi.org/10.3390/info14010054

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***e-ISBN : 978-629-98755-5-0***

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