

# The FARRIS Model: A Systematic Framework for Enhancing Technical Report Writing Skills among STEM Students

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## Abstract

Writing technical reports is an important ability to have in science, technology, engineering, and math (STEM) education. However, many high school students have trouble putting their thoughts together, presenting facts in a logical way, and using analytical thinking in writing. This research presents the FARRIS Framework (Framework for Assisting Report-writing and Reporting in STEM), a structured educational approach aimed at facilitating students in the methodical and practical development of technical reports. The framework has six steps that follow one after the other: Format, Arrange, Record, Reflect, Improve, and Submit. Each stage gives learners clear procedures to follow. The first step is to learn about the report structure and goals. The next stages are to collect and analyse the data, have a peer or instructor evaluate it, and then submit the whole report. The research was conducted in selected secondary STEM classrooms, where students were introduced to the FARRIS framework and assessed based on multiple criteria related to technical report writing proficiency. The findings demonstrate that the FARRIS Framework improves students' capacity to clarify goals, properly present data, and critically reflect on experimental results. The findings indicate that the FARRIS model serves as an effective teaching tool for connecting actual experiments with organised report writing, presenting substantial implications for STEM education and technical training at the secondary level.

**Keywords:** FARRIS Model, Pedagogical Framework, Secondary Education, STEM, Technical Report Writing.

## Introduction

Writing technical reports is a fundamental component of STEM and TVET education, enabling students to communicate experimental procedures, data, and findings in a structured and professional manner (1, 2). Beyond classroom assessment, this skill supports the development of analytical thinking, scientific literacy, and communication competencies required for higher education and future employment (3, 4). Technical writing also plays an important role in helping students document, analyse, and interpret scientific findings systematically while strengthening critical thinking and problem-solving skills (5-9). However, many secondary and vocational students experience difficulties in producing clear and well-structured technical reports (10, 11). Common challenges include the use of informal language instead of precise scientific terminology, limited understanding of report structure, and difficulties in analysing and interpreting experimental data. Although students are often able to perform laboratory tasks effectively, they frequently struggle to translate these experiences into

coherent written reports (12). If these challenges are not addressed early, they may persist into higher education, where expectations for scientific writing are significantly higher (13, 14). This may negatively affect students' academic performance and readiness for professional practice, highlighting the need for structured instructional support at the secondary level.

The proposed framework is underpinned by constructivist learning theory, specifically concept of scaffolding, which emphasises the role of structured guidance in facilitating progressive learning. The staged design of the FARRIS Framework aligns with this principle by supporting students through successive phases of report development, thereby strengthening both conceptual understanding and writing proficiency (15). Previous studies have introduced instructional strategies such as scaffolding, peer review, and rubric-based assessment to improve technical writing skills (16, 17). While these approaches have demonstrated positive outcomes, they are typically implemented as separate interventions rather than

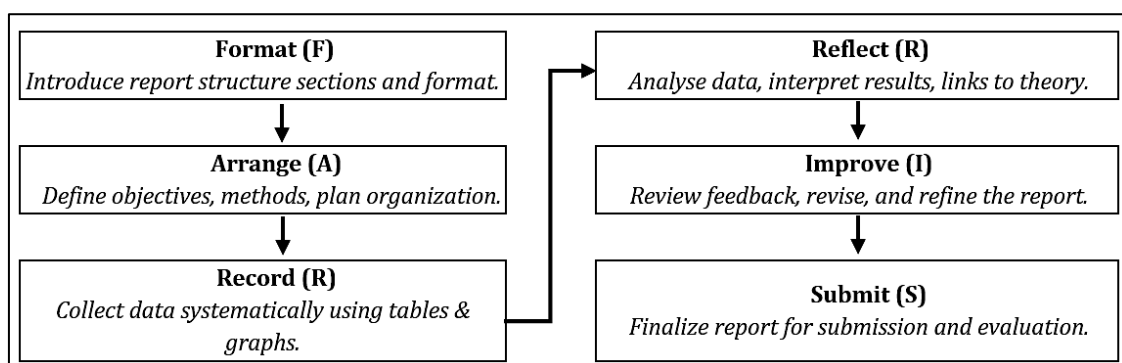
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as part of an integrated instructional framework. Rubric-based assessment helps students understand evaluation criteria and provides clearer feedback, while scaffolding strategies guide students progressively through complex writing tasks (12–14). Peer review further encourages reflection, collaboration, and critical evaluation among students (15). Despite these advantages, each approach has limitations when implemented independently. In addition, most existing research focuses on undergraduate learners, with limited attention given to secondary STEM and TVET contexts (18, 19). This creates a gap in understanding how younger learners can be systematically guided in developing technical

report writing skills. Therefore, there is a need for a structured pedagogical framework that integrates these instructional strategies into a coherent and progressive model suitable for secondary-level education.

To fill this gap, this research presents the FARRIS Framework (Framework for Assisting Report-writing and Reporting in STEM). It is a structured pedagogical approach created exclusively for secondary STEM teaching. Many students find it hard to integrate their experimental work with formal written communication when they write technical reports (20, 21). The FARRIS Framework, as shown in Figure 1, was made to meet this difficulty.



**Figure 1:** FARRIS Framework (Framework for Assisting Report-writing and Reporting in STEM)

The framework is breaking down into six simple and progressive steps: Format, Arrange, Record, Reflect, Improve, and Submit. Each step gives students specific help that lets them focus on one part of report writing at a time. This builds their confidence and skill over time.

The framework not only supports structured learning but also promotes independent learning, critical reflection, and continuous improvement throughout the report-writing process. In the beginning, students are helped to set goals and carefully record information. As the year goes on, they are challenged to think critically about their work, make improvements, and turn it in as a full final report. By doing this, the framework complies with recognised scaffolding and formative assessment principles while retaining its adaptability and utility for everyday classroom application.

Consequently, this research has two main objectives. First, to present the features of the FARRIS Framework and how it is used in secondary STEM teaching. The second is to assess the degree to which it enhances students' technical report writing skills.

## Research Questions

The study is influenced by two main research questions. First, how is the FARRIS Framework used to organise the process for producing technical reports for STEM students in secondary school? For students who may not yet be acquainted with the formal standards of scientific writing, this question focusses on how the framework's six steps might provide a methodical and understandable process.

The second question is: To what extent does the FARRIS Framework improve students' technical report writing skills, as measured through rubric-based assessment across dimensions such as structure, data presentation, and critical reflection? In this context, the evaluation focuses on measurable improvements in students' writing performance.

These enquiries together seek to investigate the framework's educational design as well as its real-world impact on students' writing proficiency. The research aims to shed light on these aspects to explain how organised instructional models might help secondary students close the gap between

written scientific communication and experimental practice.

## Methodology

The investigation was carried out in two selected secondary STEM courses over the course of eight weeks. The framework was used at this time via a series of facilitated lectures that followed its six components and were delivered in phases. Data was gathered from pre-test and post-test reports, which were then examined to gauge how much the quality of the writing had improved. In addition to these evaluations, semi-structured interviews and questionnaires were employed to acquire a better understanding of the learning experiences of participants. These techniques provide a strong basis for evaluating the effectiveness and use of the FARRIS Framework in real-world educational settings.

## Research Design

This study examined the effectiveness of the FARRIS Framework in supporting students' technical report writing. A quasi-experimental pre-test-post-test design was employed, complemented by a mixed-methods approach. Quantitative data were obtained through rubric-based assessments, while qualitative insights were collected from surveys and interviews to capture students' learning experiences, conceptual understanding, and writing development throughout the intervention.

Although randomised controlled trials (RCTs) offer higher statistical validity, they were not feasible in this study due to practical, administrative, and ethical constraints within real classroom settings. Student groupings were predetermined by school administration, and all learners were required to receive the same instructional support, making random assignment and group separation inappropriate. Therefore, the quasi-experimental design was considered the most suitable approach for this context.

To enhance the robustness of the findings, data triangulation was applied by integrating

quantitative results with qualitative evidence. This approach provided a more comprehensive understanding of the framework's effectiveness, allowing the analysis to reflect both measurable improvements in writing performance and the actual experiences of students and teachers in a real classroom environment.

## Participants

Students from two government secondary schools in Malaysia (approximate GPS coordinates 2.3020° N, 102.4406° E and 2.2892° N, 102.1143° E respectively), which deliver STEM-focused courses, were chosen to participate in this research. Ninety pupils in all, forty-one male and forty-nine female, ages sixteen to seventeen, participated in the research. This set of students was deemed appropriate for this research as they often carry out laboratory experiments and write technical reports for their assignments.

In this study, four science and technology teachers were also involved as participants along with their students. The role of these teachers is crucial because they implement learning activities in the classroom, provide feedback to the researcher on the implementation of these activities, and apply the FARRIS Framework as an approach in their teaching. It is beneficial to note that, before the intervention was carried out, all parties involved, including students, teachers, and the school, gave their permission or consent to participate in this research.

## Technical Report Guidelines

This subtopic describes the general guidelines that were developed to help students write thorough and well-organised technical reports over the course of their studies. Table 1 shows the recommended structure, formatting requirements, and writing expectations for each report section. The guidelines provide students with a methodical way to organise information, display facts, and use the right rules for scientific writing. In addition, the table serves as a reference to help students maintain consistency, clarity, and professionalism in technical report preparation.

**Table 1:** Technical Report Guidelines

Section	Guidelines
Title	a) Keep the title under 15 words. b) Include at least one verb and indicate the method or approach used. c) Use title case (capitalize main words; do not capitalize short words such as of, in, and, with)

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	d) Avoid unnecessary words, jargon, or abbreviations.
Author names	<p>a) Place the list of author names below the title on the first page.</p> <p>b) Write full names and separate multiple authors with commas.</p> <p>c) Include affiliations below each author's name (such as school or institution).</p> <p>d) Add the corresponding author's email address below the affiliations.</p> <p>e) All names and information should follow the same format and font style.</p> <p>f) Verify that each author has made a substantial contribution to the work.</p> <p>g) For a polished appearance, centre the author's names and information.</p>
Abstract	<p>a) Write the abstract in a single, 150–200 words paragraph.</p> <p>b) The introduction, problem description, objectives, project methodology, findings or results, and conclusion are the six essential components of an abstract.</p> <p>c) Structure and sentence guide:          Introduction: 1 sentence          Problem statement: 2 sentences          Objectives: 1 to 2 sentences          Project methodology: 2 to 3 sentences          Findings/results: 2 to 3 sentences          Conclusion: 1 to 2 sentences</p>
Keywords	<p>a) Include three to five keywords related to the title and abstract.</p> <p>b) Choose words or phrases that convey key study themes, variables, or methodologies.</p> <p>c) Start keywords with capital letters and separate them with commas.</p> <p>d) Select keywords for easy study discovery in databases or search engines.</p>
Introduction	<p>a) Paragraph 1: Discuss your study's background or main concept.          Provide pertinent citations to back up your argument.</p> <p>b) Paragraph 2: Describe the objective and problem statement of the study.          evidence to back up your arguments.</p> <p>c) Paragraph 3: Give a synopsis of the organisation and topic of your paper.</p>
Literature review	<p>a) Summarise prior research on the subject issue.</p> <p>b) Focus on important ideas, results, and methodologies for the investigation.</p> <p>c) Organise review by topics, ideas, or keywords.</p> <p>d) Write 2-3 paragraphs with at least 3 sentences each.</p> <p>e) Cite all sources used for facts and equations.</p> <p>f) Explain connections or similarities using figures, tables, or diagrams.</p> <p>g) Announce figures and tables in the text before inserting them.</p> <p>h) Use your own words to rephrase and explain instead of copying from sources.</p> <p>i) Conclude the section with previous study gaps or limitations supporting current research.</p> <p>j) Cite figures and tables in the text before inserting them.</p>
Methodology	<p>a) Explain how the research or project was carried out.</p> <p>b) Describe the steps, materials, and methods used to meet the objectives.</p> <p>c) Use the past tense since the study has already been completed.</p> <p>d) This section may include subheadings such as: Research design; instruments or materials; procedures or implementation steps; data collection; data analysis</p> <p>e) Use clear and concise sentences for easy understanding.</p> <p>f) Include figures, flowcharts, or tables if they help show the process.</p> <p>g) Mention each figure or table in the paragraph before placing it.</p>
Finding/Result	<p>a) Present the main results of the research or project clearly.</p> <p>b) Use tables, charts, or figures to show data when necessary.</p> <p>c) Mention each table or figure in the paragraph before placing it.</p>

- |            |   |
|------------|---|
|            | d) Explain what the data shows and not just list the numbers.   |
|            | e) Describe the findings or results using the past tense.   |
|            | f) Highlight the key patterns, trends, or outcomes.   |
|            | g) Avoid repeating material or information in tables and text.  |
|            | h) Save the detailed clarifications for the discussion section.   |
| Discussion | a) Explain the significance of the results.   |
|            | b) Compare the findings against prior research.   |
|            | c) Discuss the causes of similarities or variances in outcomes.   |
|            | d) Explain how the results support or challenge current understanding.  |
|            | e) Discuss practical or educational impacts of research.  |
|            | f) Do not duplicate data that is already in the results section.  |
|            | g) Use past tense for facts and present tense for interpretation.   |
| Conclusion | a) Summarize the main findings of the study briefly and clearly.  |
|            | b) Restate the main objective and explain whether it was achieved.  |
|            | c) Highlight the key improvements or outcomes from research or project.   |
|            | d) Mention the practical value or contribution of the study.  |
|            | e) Keep the conclusion short and focused, usually one short paragraph.  |
|            | f) Avoid adding new information or data not discussed earlier.  |
|            | g) End with a general statement about the significance or possible future application of the work.  |
| References | a) List every source that is cited in the report.   |
|            | b) At least 80% of your references should be current, meaning that the references should have been published no more than five years ago. |
|            | c) Provide every necessary detail, such as the author's name, year, title, source, page, and DOI (if available).                          |
|            | d) Follow a standard reference style, such as Harvard, IEEE, or APA.  |
|            | e) Verify that all references are mentioned inside the text and that all in-text citations are included in the reference list.            |
|            | f) Avoid using unreliable or insufficient sources.  |
|            | g) Verify spelling, grammar, and formatting accuracy twice.   |
| Appendices | a) Clearly label every appendix (Appendix A: Sample Questionnaire, Appendix B: Raw Data, etc.).   |
|            | b) Verify that each specified appendix is referenced and included in the report's main body.  |

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**Note:** STEM = Science, Technology, Engineering and Mathematics; TVET = Technical and Vocational Education and Training; DOI = Digital Object Identifier; APA = American Psychological Association; IEEE = Institute of Electrical and Electronics Engineers.

Apart from organising the content of the report correctly, other matters, such as the writing style, report format, and presentation method (for example, titles, tables, diagrams, references, and language style), are also given more attention so that the written result appears accurate, neat, and professional. Students should make sure that the text is completely justified and that the font style, size, and spacing are all the same throughout the work. This will make it easier to read. Measurements and data must be provided in the right SI units to make sure they are scientifically accurate and consistent. The entire name should be put first, followed by the acronym or abbreviation in brackets, when using it for the first time in

writing. After that, the abbreviated form should be utilised consistently throughout the report.

It is important to number equations in order and put them in an appropriate location in the text so that they are easy to find. Numbering and captioning are also necessary for tables and figures. A succinct but helpful title and, if applicable, the data source should be included with every table or figure. Visuals should be used substantively to improve understanding and interpretation, not only as decorations.

Writing ethically is as important as being technically right (10, 22). Each report may only contain writers or collaborators who made a substantial and verifiable contribution to research

or writing. This aligns with the school’s principles of being responsible and honest. Citing authors and sources make academic work more transparent. When these technical and moral rules are followed, every report that is made will be correct, make sense, and meet professional standards in both classroom and business settings. Additionally, by consistently using these standards, students may strengthen their scientific communication abilities, cultivate disciplined writing habits, and become ready for the documentation requirements of professional STEM and TVET workplaces. Students who grasp these criteria in school lay a strong basis for future research reporting, academic writing, and job advancement in technical and scientific domains.

**Analytic Rubric**

As shown in Table 2, the students' reports were graded using a rubric that was made just for this project. The six parts of the criteria were matched to the steps of the FARRIS Framework. The six parts of the criteria formula were:

- (a) Format and Structure: how well the report sections fit together and made sense;
- (b) Objectives and Methods: how clear and complete the research goals and steps were;
- (c) Data Recording: how accurate and clear the results were when shown in tables or graphs;

- (d) Analysis and Reflection: how deeply the findings were interpreted and how they were connected to theory;
- (e) Review and Improvement: how many changes were made after getting feedback; and
- (f) Final Submission: how good and complete the final report was.

Additionally, there was a Poor [1], Fair [2], Good [3], and Excellent [4] rating for each measure. This rating assists teachers and students in evaluating work consistently and pinpointing areas that want improvement. To guarantee impartial and consistent evaluations, a sample of student papers was examined by two teachers. Cohen's kappa was used to evaluate score agreement, also known as inter-rater reliability, and the outcome was 0.82. In cases of disagreement, both raters reviewed the scores and resolved differences through discussion until a consensus was reached. This demonstrates and validates those two distinct assessors gave almost identical assessments. To gather qualitative data, semi-structured teacher interviews, quantitative scores, and post-intervention student feedback surveys were used. These tools were created to find out what users thought of the system, what problems they ran across, and how to make it better.

**Table 2:** Rubric for Assessing Technical Report Writing Skills

Criteria	Excellent	Good	Fair	Poor
Format and structure	Clearly organised (title, abstract, goal, methods, data, debate, conclusion). Consistent formatting.	Minor omissions or formatting inconsistencies, but overall structure is clear.	Several missing sections or weak organisation.	Unclear structure; or disorganized sections.
Objectives and Methods	Objectives are specific and measurable; methods are clearly described and replicable.	Objectives are mostly clear; methods are adequate but lack some detail.	Objectives vague; methods incomplete or unclear.	Objectives missing or methods not described.
Data Recording	Data is accurate, systematically presented in tables or graphs with correct units and labeling.	Data mostly accurate with minor errors or incomplete labeling	Data incomplete, disorganised, or poorly labeled.	Data absent or incorrect.
Analysis and Reflection	Strong interpretation; clear connection between data and theory; critical insights presented.	Some analysis; limited linkage between results and theory.	Minimal analysis; weak or incorrect interpretation.	No analysis or reflection provided.

Review and Improvement	Substantial revisions made after feedback; improvements clearly evident.	Some revisions made; minor issues remain.	Minimal revisions; major issues persist.	No revisions or improvements are evident.
Final Submission	Report is polished, coherent, and error-free; professional presentation.	Generally clear with minor language or formatting errors.	Frequent errors; weak presentation, or incomplete work.	Report incomplete, poorly written, not submitted.

Note: [4] = Excellent; [3] = Good; [2] = Fair; [1] = Poor.

## Procedure

The eight-week intervention took place during science teaching and learning sessions at the chosen schools. Students were given a pre-test job in the first week. They were to write a technical report on a lab experiment on Ohm's Law. Using a rubric, the reports were graded to see how well they did in technical writing.

The FARRIS Framework was put into place in stages from Weeks 2 to 7, with a different model step being the focus of each week. During the "Format" stage in Week 2, students learned about the fundamental form of a scientific report and looked at an example template. During Week 3, the "Arrange" stage helped students set clear goals and write out their steps in a logical order. During the "Record" stage in Week 4, students gathered data and showed it using the right tables, graphs, and measurement units. Week 5's which is the "Reflect" stage, required students to evaluate their results, discover patterns, and apply their knowledge. Additionally, the "Improve" stage of Week 6 included report updates and enhancements. Students finish their final reports during week 7, referred to as the "Review" stage. Students must complete a post-test on Kirchhoff's Law experiment in week eight. The same standards were used for grading the post-test reports. Lastly, a comparison of the pre-test and post-test results was made to evaluate the technical writing development of the students.

Both experiments involve fundamental electrical principles and require similar procedural steps, including circuit setup, measurement, and data analysis. As such, they were considered comparable in terms of task complexity, ensuring a fair evaluation of students' technical report writing performance. This supports the validity of the comparison by ensuring that the observed improvements are attributable to the implementation of the FARRIS Framework rather than differences in task difficulty.

## Data Collection Analysis

Pre-test and post-test rubric scores were used to collect quantitative data. The mean scores and standard deviations for each of the six rubric aspects were used to summarise the performance of the students before and after the intervention. Prior to conducting the paired-sample t-test, the normality of the data was assessed using graphical methods, including histogram inspection, which indicated that the data were approximately normally distributed. All statistical analyses were performed using Microsoft Excel. The statistical significance of the mean changes before and after the test was then assessed using a paired-sample t-test. Additionally, to gauge the change in student writing performance, effect sizes (Cohen's d) were computed.

The responses indicate that there has been improvement in aspects such as instructional clarity, application convenience, and writing quality. The triangulation of qualitative and quantitative data strengthened the research. Higher scores on the post-test in the "Analysis and Reflection" category indicated that students were more confident in their capacity to assess experimental findings. Combining these data sets improved our understanding of the connection between learning outcomes and the FARRIS Framework.

## Results

The results of this research are divided into two judgments: qualitative survey, interview data and quantitative evaluations of student reports using rubrics. Using technical data from pre-tests and post-tests as references, a quantitative analysis illustrated the results of each of the six processes in the FARRIS Framework. The findings showed statistically substantial gains in data collection, data analysis, and report arrangement.

To bolster the conclusions drawn from the quantitative data, the researchers also used

qualitative data to get a deeper understanding of the participants' emotions. Using this approach enhanced strategic writing plans, simplified assignments, and facilitated effective work organisation, according to both instructors and students. Instructors agreed that the framework made it easier to provide students with comprehensive performance feedback and streamlined training. The FARRIS Framework improved students' technical reports and their confidence in writing about scientific subjects, according to both quantitative and qualitative data.

### Quantitative Results

Quantitative analysis was conducted to compare students' pre-test and post-test technical reports. This comparative effort used the rubric presented in Table 2. Meanwhile, Table 3 shows the mean FARRIS Framework scores for each of the six aspects. Results showed significant progress in all testing categories. Analysis and Reflection had the

highest shift, with the average score rising from 1.9 (SD = 0.62) to 3.1 (SD = 0.58). Data recording also improved from 2.1 (SD = 0.54) to 3.3 (SD = 0.47). This indicates the results were more structured and accurate. Even higher-rated elements like Format and Structure improved, increasing from 2.4 (SD = 0.50) to 3.5 (SD = 0.49).

The improvements were statistically significant ( $p < 0.01$ ) in all six dimensions, according to paired-sample t-tests. Reflection and Data Recording and Analysis both demonstrated significant effect sizes (Cohen's  $d > 0.8$ ), indicating their practical use. The 95% confidence intervals for the mean differences ranged from 0.84 to 1.46 across all dimensions, indicating consistent improvement in students' technical report writing performance after the intervention. These findings demonstrate how the FARRIS Framework improved students' technical reports in a measurable manner and provided them with a clear writing guide.

**Table 3:** Mean Pre-Test and Post-Test Scores for Technical Report Dimensions

Dimension	Pre-test Mean (SD)	Post-test Mean (SD)	t-value	p-value	Effect Size (d)
Format & Structure	2.4 [0.50]	3.5 [0.49]	-8.25	<0.01	0.85
Objectives & Methods	2.2 [0.57]	3.4 [0.52]	-9.10	<0.01	0.92
Data Recording	2.1 [0.54]	3.3 [0.47]	-10.45	<0.01	1.02
Analysis & Reflection	1.9 [0.62]	3.1 [0.58]	-11.15	<0.01	1.05
Review & Improvement	2.0 [0.55]	3.2 [0.50]	-9.87	<0.01	0.97
Final Submission	2.3 [0.51]	3.4 [0.48]	-8.72	<0.01	0.90

**Note:** SD = Standard Deviation; t-value = t-test statistic; p-value = significance level; d = Effect Size;  $p < 0.01$  indicates statistical significance.

### Qualitative Results

In addition to quantitative data, the qualitative information gathered from teacher interviews and student questionnaires helped to clarify the implementation of the FARRIS Framework. Three primary themes emerged from the thematic analysis: improved classroom participation, boosted student confidence, and structural clarity. For technical reports, students generally said the format was clear-cut and easy to understand. Many said that breaking the process up into six stages made it easier to understand and handle. "In the past, I just wrote everything down without knowing what was important", a student said. They now understand how to begin, compose, and wrap up an essay. Teachers also admitted that the framework provided them with a common reference that aided in class planning and focus.

The second theme was to increase student confidence. According to several participants, the framework assisted them in meeting formal technical reporting requirements. "The FARRIS technique helped me overcome my fear of producing reports," one student claims. Their work now seems more professional to them. Teachers noticed that pupils who had previously turned in incomplete or badly written reports now presented well-organised, understandable work.

The third theme was how students interacted in the classroom. During the review and improvement phase, teachers reported that students found it easier to work together and have meaningful conversations with one another. According to a teacher, "The review stage really changed how students worked together. Because they provided

helpful comments to one another, I could see that the final contributions were superior”.

These qualitative results, which demonstrated that the FARRIS Framework enhanced student writing and promoted a more dynamic and engaged learning environment, corroborated the statistical data. Instructors remarked that it was simple and adaptable to use in scientific lessons.

## Discussion

This study found that the FARRIS Framework improved technical report writing skills. Quantitative analysis demonstrated statistically significant improvements across all six criteria of the rubric, particularly in data recording, data analysis, and reflection, which are typically the most challenging components for secondary-level students due to the need for both accurate measurements and analytical thinking.

Qualitative evidence further supported these findings, showing that students perceived the framework as clear, systematic, and confidence-building, while teachers reported that the model was useful and could be effectively integrated into regular teaching practices. When considered holistically, these results suggest that the FARRIS Framework serves as an effective approach for linking hands-on experimental activities with structured scientific communication, enabling students to produce more organised and coherent technical reports.

This improvement may be attributed to the structured and sequential nature of the FARRIS Framework, which systematically guides students through each stage of the report-writing process. By breaking down complex writing tasks into manageable components, the framework enables students to organise ideas more effectively, accurately record experimental data, and engage in deeper reflection on their findings, thereby enhancing both the quality and coherence of their reports. In addition, the step-by-step guidance helps to reduce students' cognitive load, allowing them to focus on specific aspects of writing at each stage while gradually developing higher-order thinking skills.

These findings are consistent with constructivist learning principles, particularly Vygotsky's concept of scaffolding, where structured guidance facilitates progressive learning. The staged design of the framework provides continuous support,

enabling students to build writing competence incrementally and develop greater confidence in articulating their scientific understanding.

## Comparison with Previous Studies

This study's improvements are in line with other research on the use of scaffolding strategies in writing instruction. Organised scaffolding helps students in organising their ideas more logically and using academic norms with more confidence (23–25). The FARRIS Framework extends on this by including scaffolding in a step-by-step procedure that is like the steps of preparing a technical report. Each stage is meant to help students go forward step by step, making sure they get the correct amount of help as they go from preparing their research to finishing a polished scientific report. This combination of structure and flexibility shows the ideas of steady skill development that are important to constructivist learning theory.

Many people also agree that using rubric-based methods makes it simpler to comprehend what is expected of students and helps to clarify grading (26, 27). Clear evaluation standards aid instructors in giving consistent feedback to students and assist students in understanding what constitutes effective writing (28). Instead of just being used at the end for the final grade, the assessment in this research was integrated directly into the FARRIS Framework, allowing students to utilise it throughout the writing process.

Peer-review tasks are also known to help students learn how to think, work together, and control their own behaviour (5, 29). This method was used in the FARRIS Framework during the Review and Improve stage, when students worked together to improve each other's papers by giving each other helpful feedback. Teachers said that this participation made the classroom a better place to be and gave everyone a sense of responsibility for their own learning.

## Novel Contributions of the Study

As summarised in Table 4, the FARRIS Framework distinguishes itself by combining these instructional elements within a six-stage structure that connects teaching, assessment, and feedback in a coherent sequence. It changes technical report writing from a one-time task to a process of learning that keeps getting better. This model works well in STEM and TVET settings for secondary school students, which makes it even

more useful and adaptable for use in the classroom. In this way, the framework fills in the gap in teaching that was found in earlier studies and

provides a way to help students improve their scientific speaking and writing skills that can be used in a variety of classroom settings.

**Table 4:** Comparison of Existing Approaches and the FARRIS Framework

<b>Approach / Model</b>	<b>Focus area</b>	<b>Key features</b>	<b>Limitations identified in literature</b>	<b>Unique contributions of the FARRIS framework</b>
General STEM Pedagogical Frameworks (e.g., Integrated STEM, 5E Model)	Inquiry-based learning and problem-solving	Promote critical thinking and project-based learning	Do not explicitly address technical report writing or documentation skills	FARRIS focuses specifically on structured report writing within STEM experiments
Scientific Writing Guides (e.g., lab report guidelines, school templates)	Basic report formatting	Provide structure for introduction, methods, results, discussion	Serve as static templates; lack teaching strategy or scaffolding process	FARRIS integrates instructional sequencing (Format to Submit) and learning outcomes
CER Framework	Scientific reasoning and argumentation	Strengthens explanation and justification of data	Limited to discussion section; not applicable to full report structure	FARRIS covers complete report cycle including data, reflection, and revision
Rubric-Based Assessment Models	Evaluation of writing performance	Define assessment criteria and standards	Often used only at final evaluation stage; limited formative guidance	FARRIS embeds rubric criteria within each learning stage for continuous feedback
Scaffolding and Peer-Review Strategies	Supportive writing instruction	Enhance collaboration and self-assessment	Usually applied in isolation, not within a systematic framework	FARRIS combines scaffolding, feedback, self-improvement into one cohesive system

**Note:** STEM = Science, Technology, Engineering and Mathematics; 5E = Engage, Explore, Explain, Elaborate, and Evaluate; CER = Claim-Evidence-Reasoning.

Existing models such as general STEM pedagogical frameworks, the 5E instructional model, and the Claim-Evidence-Reasoning (CER) structure have each provided valuable guidance for developing inquiry and reasoning skills (15, 30, 31). However, none of these approaches offers a complete or systematic process for teaching technical report writing from start to finish. Likewise, rubric-based and peer-review strategies, although useful for assessment and reflection, are typically used as isolated methods rather than as elements of an integrated instructional system.

The FARRIS Framework breaks down the process of preparing reports into six steps that are done in order. In the past, different initiatives used comparable tactics on their own, which made the training uneven and the results inconsistent. The FARRIS model is different from other models since it is a single system that is useful for instructors and

focuses on what students need to learn. It is a simple teaching guide for instructors that they may use with their current lesson plans with just a few changes. It makes technical writing easier for pupils by breaking it down into smaller, easier-to-handle chunks. This method turns a hard work into a structured and doable way to learn.

Another important contribution of this study is its focus on secondary STEM education, which is relatively understudied. Most previous studies on writing interventions have focused on university students only. Secondary students who should learn scientific report writing have been ignored. The FARRIS Framework may eliminate higher education disparities by focussing on this early period.

## Implications of Practice

This research may have significant consequences for teaching, learning, and curriculum development. The FARRIS Framework guides teachers in course planning and evaluation. The framework arranges report writing to help instructors teach and provide task-appropriate feedback. Students get timely guidance while maintaining independence and responsibility with these alignments. Standardising student progress evaluation and conversation helps teachers remain consistent. This approach can help departments or programs work together better when students or instructors come from different technical writing backgrounds.

The framework helps students to study in a more active and thoughtful way. Peer collaboration and planned revision activities get students involved in each other's learning by making them contributors to each other's progress instead of just passive users of comments. Students learn the parts of good technical writing and gain confidence in their abilities to express scientific concepts by having to think about, change, and resubmit their reports again and over. This procedure, which students do again and over, helps them learn how to be persistent, accurate, and think critically, which are skills that transcend beyond writing and help them comprehend science better.

From a larger educational perspective, the FARRIS framework is in line with the goals of SDG 4 on Quality Education and the development of skills needed in the twenty-first century. The framework helps students learn skills that they may apply in college, vocational training, and their future jobs by teaching them how to articulate their thoughts effectively, think critically, and present facts in an organized manner.

## Conclusion

The FARRIS Framework is a structured pedagogical approach designed to enhance technical report writing skills among secondary STEM students. It comprises six sequential stages: Format, Arrange, Record, Reflect, Improve, and Submit, which systematically guide students through the complete reporting process. By providing clear and progressive guidance, the framework addresses common challenges such as idea organisation, accurate data recording, and conceptual

understanding, while also fostering students' confidence in scientific writing.

The findings indicate that the FARRIS Framework significantly improves students' abilities in data analysis and critical reflection, which are typically challenging at the secondary level. These improvements are supported by both quantitative and qualitative evidence. Students perceived the framework as clear, practical, and easy to apply, while teachers reported enhanced capacity to provide targeted feedback and more effectively integrate report writing into STEM instruction.

Overall, the implementation of the FARRIS Framework was found to be effective in supporting students' technical writing development. Its structured and progressive nature aligns with constructivist learning principles, promoting reflective thinking and continuous skill development. Furthermore, the framework contributes to the broader goals of 21st-century education and Sustainable Development Goal 4 (Quality Education) by equipping students with essential communication and critical thinking skills for academic and professional contexts.

Despite these positive outcomes, several limitations should be acknowledged. As the study was conducted in two secondary schools in Malaysia, the findings may have limited generalisability to broader educational contexts. In addition, the relatively small sample size of 90 students and the eight-week intervention period reflects short-term improvement and may not capture long-term sustainability.

Future research is recommended to extend the implementation period and include more diverse educational settings, such as interdisciplinary STEM programmes, vocational institutions, and rural schools. Comparative studies with other instructional approaches may also provide further insight into the effectiveness of the framework. Additionally, the integration of digital tools, including online peer-feedback platforms, collaborative writing systems, and AI-assisted feedback, could be explored to enhance accessibility and scalability.

In conclusion, the FARRIS Framework offers a practical and innovative approach to teaching technical report writing at the secondary level. It effectively bridges the gap between experimental practice and formal scientific communication,

enabling students to present their understanding in a clear, accurate, and structured manner.

### Abbreviations

FARRIS: Framework for Assisting Report-writing and Reporting in STEM, RCT: Randomised Controlled Trial, SDG 4: Sustainable Development Goal 4, STEM: Science, Technology, Engineering, and Math, TVET: Technical and Vocational Education and Training.

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### Author Contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

### Conflict of Interest

The author declares that there is no conflict of interest related to the publication of the work.

### Data Availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

### Declaration of Artificial Intelligence (AI) Assistance

The author used AI-assisted tools for language refinement and conceptual assistance during manuscript preparation. All figures, content, analysis, and conclusions remain the author's original work. The authors take full responsibility for the content's originality, interpretation and accuracy.

### Ethics Approval

Not Applicable. (The conducted research is not related to either human or animal use.)

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