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Enhancing Science Performance in Lower Secondary School Students Through Peer Teaching with Young Science Teachers Programme

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Abstract: This study aimed to enhance the academic performance of Form 1 and Form 2 students in science during the Final Academic Session Test (UASA) by creating a group of peer coaching known as young science teachers. Ten students from Form 1 and ten from Form 2 were selected to guide their peers, involving 220 Form 1 and 224 Form 2 students from a secondary school in Klang Valley, Malaysia. The programme's objective was to improve students' retention of science facts and concepts and their ability to answer exam questions efficiently using practical techniques. Initial surveys indicated that many students struggled with practice questions and science exams, as reflected in the Mid-Session Academic Exam (UPSA) pass rates of 49.84% for Form 1 and 33.45% for Form 2. The young science teachers' programme was introduced to address this issue. The findings showed significant improvements, as evidenced by paired t-test results. Both Form 1 and Form 2 students showed significant differences between pre-test and post-tests, with a p-value (2-tailed) of 0.000, <0.05. The highest-ranking five classes in Form 1 showed significant improvement, while the lowest-ranking five classes did not exhibit any signs of improvement. In contrast, the bottom five classes in Form 2 demonstrated significant improvement, while the top five classes did not exhibit the same level of progress. This study highlights that science can be understood and memorised effectively through this peer teaching method. The involvement of young science teachers enhances students' understanding of scientific concepts, as peer learning fosters a comfortable and receptive learning environment. Thus, the Young Science Teacher programme effectively supports weaker students and improves overall science performance.

Keywords: Peer coaching, Young Teacher; Science Pedagogy, STEM

1. INTRODUCTION

Science education in early secondary school, particularly in Form 1 and Form 2, plays a crucial role in laying the foundation for students' understanding of various scientific concepts and principles. However, students often face challenges in mastering these concepts and performing well in exams. These challenges can stem from various factors, such as the need for teachers to have a strong grasp of content knowledge to effectively help students organise and comprehend science concepts (Jelani, 2023). Additionally, students' achievement in science subjects has been linked to their mastery of science process skills, particularly in science experiments (Idris, 2022). Furthermore, the depth of science learning materials in schools has been shown to impact students' concept mastery, emphasising the importance of engaging and motivating students in the learning process, especially in science subjects (Laelandi et al., 2022).

The analysis of the UPSA 2023 at a school in Klang Valley, Malaysia, for science subjects reveals that both Form 1 and Form 2 levels have not yet achieved a 50% passing rate. Specifically, Form 1 has a passing rate of 49.84% with an average grade of the subject, GPMP of 5.13, while Form 2 has a passing rate of 33.45% with a GPMP of 5.43. In Form 1, four out of ten classes; gems (12.90%), diamonds (37.14%), pearls (12.12%), and rubies (13.79%); have not reached a 50% pass rate. Similarly, in Form 2, six out of ten classes; diamonds (42.86%), crystals (41.38%), gems (25.00%), sapphires (26.67%), pearls (10.71%), and rubies (10.71%) have not achieved this benchmark.

Given these statistics, a new approach is imperative to improve the passing percentage in science subjects. Previous studies suggest that active student engagement in the teaching and learning process, such as through investigative problem-solving activities, positively impacts student learning (Che Nizam, Saidatul, & Mohd Faizal, 2017). This active engagement facilitates changes in teaching and learning in science education. Furthermore, Nursuhaili (2010) asserts that students develop social skills and cognitive abilities through active participation. Peer coaching in learning science at early secondary levels offers several advantages, as research has shown that peer teaching allows for the exchange of knowledge and skills between students, benefiting both the tutor and the student being taught (Rees et al., 2015). This collaborative approach not only enhances the understanding of scientific concepts but also boosts the confidence of students and fosters positive relationships with their peers (Menezes & Premnath, 2016). Additionally, peer coaching can contribute to the development of teaching and communication skills among students, preparing them for future roles as educators (Karia et al., 2020).

The purpose of this study is to enhance academic performance in science among Form 1 and Form 2 students through the implementation of the Young Science Teacher program. This programme involves the selection of peer instructors who assist in teaching their classmates and improving their exam techniques. The primary research objectives are to improve students' retention of science facts and concepts and to enhance their ability to answer exam questions efficiently.

2. LITERATURE RIVIEW

2.1 Challenges in Science Education

Common challenges students encounter in learning science concepts are multifaceted and well-documented in the literature. These challenges include linguistic barriers, where students struggle with both the technical vocabulary and grammar of science writing, which can impede their understanding of scientific concepts Cheng (2021). Moreover, the abstract nature of science subjects often necessitates understanding concepts through multiple representations to fully grasp the content (Novianti et al., 2023). Additionally, a lack of comprehension of fundamental concepts, such as energy, organs, or the circulatory system, can hinder students' progress in science education (Maryani et al., 2018; Akram et al., 2022; Nurdiansyah et al., 2021).

Various factors contribute to students' underperformance in science exams. Misconceptions or difficulties with understanding science content areas can significantly impact their performance (Narjaikaew et al., 2016). For instance, the abstract and mathematical aspects of chemistry can pose challenges, requiring a high-level skill set for success in the subject (Uzezi et al., 2017). Furthermore, difficulties in problem-solving during exams can arise from a lack of understanding of scientific concepts that involve algebraic manipulations or multiple steps for completion (Retnawati et al., 2017). The abstract nature of certain science subjects, like the electric field, can also present obstacles to meaningful learning and performance in assessments (Karal & Uzun, 2018).

To enhance science learning outcomes, various strategies are employed, including peer teaching and other intervention methods. Peer teaching, a collaborative learning approach where students teach and learn from each other, has been shown to be effective in improving academic performance and fostering deeper understanding of scientific concepts Tullis (2020). Peer teaching not only enhances interaction between students but also promotes active engagement and critical thinking, leading to improved learning outcomes (Sin et al., 2019).

2.2 Peer Coaching

In the context of peer coaching, a young teacher or trainer can be defined as a novice educator who engages in coaching interactions with their peers to enhance teaching practices, develop instructional skills, and improve student learning outcomes. Young teachers or trainers participating in peer coaching programs typically collaborate with more experienced colleagues or fellow educators to receive feedback, guidance, and support in refining their teaching approaches and strategies Kickbusch & Kelly (2021). This collaborative process allows young teachers to benefit from the expertise and insights of their peers, leading to professional growth, increased confidence, and improved instructional effectiveness (Sutton et al., 2021).

Peer coaching involving young teachers often involves activities such as observing classroom practices, providing constructive feedback, sharing best practices, and engaging in reflective discussions to enhance teaching and learning experiences (Kshetree, 2023). Through peer coaching, young teachers can develop a deeper understanding of pedagogical techniques, classroom management strategies, and student engagement methods, ultimately contributing to their professional development and effectiveness in the classroom (Ries et al., 2023).

Furthermore, the concept of a young trainer in peer coaching aligns with the idea of reciprocal learning and mutual support among educators. Young trainers can serve as both coaches and learners in the peer coaching process, benefiting from the expertise of their peers while also contributing their unique perspectives and experiences to the coaching dynamic (Rosholm, 2024). This reciprocal exchange of knowledge and skills fosters a culture of continuous learning, collaboration, and improvement among educators, ultimately enhancing the quality of teaching and learning in educational settings (Hagen et al., 2017).

Comparing peer teaching with other intervention methods, such as peer feedback training and reciprocal peer tutoring, reveals distinct advantages and applications. Peer feedback training in English writing has been found to encourage active participation, revision, and interaction among learners, enhancing their writing skills (Chen, 2021). On the other hand, reciprocal peer tutoring has been shown to result in greater learning gains compared to traditional classroom instruction, emphasizing the effectiveness of peer-to-peer teaching interactions in academic performance (Zhang, 2023).

A young teacher or trainer in the context of peer coaching refers to a novice educator who actively engages in collaborative coaching interactions with peers to enhance their teaching practices, develop their instructional skills, and improve student outcomes. By participating in peer coaching programs, young teachers can benefit from mentorship, feedback, and shared expertise, leading to professional growth and increased effectiveness in the classroom.

2.3 Theoretical Framework

The theoretical foundation of peer teaching is based on several educational theories, including social constructivism and constructivist learning theory. Peer instruction is an active learning technique that is rooted in the concepts of social constructivism. Social constructivism highlights the significance of social interactions and collaborative learning in the process of knowledge construction (Woo et al., 2022). According to constructivist learning theory, learners actively construct their understanding of concepts by engaging in experiences and reflecting on them. This theory is consistent with the participatory character of peer teaching (Woo et al., 2022).

Peer instruction provides both cognitive and social advantages during the learning process. Peer teaching improves students' comprehension of intricate topics by fostering active participation, analytical thinking, and problem-solving abilities, as viewed from a cognitive standpoint (Moore & Chaisson, 2022). Peer education allows students to elucidate concepts to their peers, so strengthening their own comprehension and facilitating the consolidation of knowledge through the act of teaching others (Aricò & Lancaster, 2018). Engaging in the process of elucidating and exchanging ideas with colleagues can result in enhanced comprehension and long-term memory of information (Fuaddi et al., 2020).

Peer coaching promotes a cooperative and encouraging learning atmosphere on the social aspect, allowing students to engage, exchange ideas, and acquire knowledge from one another (Davis et al., 2022). Peer instruction facilitates the development of peer-to-peer communication, teamwork, and cooperation, which are crucial competencies for achieving academic and professional accomplishments (Gok, 2018). Moreover, peer teaching has the potential to bolster pupils' self-assurance, proficiency in communication, and feeling of inclusion within the educational community (Tullis, 2020). Collaborative peer teaching situations foster the development of students' social skills, empathy, and a sense of responsibility towards their peers' learning (Garwood et al., 2020).

Peer coaching, based on social constructivism and constructivist learning theory, provides cognitive advantages by fostering active learning and enhancing comprehension of concepts. Additionally, it promotes social advantages by cultivating cooperation, interaction, and interpersonal abilities among pupils. Through the practice of peer education, learners can improve their academic performance while simultaneously cultivating essential cognitive and social skills that contribute to their overall growth and development.

3. METHODS

The method used in this study involves a structured, multi-stage approach to peer teaching aimed at improving science education among Form 1 and Form 2 students. Initially, a selection process identifies 10 capable students from each level to act as young teachers. These young teachers receive intensive mentoring on specific topics, ensuring they gain a thorough understanding within a week. They then present and teach these topics to their peers using engaging methods, which not only reinforces their own knowledge but also aids in the learning process for their classmates. This peer teaching phase emphasizes the development of self-confidence, critical thinking, and creativity. The final stage of the method involves ongoing support, where young teachers continue to assist their peers as needed and act as facilitators for challenging topics, under the continuous guidance of their mentors. This comprehensive approach leverages peer influence and active engagement to enhance overall academic performance in science.

This study encompasses the entire population of Form 1 and Form 2 students at a specific school in Klang Valley, Malaysia. The total number of students is 220 for Form 1 and 224 for Form 2. Each form consists of 10 students who serve as young scientific teacher. Using the data gathered from the original survey, the teacher identified a suitable approach for implementation. This study focuses on selected topics that are comprehensive and aid students in scoring well on exams, as these topics are challenging for students to study independently at home. The topics are as follows: For Form 1, the topics include Cell Respiration and Photosynthesis, Coordination and Reaction, Plant Breeding, Three States of Matter, Mixtures and Compounds, Composition of Air and Combustion, and Light and Optics, covering Use of Mirrors, Properties of Light, Reflection of Light, Refraction of Light, Light Scattering, and Addition and Subtraction of Light. For Form 2, the topics are Biodiversity, Ecosystem, Nutrition, Human Health, Water and Solutions, Acids and Alkali, Electricity and Magnetism, Forces and Friction, Heat, and Sound Waves.

Two types of questions are used in the pre-and post-tests: objective and subjective. Objective questions are multiple-choice questions, with options A, B, C, or D, while subjective questions require students to fill in the blanks. All questions for each topic are contained on one page. Completed questions will be organized correctly and compiled into the young science teacher module. Students were initially given a set of Young Teacher Modules for a pre-test, which included objective and subjective questions across 10 selected topics. Prior to the pre-test, traditional teaching methods were used, such as listening to explanations, taking notes, and revising independently. The pre-test, conducted without peer assistance, lasted 30 minutes per topic. After two weeks, students received guidance from their trained peers, the young teachers, who employed various teaching techniques to help their classmates understand the topics. Two weeks following this peer-teaching phase, a post-test was administered under the same conditions as the pre-test, also lasting 30 minutes. This process can illustrate as the Figure1.

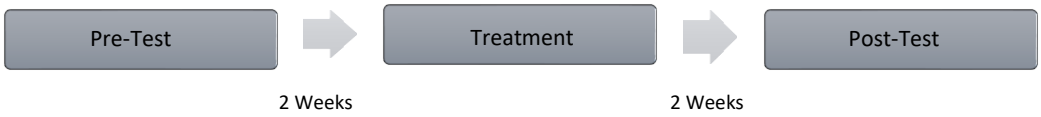

Figure 1. *Research Process Conducted*

4. FINDINGS AND DISCUSSION

The analysis results for the pre-test Form 1 and Form 2 found that most students did not answer the questions, leaving a blank space in the answer column. This shows that they cannot understand the purpose of the question with the correct answer. At the same time, many questions are not answered according to the distribution of question marks. For factual questions, students could not answer the question at all, while for thinking-level questions, students tried to answer but did not meet the answer requirements.

The effectiveness of this method can be seen by conducting a post-test for the students after they have completed the young science teacher activities. The post-test questions are almost the same as the pre-test questions. The post-test results have found that most students can answer all the questions correctly. However, a few students are still confused by the technique and format to answer some questions. At the same time, students can answer objective questions easily without any confusion. The post-test score was very good; most students scored above 10 out of 20. The analysis was done using the Statistical Package for the Social Sciences (SPSS) software version 29. This software carefully compared the pre and post-scores for each level. This study also used the paired t-test (paired sample t-test) method to show whether the comparison of the pre-and post-test was significant. This study also compares the pre and post-test results for the five upper classes and the five lower classes in Form 1 and Form 2. This is because specific studies can have an impact on future improvements.

The results of the Paired T-Test for Form 1 (Table 1) show a significant value between the pre and post-test with a significant value (2-tailed) $p = 0.000 < 0.05$. This indicates that the acceptance of the activities of young teachers for Form 1 is very good. The effectiveness of young teachers in guiding their peers improved for post-tests. The comparison is made more deeply by looking at the pre and post-test results for the five upper classes and the five lower classes of Form 1. The comparison results of the pre and post-test for the five upper classes (Table 2) are significant with a significant value (2-tailed) $p = 0.000 < 0.05$. The comparison of the pre-and post-tests for the five lower classes (Table 3) is not significant with a significant value (2-tailed) of $p = 0.000 > 0.05$. This shows that the weak class is not suitable to be guided by peers. They need teachers for regular and effective guidance and instruction. Furthermore, students from this weak class also need one-to-one guidance from desk to desk to be guided.

Table 1. Paired T-Test Results for Pre And Post for Form 1 (N=220)

		N	Correlation	Sig.
Pair 1	Pre & Post	220	.244	.000

Table 2. Paired T-Test Results for Pre And Post for Five Upper-Class Form 1 (Firus, Emerald, Baiduri, Diamond, Crystal) (N=98))

		N	Correlation	Sig.
Pair 1	Pre & Post	98	.537	.000

Table 3. Paired T-Test Results for Pre And Post for Five Classes Below Form 1 (Gems, Sapphires, Diamonds, Pearls, Ruby) (N=122)

		N	Correlation	Sig.
Pair 1	Pre & Post	122	.156	.085

The results of the Paired T-Test for Form 2 (Table 4) show a significant difference between the pre-and post-test scores with a p-value (2-tailed) of $0.000 < 0.05$. This indicates that the acceptance of the young teachers' activities for Form 2 is very positive. Students understand the topics better when guided by their peers, and the effectiveness of young teachers in guiding their peers is reflected in the improved post-test scores. A deeper comparison was made by examining the pre-and post-test results for the top five classes and the bottom five classes in Form 2. The results for the top five classes (Table 5) are not significant with a p-value (2-tailed) of $0.000 > 0.05$. This lack of significance is because students who excel in your class do not need peers to guide them as they prefer to study independently. Additionally, the scores for the pre-and post-tests of these top-performing students were not significantly different from those of the lower-performing students, further contributing to the

insignificance of this test for the top classes. Meanwhile, the comparison of the pre-and post-test results for the bottom five classes (Table 6) is significant with a p-value (2-tailed) of 0.000 <0.05. This is because lower-performing students benefit more from peer guidance than teacher instruction. They may be shy about seeking help from teachers and feel more comfortable when their peers teach and support them.

Table 4. Paired T-Test Results for Pre And Post for Form 2 (N=224)

		N	Correlation	Sig.
Pair 1	Pre & Post	224	.536	.000

Table 5. Paired T-Test Results for Pre And Post for Five Upper-Class Form 2 (Firus, Emerald, Baiduri, Diamond, Crystal) (N=114)

		N	Correlation	Sig.
Pair 1	Pre & Post	114	.063	.504

Table 6. Paired T-Test Results for Pre And Post for Five Classes Below Form 2 (Gems, Sapphires, Diamonds, Pearls, Ruby) (N=110)

		N	Correlation	Sig.
Pair 1	Pre & Post	110	.629	.000

5. CONCLUSION

This study demonstrates that science is not difficult to understand and memorize. Various methods can be employed to help students retain the facts they learn, particularly using young science teachers. Implementing young science teachers can indirectly enhance students' understanding of scientific concepts, as students are more inclined and comfortable learning from their peers. Therefore, utilizing fellow students in the young science teacher program helps weaker students to some extent. This is evident when the Young Teachers start conducting activities and sharing in the class. All the students gave their full attention and were happy to engage with the topic.

In addition, young teachers need to master the chosen topics thoroughly. A high level of understanding of the topic to be taught enables them to teach and guide their peers effectively. Frequent coaching sessions with mentors are necessary to ensure they comprehend how to answer the questions that will be asked. Mastery of the topic is essential for effective teaching, including the technique of answering questions. Furthermore, peers exert significant influence. They can increase motivation, encourage engagement in learning, improve academic achievement, and strengthen relationships between classmates (Mustafa Kamal, N. M., Hussin, Z., & Sulaiman, A. M., 2022).

Peers play a significant role in influencing student academic achievement through a combination of peer selection and peer influence mechanisms. Research has shown that students' friends can impact their academic functioning, with evidence supporting both peer selection and peer influence as factors in how friends affect academic outcomes (Rambaran et al., 2016). Peers can influence an individual student's academic achievement through peer academic evaluations, indicating a direct impact on academic performance (Gremmen et al., 2017). The observable efforts students make, such as seeking extra help or earning academic honors, are influenced by peer support, suggesting a broader impact on educational investments (Bursztyn & Jensen, 2015)

This study also found that outstanding students can effectively guide their peers. However, students at a lower academic level particularly need guidance from the teacher to understand the format of science questions better. These students benefit from more individualized or small group instruction from subject teachers, allowing them to focus more intently and understand the material better. Furthermore, the preparation of young science teachers needs to be carefully researched and emphasized. These young teachers need to gain knowledge from mentors to diversify their techniques and activities and to socialize with their peers. Despite these needs, the overall response from students showed excitement and interest in becoming young science teachers. This study positively impacts student achievement and helps build students' self-confidence in answering questions more effectively.

The young teacher method is suitable for all science subjects to help students remember important facts and concepts. This method can be implemented as early as Form 1, allowing teachers to assess students' abilities to master science subjects. Furthermore, students who have mastered the topics will be trained by participating in various STEM activities at school, encouraging their peers to engage in healthy competition. Additionally, the young teacher method is also suitable for other subjects requiring memorization and group work, like science. It is hoped that the young teacher method can serve as a platform for students interested in reading and

memorizing science facts, thereby helping them master Science subjects more effectively and enhancing overall excellence in these subjects.

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