Innovative STEM-Agile Strategy Empowering Teachers Best Practices in the Teaching and Learning of Science for the Malaysian Vocational Certificate (SVM) Semester 1

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ABSTRACT

This research was primarily conducted to improve students' academic performance, particularly in the Final Assessment (PA) of Malaysian Vocational Science Semester 1, while strengthening student motivation, engagement and understanding of various science topics through the STEM-AGILE approach. This study is grounded in the continuous improvement of teachers' existing best practices in Teaching and Learning (PdPc). The STEM-AGILE model developed combines the elements of Science, Technology, Engineering and Mathematics (STEM) with the principles of AGILE Learning (Active Learning, Gamified Exploration, Interactive Reflection, Learning Collaboration, Evaluation Empowerment). A total of 186 Semester 1 students from various programmes at Kolej Vokasional Miri were involved as the target group. Various intervention strategies were implemented including Science Knowledge Auction, Science Photo Album, Mystery Cards, Scientific Role Play and Science Escape Room. Data were collected through triangulation methods, namely pre/post-tests (Final Assessment), motivation questionnaires and structured observations. Findings for 2025 showed an extraordinary improvement with the pass rate soaring to 100%, mean GPA increasing to 3.41, and 81 students successfully obtaining Grade A. This study proves that continuous improvement efforts on existing PdPc practices through the STEM-AGILE model can stimulate intrinsic motivation and create a 21st-century learning ecosystem that is enjoyable for vocational science education.

Keywords: STEM-AGILE, Learning and Facilitation (PdPc) Improvement, Active Learning, Student Motivation, Vocational College.

Reflection On Teaching and Learning / Preliminary Survey

As educators at Kolej Vokasional Miri, we always practise the principles of dynamic teaching. Throughout teaching the SVM Science Semester 1 subject, various best PdPc practices based on hand-on activities have been applied in the classroom to suit the profile of vocational students who tend towards practical skills. However, through critical self-reflection we found that the existing best practices were still fragmented, less structured, and not strong enough to maintain student motivational momentum when facing abstract theoretical topics.

When science concepts were delivered using mainstream teaching patterns, several students were found to become less motivated to give full attention. The main issue was not that students did not like science but that they lost motivation when existing best practices were not mixed with elements of healthy competition and rapid reflection. As a result, some students appeared drowsy and less responsive during theory sessions. The inability to deeply relate abstract theories such as topics on Isotopes, Green Technology, and Safety Steps caused their long-term memory to be affected, thus impacting the quality of Final Assessment (PA) grades in the years before the intervention.

Therefore, this action research was driven by the awareness to carry out structured improvement on existing best practices. The STEM-AGILE innovation was implemented not to discard old methods, but to empower existing PdPc practices to become more low cost, low risk, and high impact.

Research Focus / Problem Statement

This study focuses on the effort to transform and improve existing best PdPc practices to overcome the following constraints:

- Need for Refinement of Existing PdPc Practices: Existing teaching activities need to be restructured using more flexible and agile instructional management principles (Agile).
- Level of Intrinsic Motivation that Needs to be Increased: Helping students overcome the feeling of being less motivated when learning science concepts that are theoretical in nature.
- Issue of Mental Presence (Engagement) in the classroom: Changing the status of students who are passive or drowsy during theory sessions to total physical and mental involvement.
- Short-term Memory Capacity: Replacing passive memorisation processes with the building of positive emotional impact so that science facts stick in long-term memory.

Research Objectives & Research Questions

3.1 Research Objectives

1. General Objective: To implement improvement of existing best practices in Vocational Science Semester 1 PdPc through the STEM-AGILE model to boost student intrinsic motivation and academic achievement.

2. Specific Objectives:

- To boost the average grade (GPA) and significantly increase the number of Grade A achievements in the Final Assessment (PA).
- To increase student intrinsic motivation to the point of creating a sense of excitement and cultivating a high inquiry habit in Science PdPc.
- To strengthen teachers PdPc practices through the integration of low-cost note visualisation strategies and active gamification.

3.2 Research Questions

1. Can the implementation of the STEM-AGILE model increase the number of students obtaining Grade A and maintain 100% pass rate in the Final Assessment?
2. How can STEM-AGILE gamification strategies change student perception from viewing science as "difficult" to feeling "excited and curious" about the next activity?

Target Group

This study involved 186 Semester 1 students covering all Malaysian Vocational Certificate (SVM) programmes at Kolej Vokasional Miri. The academic profile of this target group is at a moderate to weak level for theory-based subjects, but they have high motor (practical) potential. Most students involved in this study were identified as having science mastery at a moderate to weak level.

This indicates the need for more interesting, innovative and student-centred teaching strategies to increase their interest, engagement and understanding. With the diversity of student backgrounds, this study is expected to prove the effectiveness of game-based learning approaches such as Mystery Box, Knowledge Auction and Mystery Cards in creating an enjoyable learning atmosphere, thereby helping students improve long-term memory of the Science concepts learned.

LITERATURE REVIEW

The integration of STEM in the classroom has been proven effective in enhancing critical thinking, creativity and student engagement (Beers, 2011; Bybee, 2013). A study by English (2016) emphasised that a design-based STEM approach can make learning more authentic and meaningful.

In the context of game-based learning, a study by Hamari et al. (2016) showed an increase in student intrinsic motivation through elements of competition, collaboration and challenges. The use of methods such as escape rooms in science has also been proven to enhance collaboration and conceptual understanding (Fotaris & Mastoras, 2019).

In addition, studies in the context of vocational education show that innovative learning strategies are needed to address the challenges of mastering abstract concepts such as isotopes (Ismail et al., 2017). Game-based active learning approaches help vocational students more easily connect theory with real world applications.

The STEM-AGILE model that combines games, collaborative learning and flexible approaches is aligned with the needs of 21st-century education. It not only supports the development of cognitive skills but also builds important soft skills such as communication, cooperation and problem-solving.

Action Implementation & Intervention (Stem-Agile Model)

The process of improving existing best PdPc practices was designed by uniting the 5E Model and AGILE Learning principles. The main approach of this intervention retains the DNA of vocational education which is to maximise the use of student physical dynamics and minimise dependence on expensive external technology (Low Cost, High Impact).

Table 1: STEM-Agile Intervention Actions

Existing PdPc Practice	Structural Improvement (STEM-AGILE Model)	Specific / Creative Intervention Activities	Impact Description & Low-Cost High Impact Elements
Copying Theory Notes (Chapter 1: Laboratory Safety)	G- Gamified Exploration	Science Photo Album & Safety Selfie	Students use their own devices to record safety simulations, then print them as a "Visual Diary" in their notebooks. (Zero cost, transforming theoretical note-copying into strong visual memories). Squid Game-style group note hunt.
Teacher Demonstration (Chapters 2 & 3: Emergency Aid & Health Parameters)	A – Action Learning	Scientific Role Play (Paramedic/Rescuer)	Empowering existing demonstration practices into full student-centred simulations. Students' physical bodies are fully mobilised to practise CPR and Heimlich Maneuver techniques.
Group Discussion (Chapter 4: Green Technology)	L – Learning Collaboration	Letter from the Future (Mystery Cards)	Existing group activities injected with exciting storytelling elements through "Letters from the Future" to build green technology solutions using school waste materials.
Slide Explanation / Lecture (Chapter 5: Elements and Materials – Isotopes)	I – Interactive Reflection	Trip to Hawaii & Matching-Matching Isotopes	Eliminating the constraints of abstract topics through car rental analogies and manipulation of cheap plasticine. Dispelling students' initial stigma that the Isotope topic is "difficult".
Written Tests / Worksheets (Formative Assessment)	E – Evaluation Empowerment	Science Knowledge Auction & Science Escape Room (Quizizz)	Replacing conventional written quizzes with "Bidding Games" using science money. Digital Quizizz assessment sets full autonomy: students must achieve 100% Mastery Score for early break release.

RESEARCH FINDINGS & DATA ANALYSIS

The research findings show a very significant improvement in the Final Assessment (PA) results for the Science subject after the implementation of the STEM-AGILE intervention. In 2022, the overall pass rate was only 84.6%, with a mean GPA as low as 2.46 and the percentage of students obtaining grade A or A- was only 8.8%. Although there was a small improvement in 2023 (96.8% pass, GPA 2.95) and 2024 (99.1% pass, GPA 3.08), the performance still had not reached the academic KPI targets. However, after the STEM-AGILE intervention was fully introduced in 2025 results soared dramatically with 100% of students passing, mean GPA increasing to 3.41 and the percentage of students obtaining grades A and B reaching 43.8%. No students obtained grades D, E, or F, while only 4 students (2.2%) obtained grade C, demonstrating the effectiveness of the intervention in improving the overall academic performance of students. Empirical evidence shows that continuous improvement of PdPc practices has yielded the best results in 2025.

Table 2: Analysis of Science Student Results at KV Miri

Success Parameter	**Year 2022 (Existing Practice)**	**Year 2023 Pilot Phase**	**Year 2024 Improvement**	**Year 2025 (Full STEM-AGILE Implementation)**
Pass Rate (%)	84.6%	96.8%	99.1%	100.0% (Full Pass)
Mean GPA	2.46	2.95	3.08	3.41
Number of Grade A Students	16 students (8.8%)	–	–	81 students (Absolute Grade A)
Failing Grades (D, E, F)	High	–	–	0% (None)

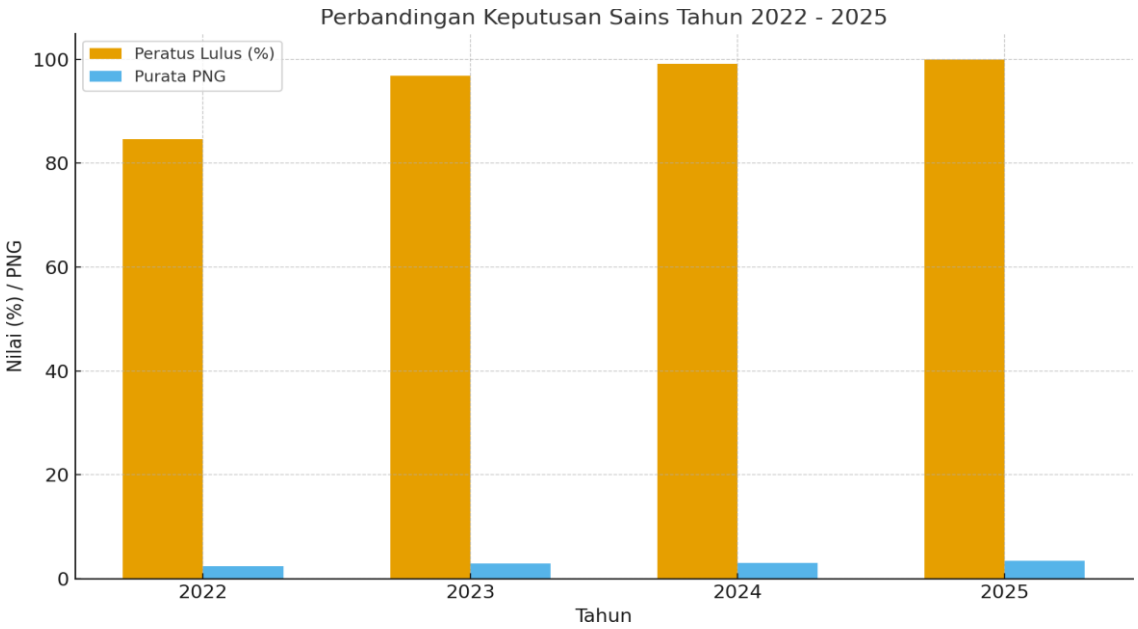

Figure 1: Comparison of Science Results 2022–2025

The decision to maintain 100% pass rate and produce 81 Grade A students (nearly 44% of the entire target population) proves that the benchmarking of PdPc practices through this STEM-AGILE model is at a very excellent standard.

Overall, the implementation of STEM-AGILE not only produced quantitative improvements in examination results but also brought qualitative impact on student learning attitudes and discipline. Students showed new interest in science, more confidence in discussions and demonstrated deeper conceptual understanding. Pictorial activities in science notebooks also gave positive emotional effects to students and they preferred to reopen their

notes because they displayed the results and memories of their own activities. The success of achieving 100% pass rate and significant increase in grades A and B proves that the STEM-AGILE approach is an innovative practical pedagogical model suitable for application in the context of 21st-century vocational learning.

Analysis Of Student Motivation Transformation (Qualitative)

The improvement of existing best PdPc practices brought about very significant qualitative changes:

1. **Transformation of Psychological Message:** When asked about the impact of the activities student consistent answer was "When Science is mentioned, we no longer think it's difficult, teacher, but excited!" This means the STEM-AGILE model successfully changed their mental perception of theory-based subjects.

2. **Birth of Active Inquiry Culture:** The most significant change recorded in teacher observations was the emergence of a proactive student culture. Students no longer passively waited for class to end instead, they asked questions and chased teachers with questions: "Teacher, what science activity are we doing next week?" This spontaneous dialogue became a genuine indicator that student intrinsic motivation level was at its peak.

3. In addition, students showed **better memory retention** of lesson content because learning activities were accompanied by visual elements, games and real experiences that triggered positive emotions. They enjoyed reopening their pictorial science notebooks because they reminded them of the enjoyable activities and helped retain important facts in long-term memory. Teachers also observed a significant increase in discipline, motivation and group cooperation. Students who were previously passive now actively led discussions and helped their teammates. Overall, teacher observations prove that the STEM-AGILE approach not only improves student understanding and academic results but also rekindles their curiosity and love for the Science subject.

REFLECTION AND RECOMMENDATIONS

In conclusion, this research clearly proves that the process of reflectively improving existing best practices is the main key to PdPc effectiveness. The STEM-AGILE model successfully proves that teachers do not need to discard old best practices instead they only need to structure and provide creative, realistic and student-centred value-added elements.

Overall reflection from the STEM-AGILE implementation shows that this approach not only successfully improved students' academic results but also brought significant changes in the culture and atmosphere of science learning in the classroom. Students who were previously passive, less interested and often drowsy now show a very positive transformation more cheerful, active, brave to try and always looking forward to the next activity. Teachers also feel more enthusiastic because teaching sessions have now become more meaningful, enjoyable and interactive. Methods such as Knowledge Auction, Mystery Cards, Escape Room and Scientific Role Play make abstract science concepts easier to understand and remember. The increase to 100% pass rate and dominance of grades A and B proves the effectiveness of this approach not only from a pedagogical aspect but also from the emotional and psychological aspects of students. This success also affirms that science learning does not necessarily have to be rigid or boring in fact it can become an enjoyable and meaningful experience if planned with the right strategies.

Nevertheless, several improvements can be made to strengthen the effectiveness of this study in the future. Among the main recommendations is to expand the implementation of STEM-AGILE to other topics and to the next semester so that its effectiveness can be evaluated in a more comprehensive context. In addition, the integration of digital technology such as virtual laboratory simulations, interactive learning videos and AR (Augmented Reality) applications can be enhanced to provide variation to the learning experience. Teachers also recommend the formation of a "STEM-AGILE Kit" containing activity modules, mystery cards, reflection sheets and a set of digital assessments so that it can be used continuously by other teachers at the Vocational College. This reflection shows that true success is not only measured through numbers and results but through changes

in students' attitudes, interest and confidence towards science something that becomes the main goal of 21st-century vocational education.

CONCLUSION

Overall, this research proves that the STEM-AGILE approach can become an effective, enjoyable and relevant pedagogical innovation in the context of current vocational education. The implementation of STEM-AGILE has successfully changed students' perception of the Science subject from something boring to an interesting and meaningful learning experience. Final Assessment results showed 100% of students passed, with the majority obtaining grades A and B, indicating a significant increase in terms of academic achievement and scientific conceptual understanding. More than that, the positive changes seen in student attitudes such as courage to ask questions, spirit of cooperation and joy of learning prove the effectiveness of this intervention in building competitive students who possess 21st-century skills. Through approaches based on Active Learning, Gamification, Innovation, Learning Collaboration and Evaluation Empowerment this study shows that when students are actively involved in the learning process, they not only understand knowledge better but also build values of confidence responsibility and curiosity. This study is hoped to serve as a reference for other teachers in diversifying PdP methods to be more interactive and suited to the needs of diverse vocational students. The success of STEM-AGILE implementation is not the end of the learning journey but the beginning of a progressive and reflective teaching culture towards producing students who not only know, but are able to think, innovate and give impact to the real world.

As a continuity plan for the next cycle in 2026, the best practices that have been improved will be documented in the form of a "STEM-AGILE Kit" to be disseminated and used as a reference guide by fellow science educators at other Vocational Colleges at the national level.

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