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Making Chemistry Click: Unleashing Personalized Voices and Computational Thinking in Stoichiometry Learning

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Abstract: *Innovative teaching strategies are crucial in improving matriculation students' understanding of complex chemistry topics such as stoichiometry. Despite its fundamental role, students often struggle with stoichiometry due to cognitive overload and a lack of engaging learning resources. This study explores the integration of the Multimedia Personalized-Voice Principle (MPVP) and Computational Thinking (CT) within a mobile learning application to address these challenges. Using qualitative methods, in-depth interviews were conducted to identify learning difficulties and analyze the impact of MPVP and CT on students' learning experiences. Findings indicate that the integration of MPVP and CT enhances conceptual understanding, reduces cognitive load, and increases students' confidence in solving stoichiometry problems. The study underscores the potential of technology-driven approaches in making chemistry learning more effective and accessible.*

Keywords: Multimedia Personalized-Voice Principle, Stoichiometry, Computational Thinking, Mobile Applications, Matriculation Students

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1. Introduction

In today's digital education era, it is imperative to explore effective teaching strategies that support students in mastering complex scientific concepts. Chemistry is a core subject in Malaysian matriculation programs, requiring students to develop a strong foundation in theoretical and practical aspects. Chemistry is a compulsory subject for all Malaysian matriculation college students in the science stream, encompassing lectures, tutorials, and practical components (Bahagian Matrikulasi Kementerian Pendidikan Malaysia, 2020). Completion of this one- or two-year pre-university program is a prerequisite for pursuing a degree at public universities. The main goal of the chemistry curriculum is to equip students with essential concepts, lab skills, and problem-solving abilities in physical chemistry (Nurul Fatni et al., 2021). Despite the curriculum's aims, student performance in chemistry needs improvement.

Many difficulties in chemistry are related to stoichiometry (Lee, 2020), a major topic in chemistry learning. Stoichiometry is a fundamental concept in chemistry that involves the quantitative relationships between reactants and products in chemical reactions. It is essential for understanding how substances interact and transform during chemical processes, and it is widely applied in various fields such as materials science, biochemistry, and chemical engineering (Vogt, 2017). Despite its importance, students often find stoichiometry challenging due to a variety of factors, including a lack of understanding of basic chemical concepts (Alfiyanti & Sukarmin, 2021), poor problem-solving techniques (Fitriani et al., 2022), ineffective learning approaches (Jammeh et al., 2023), and a shortage of engaging, interactive learning materials (Alfiyanti & Sukarmin, 2021). In addition to the factors mentioned, it is crucial to address the negative emotions and high cognitive load that students often experience when learning chemistry (Hu et al., 2022) such as stoichiometry topic. Hue et al. (2022) also mentioned that feelings of anxiety, insecurity, and being overwhelmed can hinder the development of a deep, conceptual understanding of the topic. Similarly, the mental strain caused by excessive cognitive load can lead to fatigue, disinterest, and suboptimal learning outcomes.

To tackle these challenges and create a more supportive, engaging, and effective learning environment for stoichiometry, technology-focused approaches, such as mobile applications, hold great promise. Furthermore, with the widespread adoption of mobile technology, particularly among Generation Z, mobile applications have become integral to education (Wan Ali & Wan Yahaya, 2022). These apps can also be tailored to meet individual learning needs, providing personalized learning experiences that enhance outcomes. Key strategies include combining words with graphics, using a conversational style in narration, employing human voices, and reducing cognitive load through well-designed multimedia elements (Mayer, 2014). CT, on the other hand, involves a set of problem-solving skills and techniques (Wing, 2006). By incorporating CT strategies into the mobile learning platform, students can develop critical thinking and problem-solving abilities that are applicable across disciplines (Mohmad Fuzi & Wan Yahaya, 2024). The combination of MPVP and CT within a mobile learning environment allows for the creation of a more personalized, engaging, and effective learning experience. Multimedia elements can help visualize complex concepts and make the content more accessible, while the personalized-voice approach and CT strategies can enhance learner engagement and foster the development of essential problem-solving skills.

By combining these complementary strategies within a mobile application, educators can address the emotional and cognitive barriers that often hinder the learning of stoichiometry. The personalized-voice principle can help alleviate negative emotions by making the content feel more accessible and engaging (Shah, 2020), while the CT approach can reduce cognitive load by providing a systematic problem-solving framework (Chen & Wang, 2023). This synergistic effect has the potential to empower matriculation students to develop a deeper understanding and appreciation for this critical chemistry concept, ultimately setting them up for success in their future chemistry studies and beyond. With this approach, it is hoped that this study can make a significant contribution in improving the effectiveness of teaching stoichiometry at the matriculation level, as well as opening up space for further research in this field.

This study has important implications in several areas. From an educational policy standpoint, it offers valuable guidance on how to effectively integrate technology into stoichiometry teaching, which could enhance students' academic performance and better prepare them for advanced studies and careers in science. For the wider community, mobile applications designed with personalized voice and computational thinking can make stoichiometry learning more accessible to students from diverse backgrounds, promoting equal access to effective learning strategies and contributing to the community's overall intellectual and competitive growth. In the industrial sector, the study highlights the need to develop computational thinking skills as part of science education, which is essential for creating a skilled and technologically proficient workforce that can meet the increasing demands of the science and technology fields in the digital age (Ahmad & Lajium, 2020).

From a knowledge contribution standpoint, this study presents novel insights into the potential of integrating MPVP and CT approaches for educational purposes. The exploration of this synergistic framework in the context of stoichiometry learning adds to the existing literature on leveraging technology to enhance the understanding of complex science concepts among matriculation students (Mohd Adnan & Hamid, 2020). Overall, this article offers significant value to policymakers in education, the broader community seeking equitable access to quality science education, industry leaders in the science and technology sectors, and the academic community researching the application of technology-driven pedagogical strategies.

The scope of this study on 18-year-old matriculation students in the Ministry of Education Malaysia majoring in Science, including students from 1-year and 2-year programs, was chosen with several important justifications. First, matriculation students are a relevant target group because they face important tests in learning stoichiometry as part of their preparation for higher studies in science (Marziah, 2018). Second, the emphasis on Science majors shows the need to provide effective learning approaches and appropriate technology in this subject, which can benefit students from 1-year and 2-year programs (Lok & Hamzah, 2021). This justification ensures that this study focuses on an accurate and comprehensive target group, providing relevant data to improve the teaching and learning of stoichiometry in the context of matriculation education in Malaysia.

This article is divided into important parts. The first part is the introduction which introduces the title of the study, statement of the problem, and objectives of the study. The next section is significance and contribution, which highlights the implications of the study in the context of government, community, industry, and science. Finally, this article also covers the scope of the study which defines the target groups and the justification of their selection.

2. Literature Review

Introduction

Education is currently experiencing a significant transformation with the increasing use of technology in teaching and learning. Multimedia principles are developed and employed to design effective multimedia instructions that foster learning (Mayer, 2014). According to Mayer (2014), multimedia principles such as personalization, voice, and embodiment principles are developed based on social cues to promote deep learning. Research on the personalization principle, which is one of Mayer's 12 Principles of Multimedia Learning, has demonstrated that students learn more effectively when instructional materials are presented in a conversational style rather than a formal one. The voice principle in multimedia learning posits that people learn better when the narration is delivered in a human voice rather than a machine-generated voice. This principle enhances social presence and engagement, leading to deeper learning experiences.

When instructional materials utilize a conversational style (personalization principle) and are narrated by a human voice (voice principle), students demonstrate improved learning outcomes compared to more formal presentations with machine-generated voices. In this approach, known as the Multimedia Personalized-Voice Principle (MPVP), aims to personalize the learning experience through voice elements tailored to the needs of students, increasing motivation and allowing for more effective teaching (Mayer, 2021). However, most researchers in the past have investigated the individual effects of these principles on learning (Shah, 2020). Therefore, in this study, Multimedia Personalized-Voice Principle (MPVP) represents an approach that aims to personalize the learning experience through voice elements tailored to the needs of matriculation students in learning chemistry.

Chemistry, being a complex subject, demands abstract thinking and diverse problem-solving approaches. CT, popularized by (Wing, 2006), is a valuable technique in 21st-century education that involves systematic problem-solving to enhance students' digital technology skills. Research has highlighted the integration of CT in chemistry education, leading to substantial improvements in students' achievement and problem-solving skills (Aslan et al., 2020; Chongo et al., 2021). The integration CT into the teaching of a variety of subjects using mobile applications as a delivery method has been an area of growing interest in recent years. Several studies have examined the use of mobile applications in education to improve students' understanding of abstract concepts and problem-solving skills. For example, the mobile app Patrony, developed by Lucia et al. (2022), aimed to enhance students' pattern recognition skills through CT activities, leading to better learning outcomes for users of the app. Similarly, Connolly et al. (2021) used mobile software to introduce pre-service teachers to CT concepts relevant to their future teaching. Therefore, this study aims to explore the combination of the Multimedia Personalized-Voice Principle (MPVP) and CT through a mobile app to enhance stoichiometry learning among matriculation students. By integrating these approaches, the study seeks to improve motivation, engagement, and overall learning outcomes in this challenging area of chemistry.

Main Themes and Topics

This literature review highlights several important themes regarding the use of the Multimedia Personalized-Voice Principle (MPVP) and Computational Thinking (CT) in stoichiometry learning. MPVP focuses on personalizing education, which significantly increases student engagement and interest. By adapting instruction to fit individual learning styles and needs, MPVP creates a more engaging and meaningful learning experience. Additionally, CT is becoming essential in education, equipping students with skills in systematic thinking, problem-solving, and technology use to tackle complex scientific issues. As technology advances, the ability to break down problems, create algorithms, and analyze data is vital for success in science. Integrating MPVP and CT into mobile applications makes these important tools more accessible, broadening science learning conventional learning environments (Connolly et al., 2021). Furthermore, mobile applications provide the flexibility of 24/7 access to learning materials and technology-driven interactions (Lazaro & Duart, 2023). However, the adoption of this technology also presents challenges, including issues of access, effective usage, and concerns about technological disparities among students.

Research Opportunities

Although there is growth in the literature on the use of MPVP and CT in learning, there are several knowledge gaps that need to be clarified. Studies that explore the integration of these two concepts in mobile applications, especially in the context of matriculation education in Malaysia, are still limited (Mohmad Fuzi & Wan Yahaya, 2024). Further research is needed to understand the impact of using this technology on reducing cognitive load and negative emotions, as well as to develop more effective pedagogies. In addition, the need for more in-depth studies in technological aspects, such as the effectiveness of mobile application platforms in improving academic performance and student satisfaction, is also a priority (Gasah et al., 2020). This research will help in strengthening the scientific evidence on the benefits of using technology in science education.

Formation of Conceptual Framework

To face the complexity of these issues, this article proposes a conceptual framework that investigates the integration of MPVP and CT as a key factor influencing stoichiometry learning through mobile applications. These factors are expected to play an important role in improving the understanding of the concept of stoichiometry, reducing cognitive load, and avoiding negative emotions among matriculation students.

Key Findings and Controversies

Findings from previous studies show that the use of MPVP and CT can provide advantages in learning. This approach has been proven to increase learning motivation, improve conceptual understanding, and improve problem solving skills. However, there is also controversy over the implementation and long-term effects of structured learning, including concerns about over-reliance on technology.

Overall, this literature review provides a comprehensive view of the effects of MPVP and CT in mobile applications on stoichiometry learning among matriculation students. The need for further, more in-depth research in the Malaysian educational context is essential to understand the effects more holistically. By expanding the landscape of literature in this field, this study is expected to make a significant contribution to the improvement of science education in Malaysia.

3. Methodology

This study uses a qualitative research approach that aims to deepen the impact of the use of Multimedia Personalized-Voice Principle (MPVP) and Computational Thinking (CT) in mobile applications on the learning of stoichiometry among matriculation students. Qualitative research was chosen because it allows the researcher to gain an in-depth understanding of the experiences, views, and perceptions of participants in a more naturalistic context.

Research Design - Basic Qualitative Inquiry

Basic qualitative inquiry was chosen because it fits the objective of the study to identify factors that contribute to low academic achievement in stoichiometry, as well as to analyze the effects of CT and the use of the principle of Personalized-Voice in reducing negative emotions and cognitive load of students. This approach gives the researcher space to conduct in-depth interviews with participants and observe their interactions with the mobile application.

Data Collection

Primary data collection was done through in-depth interviews with five purposively selected participants. Structured interviews were used to collect data on students' experiences and views on the use of mobile applications in stoichiometry learning. The rationale for selecting interviews is to gain a deep understanding of the issues under study, including the impact of technology use in science learning. In addition to interviews, observations were also conducted to complete the data obtained by understanding students' interactions with mobile applications directly. This helps in capturing the learning context that may not be revealed through interviews alone.

Sampling Strategy

The sampling strategy used is purposive sampling, where participants are selected based on certain criteria relevant to this study. The participants consisted of matriculation students who faced challenges in understanding stoichiometry and who used mobile applications in their learning process. A sample size of five participants was chosen based on adequacy to obtain variation in views and experiences, as well as to ensure the quality of the data obtained.

Data Analysis

The data analysis technique used involves manual coding and thematic analysis using Microsoft Word software. Coding was used to identify the main themes that emerged from the interview data, while thematic analysis was used to organize and analyze the findings that were relevant to the research objectives. This approach is suitable because it allows the researcher to dig into the meaning and patterns in the data collected in a systematic and in-depth manner.

Ethical Considerations

Ethical considerations have been taken into account by obtaining approval from the educational institution involved before conducting this study. Participants were given the freedom to withdraw from the research at any time and the confidentiality of their information was strictly maintained. All data collection and analysis processes are done by prioritizing trust and fairness towards participants.

Data Validity and Reliability

The validity of the data is strengthened through the use of triangulation techniques, where data from various sources such as interviews and observations are used to confirm the findings. The reliability of the data is strengthened by a careful and systematic analysis process, as well as by taking into account the variation in the views of the participants.

Overall, this research methodology was carefully designed to ensure clarity in data collection, analysis, and interpretation. The qualitative approach used gives room for a deep understanding of students' experiences in learning stoichiometry through mobile applications. With this, the study is expected to make a significant contribution to the field of science education, especially in improving the effectiveness of technology in the learning process in Malaysia.

4. Findings

This study aims to understand the effects of Multimedia Personalized-Voice Principle (MPVP) and computational thinking (CT) in stoichiometry learning through mobile applications on academic achievement, emotions, and cognitive load of matriculation students. The following are the main findings obtained from interviews with five study participants.

Factors Contributing to Low Academic Achievement

From the interview results, several factors identified as contributing to low academic achievement in the topic of stoichiometry are learning materials that are less interactive and less interesting, as well as a lack of guidance after class time. As stated by Participant 1, *"I think... I don't understand the concept of stoichiometry. One of the reasons is that the learning material is less interactive. Usually the lecturer only gives lecture notes in pdf form. We have to download and read the notes."*

Participant 2 also supports this view by stating, *"The learning material is not interesting. It's just lecture notes."* Meanwhile, Participant 3 added, *"The learning materials do not provide clear explanations or interesting illustrations."* The lack of guidance is also an issue as stated by Participant 4, *"Sometimes I can't solve stoichiometry when I study by myself. When I want to ask the lecturers, they can't take the time to discuss with the students after class."*

Learning Experience Through Mobile Applications

All study participants expressed their positive experience using mobile applications for learning stoichiometry. Participant 1 stated, "I like to learn using mobile applications. Usually mobile applications have learning materials that are interactive and fun."

Participant 2 added, *"I really like using the mobile application because it is easy and quick to access various learning resources such as video tutorials, interactive exercises, and quizzes."* Participant 3 said, *"Sometimes I can't focus in class. But with the mobile application, I can study anytime and anywhere according to my mood."* Participant 4 emphasized, *"In the mobile application there are videos, animations, and games. So it's interesting and fun to learn."* While Participant 5 stated, *"The notes provided in the application are more concise, interesting, organized and there is a pedagogical agent's voice that guides to understand the learning."*

Use of Personalized-Voice Principles in Mobile Applications

All participants agreed that the use of the principle of Personalized-Voice in mobile applications helped in better understanding the concept of stoichiometry. Participant 1 stated, *"Mmm... it is very necessary to have a Personalized-Voice in the application because, a voice adapted to the student's learning style can provide explanations that are easier to understand, and also improve the student's understanding of complex concepts."*

Participant 2 supports this view by saying, *"A Personalized-Voice in a mobile application can make learning more interesting and interactive. Students may be more engaged and motivated to learn when they hear a friendly voice that suits their needs."* Participant 3 added, *"Lessons that only rely on text can be boring. By using a Personalized-Voice in multimedia, students can enjoy more dynamic and effective learning, which can reduce boredom and mental fatigue."*

Participant 4 said, *"Provides a more personalized and comprehensive learning experience, helping students understand stoichiometry at a pace and way that works best for me."* Participant 5 stated, *"The learning application can help me remember and understand the concept of stoichiometry better because I can listen and process information simultaneously. CT makes it easier for students to understand and solve stoichiometry problems systematically."*

Learning Stoichiometry Using Computational Thinking (CT)

The use of CT in learning stoichiometry also received a positive response from the study participants. Participant 1 stated, *"Mmm... I think CT is good because it can help solve questions step by step in a more organized way."*

Participant 2 blinked will, *"I don't have the skills to solve problems. Usually I just try to memorize the steps necessary to solve stoichiometry problems. I think using CT concepts can help me see chemistry concepts more easily."* Participant 3 added, *"By using CT, mmm, I think I can learn to identify patterns and structures in stoichiometry problems more easily."*

Participant 4 stated, *"CT can be a more organized approach to learning stoichiometry."* While Participant 5 stated, *"CT makes it easier for students to understand and solve stoichiometry problems systematically."*

Overall, this study found that the integration of MPVP and CT in a mobile application has great potential in improving the learning of stoichiometry among matriculation students. Learning materials that are more interactive, interesting, and adapted to students' learning styles can help overcome low academic achievement. The use of MPVP and CT approach not only helps reduce cognitive stress, but also increases students' understanding and motivation in learning stoichiometry. This study shows that a more comprehensive and personal approach to learning can have a significant impact on student achievement and learning experience.

5. Main Results and Observations

5.1 Factors Contributing to Low Academic Achievement

The results of the interviews show that learning materials that are less interactive and less interesting are the main factors that contribute to low academic achievement in the topic of stoichiometry. Table 1 identifies themes including a lack of interactive learning materials and guidance.

Table 1: Coding and Themes for Factors Contributing to Low Academic Achievement in Stoichiometry

Coding		Theme
Learning materials are less interactive and not interesting	-	Interactive Learning Materials
Lecture notes in PDF format	-	Interactive Learning Materials
Lack of problem solving skills	-	Problem solving skills
Lack of clear explanation	-	Interactive Learning Materials
Not enough interesting illustrations	-	Interactive Learning Materials
There is no guidance after class time	-	Class Guidance

This theme was formed based on the answers of the participants who mentioned that the learning materials provided are less interactive and less interesting, less problem solving skills as well as the lack of guidance after class as a factor that contributes to low academic achievement.

5.2 Learning Experience Through Mobile Applications

The study participants showed that learning stoichiometry through a mobile application provided a more positive experience and helped in learning. Table 2 identifies themes including advantages of mobile apps and use of interactive learning materials.

Table 2: Coding and Themes for Learning Experience Through Mobile Applications

Coding		Theme
Mobile apps are interesting and fun	-	Advantages of Mobile Apps
Mobile applications are easy and quick to access	-	Advantages of Mobile Apps
Can study anytime and anywhere	-	Advantages of Mobile Apps
Can study according to mood	-	Advantages of Mobile Apps
Can study according to mood	-	Use of Interactive Learning Materials
Notes are more concise, interesting, and organized	-	Use of Interactive Learning Materials
The voice of a helpful pedagogical agent	-	Use of Interactive Learning Materials

This theme was formed based on the participants' answers that stated that mobile applications provide more interactive and interesting learning materials, as well as provide ease in access and learning flexibility.

5.3 Use of Personalized-Voice Principles in Mobile Applications

The use of the principle of Personalized-Voice in mobile applications was found to be helpful in improving the understanding of the concept of stoichiometry. The themes identified are tabulated in Table 3 and include the advantages of personalized voice and increased understanding.

Table 3: Coding and Themes for Use of Personalized-Voice Principles in Mobile Applications

Coding		Theme
A more understandable explanation	-	Advantages of Personalized-Voice
Interesting and interactive	-	Advantages of Personalized-Voice
Student engagement and motivation	-	Advantages of Personalized-Voice
Reduces boredom and mental fatigue	-	Advantages of Personalized-Voice
A personalized and comprehensive learning experience	-	Advantages of Personalized-Voice
Helps remember and understand concepts	-	Increased Understanding
Concurrent information processing	-	Increased Understanding
Systematic problem solving	-	Increased Understanding

This theme was formed based on the responses of the participants who stated that the Personalized-Voice in the application helps in providing explanations that are easier to understand and increase students' understanding and motivation.

5.4 Learning Stoichiometry Using Computational Thinking (CT)

The use of CT in learning stoichiometry shows that it helps students in solving problems in a more orderly and systematic way. The themes identified in Table 4 include the benefits of CT and a systematic approach to learning.

Table 4: Coding and Theme for Learning Stoichiometry Using Computational Thinking

Coding		Theme
CT helps solve questions step by step	-	Benefits of CT
An orderly way	-	Benefits of CT
Memorize the steps	-	Benefits of CT
CT helps see chemistry concepts more easily	-	Benefits of CT
Identify patterns and problem structure	-	Benefits of CT
A systematic approach to learning stoichiometry	-	An Orderly Approach in Learning
Understand and solve systematic problems	-	An Orderly Approach in Learning

This theme was formed based on the participants' answers stating that CT helps in solving stoichiometry problems in a more organized and systematic way, as well as facilitating the understanding of concepts.

Overall, the results of this study show that the use of Multimedia Personalized-Voice Principle (MPVP) and computational thinking (CT) in mobile applications have a positive effect on stoichiometry learning among matriculation students. Interactive and engaging learning materials, as well as approaches adapted to students' learning styles, help improve understanding, reduce cognitive load, and increase student motivation. The integration of MPVP and CT in a mobile application shows great potential in improving the learning experience and achievement of students. This finding makes a significant contribution to understanding how technology can be used to improve science education in Malaysia.

The main findings of this study show that the use of Multimedia Personalized-Voice Principle (MPVP) and computational thinking (CT) principles in mobile applications has a positive effect on stoichiometric learning. The use of MPVP was found to help students better understand the concept of stoichiometry through explanations adapted to the student's learning style. Participant 1 stated, *"mmm, it is very important to have a Personalized-Voice in the application because a voice adapted to the student's learning style can give explanations that are easier to understand."* This shows that MPVP improves students' understanding by providing more understandable and interesting explanations.

CT helps students in solving stoichiometry problems in a systematic and orderly manner. Participant 1 said, *"mmm, I think CT is good because it can help solve questions step by step in a more organized way."* Participant 5 also stated, *"mmm, CT makes it easier for students to understand and solve stoichiometry problems systematically."* This suggests that CT helps students understand and solve stoichiometry problems more easily and systematically, reducing excessive cognitive load.

Unexpected or Contradictory Findings

Although most of the findings of this study were positive, there were some unexpected or contradictory findings. For example, although the use of the mobile application was generally well received, there were participants who still had problems in learning stoichiometry. Participant 2 stated, *"mmm, I don't have the skills to solve problems. Usually I just try to memorize the steps necessary to solve problems."* This shows that although mobile applications and CT principles help in learning, there are students who still face challenges in applying these skills effectively.

In addition, there were also participants who felt that although Personalized-Voice was helpful, it was not enough to solve all learning problems. Participant 4 said, *"mmm, a Personalized-Voice can help, but sometimes I still don't understand concepts without additional guidance from the lecturer."* This shows that although MPVP provides benefits, it still needs additional support from lecturers to ensure student understanding.

Overall, the findings of this study show that the use of the Multimedia Personalized-Voice Principle (MPVP) and computational thinking (CT) in mobile applications has a positive effect on stoichiometry learning among matriculation students. MPVP helps improve student understanding through explanations tailored to the student's learning style, while CT helps students solve problems in a systematic and orderly manner, reducing excessive cognitive load. Although there are some unexpected or contradictory findings, the overall findings of this study provide a significant contribution in understanding how technology can be used to improve science education in Malaysia. By expanding the use of technology such as MPVP and CT in learning, it is hoped to improve academic achievement and the overall student learning experience.

MPVP-CT Integration Model in Stoichiometry Learning

The study aims to identify factors that contribute to low academic achievement in stoichiometry among matriculation students and to analyze the effect of CT and the use of MPVP in mobile applications on reducing negative emotions and high cognitive load in stoichiometry learning.

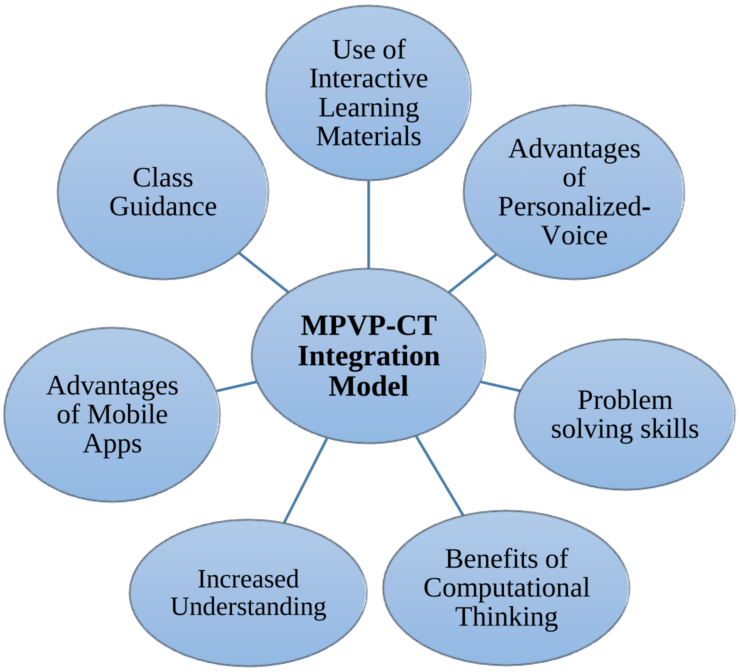

Figure 1: MPVP-CT Integration Model in Stoichiometry Learning

The following section will provide a detailed description of the model used in this study.

Contributing Factors:
Less interactive learning materials and lack of problem-solving skills. Based on participant feedback, learning materials that are not interactive and do not provide clear explanations are the main causes of low academic achievement in stoichiometry. Additionally, students stated that they do not have problem-solving skills. This shows the need for more interesting and easy-to-understand materials, along with effective problem-solving techniques.

Computational Thinking (CT):
Systematic and Orderly Approach: CT helps students solve stoichiometry problems in a systematic and orderly manner, reducing excessive cognitive load and improving comprehension.

Mobile Application with Personal Voice Principle (MPVP):
Interactive and Engaging Learning: MPVP provides learning materials that are tailored to students' learning styles, increasing interaction and motivation.

Reduction of Cognitive Load and Negative Emotions:
Clear Guidance and Explanation: The use of personal voice and interactive materials helps reduce cognitive stress and negative emotions, allowing students to understand concepts better and more effectively.

Improved Understanding and Academic Performance:
Learning Effectiveness: The integration of CT and MPVP in mobile applications supports more effective learning, leading to increased academic achievement and understanding of stoichiometry concepts. This model shows how the integration of CT and MPVP in a mobile application can address the problem of low academic achievement in the topic of stoichiometry. By providing learning materials that are more interactive, clear, and adapted to students'

learning styles, this model aims to reduce cognitive load and negative emotions, further increasing understanding and academic achievement among matriculated students. This model, called the MPVP-CT Integration Model in Stoichiometry Learning, can be used as a basis for future efforts in applying new technologies and approaches in science education, especially in the topic of stoichiometry.

6. Conclusion

In this article, the effects of using the Multimedia Personalized-Voice Principle (MPVP) and Computational Thinking (CT) in mobile applications on stoichiometry learning among matriculation students are examined. The main findings of this study provide a clear picture of the factors contributing to low academic achievement in stoichiometry and the positive effects of using MPVP and CT in reducing negative emotions and students' cognitive load.

First, factors such as less interactive learning materials and unclear explanations were identified as the main causes of low academic achievement in stoichiometry among matriculation students. This is reinforced by feedback from participants who stated the lack of interesting learning materials and the lack of interaction in the learning process. Second, the use of MPVP and CT in mobile applications has had a positive effect in improving the understanding of the concept of stoichiometry, as well as reducing the cognitive and emotional burden on students. Study participants described that this approach gave them access to more interesting and interactive learning materials, as well as helping them in solving stoichiometry problems in a structured way.

These findings support the objectives of the study to identify factors contributing to low achievement in stoichiometry and analyze the positive effects of MPVP and CT use. In this context, the coding reveals themes such as "Lack of Interactive Learning Materials" and "Increasing Understanding Through CT and MPVP." These themes are formed based on data analysis that connects empirical findings with theories of science education and teaching. This study makes a significant contribution to the field of science education by showing the effectiveness of the integration of MPVP and CT in learning stoichiometry using mobile applications. The results of the study suggest that this approach not only improves students' academic performance but also opens up space for innovation in science teaching approaches based on technology.

Thus, the results of this study suggest the need to expand the use of technology in the context of Malaysian education to strengthen the understanding of science concepts among matriculation students. Based on the discussion above, this study outlines the need for the formation of an effective model in dealing with the problem of low academic achievement in learning stoichiometry among matriculation students. The proposed model is "Mobile App with Personalized Voice Principle and Computational Thinking (CT) in Stoichiometry Learning Model".

This model is designed to integrate two main elements, namely the use of the principle of personalized personal voice to deliver learning materials in a more interactive and relevant way to students, as well as the application of CT in solving stoichiometry problems systematically and efficiently. This approach is expected to overcome the shortcomings in less interesting learning materials and the need for a deeper understanding of concepts.

The formation of this model is based on findings from studies that show factors such as the lack of interactivity in learning materials and the lack of problem-solving techniques in solving stoichiometric problems are the main causes of low academic achievement. By integrating MPVP and CT in a mobile application, this model is expected to increase student motivation and understanding, as well as reduce cognitive load and negative emotions during the learning process.

Overall, this model makes a significant contribution in the context of science education, especially in improving the academic performance of matriculation students in learning stoichiometry. The next step is to carry out further research and testing to ensure the effectiveness of this model in the context of Malaysian education.

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