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Crafting Comprehensive Lab Reports: Techniques for Improved Technical Writing and Data Interpretation Skills

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Abstract

Teaching labs are a vital component of engineering education. They allow students to participate in all stages of experiential learning, beginning with conceptualization and exploration and progressing to reflection, analysis, and data interpretation. Laboratories promote a variety of abilities, including communication, knowledge, teamwork, ethics, and information acquisition, and they supplement lecture learning by improving students' understanding of theoretical topics. In addition, the importance of laboratories in engineering education is evident from two of the student learning outcomes required by ABET for program accreditation. The outcomes state that students must be able to conduct experiments, analyze and interpret data, and communicate effectively for those outcomes to be attained.

To achieve these objectives in our engineering program, detailed lab report guidelines are provided for both students and laboratory instructors in all courses having a lab component. To complete their lab reports successfully, students need to correctly establish the scientific concept of the lab, effectively present the objectives and purpose of the lab, clearly explain how they perform their experiments, list and discuss the outcomes of the experiments, and finally draw logical conclusions out of these outcomes. In addition, students must present the findings clearly and with sufficient support and successfully integrate written and visual representations. In the conclusion section, students need to provide the main findings and state whether the results support or contradict the hypothesis being tested.

In this paper, we will demonstrate the program's experience with lab reports writing and rubric development over the last ten years, which includes three different phases. The first is when there was no standard lab report rubric with guidelines (before 2018), the second is when the first generation of standard lab report rubric and guidelines was introduced (2018-2022), and the third one is when an augmented versions of the standard lab report rubric were used (2023-2024). This paper will also include a comparison of the assessment results from various courses in the program, which shows the effect of rubrics in the improvement of students' technical writing and data interpretation skills through the three phases.

Keywords

Teaching laboratories; Laboratory reports; Technical Writing; Rubric Development, and Data Interpretation Skills.

Introduction

Laboratory experiments have historically been a fundamental component of the engineering experience [1]. ABET student outcome (6) explicitly mandates that students cultivate "an ability

to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to conclude [2]." Benefits of lab work include acquiring hands-on practical skills, observation and deduction skills, and applying theoretical information to empirical work. Best practices involve pre-lab activities, hands-on lab time, and post-lab activities such as data analysis and report writing [3].

Laboratory reports function as an essential medium for conveying scientific research and findings. They are essential to learning science, technology, engineering, and mathematics (STEM) disciplines, allowing students to develop and enhance their technical writing and analytical skills. A comprehensive laboratory report reflects both the technical comprehension of the experiment and the capability to present intricate information in a clear and organized format. Many students struggle to write laboratory reports, requiring integrating precise technical details with effective communication. Writing an effective laboratory report necessitates mastery of several interconnected skills, including comprehension of the experimental process, critical data interpretation, and organization of findings into a coherent narrative. Laboratory reports facilitate a deeper understanding of the scientific method by prompting students to engage critically with experimental design, data collection, and result interpretation.

Technical writing is an important talent for engineers and scientists because it bridges the gap between technical knowledge and successful communication. Laboratory reports, a staple of engineering education, provide an organized environment for students to develop and hone this talent. Students learn to explain technical concepts effectively and professionally by documenting experimental techniques, assessing outcomes, and presenting findings. This step prepares them for real-world engineering difficulties. The ability to effectively explain technical information is just as vital as technical expertise in engineering. Employers seek graduates who can communicate complicated ideas to technical and non-technical audiences. Laboratory reports provide a great environment for developing these skills. According to the American Society for Engineering Education (ASEE), including technical writing in laboratory courses solves a longstanding gap in engineering curricula by emphasizing clarity, precision, and audience awareness [4]-[15].

Various methodologies have been utilized to improve technical writing skills in laboratory environments. An effective method is the scaffolded peer review technique. This strategy entails deconstructing the laboratory report into smaller components, allowing students to concentrate on one section at a time. Guided peer reviews improve this process by offering constructive feedback, promoting critical thinking, and facilitating a collaborative learning environment. Studies demonstrate that scaffolded peer review enhances students' writing skills and self-assurance [5]. Another innovative approach involves client-focused assignments, wherein students tackle real-world issues hypothetical clients encounter. This method necessitates that students customize their communication for particular audiences, a critical competency for professional engineers. Research indicates that client-focused writing enhances students' capacity to communicate technical information to various stakeholders while promoting problem-solving and critical-thinking abilities [7], [15].

Lab report writing is very useful for developing a wide range of abilities at various levels of abstraction [8]. Low-level skills include discussing work in chronological order, defining key

phrases, and listing equipment and related duties. Medium-level skills, such as classification, comparison, and summarization, require students to extensively study material. Laboratory work provides an opportunity to enhance these skills through practice. High-level talents are ideal for professional and graduate work. Students must be able to conclude from evidence, compare them to past research, and justify their findings to excel in scientific and academic argumentation and analysis. Lab reports, which include statistical data analysis, graphical presentation, and uncertainty analysis, are ideal for evaluating high-level skills.

Comprehensive laboratory reports serve as a course requirement and an essential instrument for developing technical writing and data interpretation skills. Emphasizing structure, clarity, and critical analysis enables students to improve their communication skills and scientific comprehension substantially. Educational institutions should incorporate training modules that emphasize these skills to prepare students for professional challenges adequately.

Smyser and Tariq [13] call attention to the differences between students' actual methods of data processing and their offered instructions. Even when students are advised to participate in activities incorporating data for consistency and comparison of outcomes to theoretical assumptions, occasionally they fail to appropriately evaluate or draw conclusions from their data. Given that students seemed to overestimate their involvement in these critical analysis behaviors, the study suggests more particular education and experience in data interpretation is needed. Kim and Howes [17] look at common challenges students have when written lab reports for basic engineering classes. They identify specific areas of student difficulties and suggests customized teaching strategies to help with these problems.

In general laboratory reports hold significance that transcends academic contexts. Effective documentation and communication of scientific findings are crucial for collaboration, innovation, and decision-making in professional settings. Consequently, acquiring the skill to produce thorough laboratory reports is essential for fostering students' academic achievement and professional proficiency. To be able to make the best of laboratory report writing in enhancing these essential skills, a well-developed rubric is the key. such a rubric benefits both students and instructors. It ensures clarity, fairness, and consistency in grading, as well as promotes skill development, and enhances learning outcomes. Additionally, it provides a structured framework that helps students improve their scientific writing and reporting skills. Essentially, the rubric serves as a roadmap for the student and the instructor throughout the lab report process. Throughout the last 5 years (2018-2023), the program has been determining and evaluating the most effective, accurate, and transparent rubric to use in guiding the students and and grading their technical laboratory reports [15], [16]. In this paper we discuss the best practices for developing laboratory report rubric that improves the technical writing skills of students. In addition, the paper outlines the fundamental elements of a laboratory report, presents methods for enhancing clarity and conciseness, and underscores the importance of data interpretation and visualization in scientific communication.

The Approach for Courses with Lab Components

The curriculum mandates that, alongside the Physics and Chemistry Labs in the first year, students must complete laboratory courses each semester from their sophomore year to their junior year. This paper covers four courses along with their corresponding laboratory components: PETE 225 Petroleum Drilling System (Fall Semester, Sophomore Year), PETE 311 Reservoir Petrophysics (Spring Semester, Sophomore Year), PETE 310 Reservoir Fluids (Fall Semester, Junior Year), and PETE 325 Petroleum Engineering Production Systems (Spring Semester, Junior Year). Before 2018, each lab course instructor used their lab report format and evaluation standards. While this allowed instructors to adjust the report requirements to their teaching style and the unique demands of their courses, it also had some important drawbacks. First, the lack of a single structure confused students, particularly those simultaneously enrolled in various lab courses. They frequently had to adjust to new expectations and forms, which was time-consuming and could result in errors in their submissions. Second, it resulted in variations in grading criteria because each instructor applied their standards. This format made it impossible to maintain fairness and consistency in assessments across multiple lab courses. Furthermore, students struggled to create a clear and consistent approach to report writing since the many forms made it difficult to establish a standardized skill set. Over time, this inconsistency may impair their capacity to write professional, high-quality reports in advanced courses or real-world applications. Finally, the lack of a consistent format hindered the process of academic assessment and comparison across courses, as the variety of report styles made it difficult to evaluate overall student performance and identify areas for curricular development. Implementing a uniform lab report format in 2018 solved these concerns by providing guidelines that clarified the expectations and generated a more coherent learning experience for students.

In 2018, academics and lab instructors created a lab report rubric and used it in all lab courses throughout the program. Table 1 displays the rubric, which includes the report's components and grade. The rubric was gradually adopted, beginning with the first class of the sophomore year (PETE 225) and progressing through the junior classes in the second year. This staggered introduction allowed students to become acquainted with the rubric early in their academic careers, assuring a solid foundation for its use as they progressed through more complex courses. By regularly applying the same rubric across different classes, students knew the expectations for lab reports and other tasks, reducing uncertainty and improving their ability to satisfy academic standards.

This continuity gave a disciplined approach to scientific writing and encouraged students to polish and improve their abilities over time. As students proceeded through their curriculum, they reported feeling more confident in their abilities to create high-quality reports that followed the rubric's criteria. The constant use of the rubric also enabled instructors to deliver more targeted comments, assisting students in identifying areas for improvement and improving their performance in future assignments.

According to the findings of a student survey, the rubric was deemed quite valuable by most pupils. They appreciated how it offered clear information on what was anticipated in their submissions, making it easy to structure their reports and ensuring they included all essential

sections. Many students appreciated the rubric's openness, which explained the criteria for evaluating their work, allowing them to focus their efforts and obtain higher results.

Table 1. Grading rubric for laboratory reports 2018

Section	Description	Maximum Points Possible	Your Points
Abstract	Conveys a sense of the full report concisely and effectively	15	
Introduction	• Successfully establishes the scientific concept of the lab • Effectively presents the objectives and purpose of the lab	25	
Experimental Methodology	Gives enough details to allow for a replication of procedure	10	
Results and Discussion	• Presents verbal findings clearly and with sufficient support • Successfully integrates verbal and visual representations • Backs up statement with reference to appropriate findings • Provides sufficient and logical explanation for the statement	25	
Conclusion	Convincingly describes what has been learned in the lab	15	
Presentation	• Citations and references adhere to proper format • The format of tables and figures is correct • Report is written in a scientific style: clear and to the point • Grammar and spelling are correct	10	
Total score		100	

Furthermore, implementing standardized rubrics promoted a sense of fairness in grading, as students perceived that their work was being evaluated using consistent and objective standards. This process helped to create a more positive learning environment and reduced the stress associated with ambiguity regarding evaluation techniques. Overall, the rubric implementation was considered a good improvement, raising educational quality and giving students useful abilities to carry over into their future academic and professional efforts.

After two years of using the rubric, faculty and lab instructors thoroughly evaluated its growth and efficacy. Then, updated that first rubric. Table 2 shows the updated rubric, which was altered as part of the continuous improvement approach to better meet the needs of both students and the academic program. This updated version incorporates the collective insights from faculty reviews, student input, and outcome analysis throughout the two years since the rubric's first adoption.

Table 2. Grading rubric for laboratory reports 2020

Section	Description	Maximum Points Possible	Your Points
Abstract	• Conveys a sense of the full report concisely and effectively	15	
	Comments		
Introduction	• Successfully establishes the scientific concepts discussed in the lab • Effectively presents the importance and gives an overview of the lab	20	
	Comments		
Results and Discussion	• Presents the lab findings clearly and with sufficient support • Indicate possible errors in measurements and methods of mitigation • Backs up statement with reference to appropriate findings • Provides sufficient and logical explanation for the statement	35	
	Comments		
Conclusion	• Convincingly describes what has been learned in the lab	15	
	Comments		
Presentation	• Citations and references adhere to the proper format • The format of tables and figures is correct • The report is written in a scientific style: clear and to the point • Grammar and spelling are correct	15	
	Comments		
Total score		100	

This study sought to analyze how effectively the rubric performed its intended function of standardizing report assessments, improving student learning outcomes, and promoting consistency across courses. During the conversations, faculty members expressed their observations and suggestions, stressing the rubric's strengths and areas that may be improved to better correspond with course objectives and student requirements.

One major decision from this evaluation was removing the "Experimental Methodology" part from the rubric. This part was considered superfluous because students were already given thorough instructions and techniques in the laboratory manuals for each module. By deleting this requirement, the rubric was simplified, allowing students to concentrate on other important components of their reports, such as data analysis and formulating relevant conclusions.

Furthermore, the weight allocated to the "Results and Discussion" section was greatly raised. This change stressed the significance of understanding experimental data and drawing useful conclusions from laboratory activity. By emphasizing this segment, the faculty hoped to encourage students to understand the scientific process better, strengthen their analytical skills, and connect their discoveries to theoretical topics in class. This adjustment also encouraged students to conduct detailed and careful analyses, supporting the development of critical thinking and problem-solving skills.

The "Presentation" part also gained weight in the rubric. This choice emphasized the value of clear and professional communication in scientific reporting. Students were urged to style their reports appropriately, research and cite reputable references, and create well-organized tables and figures based on their experimental findings. The increased emphasis on this segment was intended to assist students in improving their abilities to present data visually and convey their findings effectively and professionally. As a result, students were better prepared for future academic research and professional situations requiring high-quality presentations.

In addition, a dedicated comments section has been introduced to the rubric to provide students with specific criticism and guidance on areas for future improvement. This new section is intended to provide constructive, practical, personalized feedback suited to each student's work, assisting them in identifying specific strengths and problems in their submissions. in addition, this section allows instructors to explain more thoroughly how students can improve their skills in crucial areas such as data interpretation, writing clarity, and presentation quality. Such feedback promotes continual learning and growth, allowing students to fine-tune their approach and attain better academic success. The comments section also promotes greater communication between students and professors by offering a platform for specific guidance that supplements the rubric's uniform criteria. This addition demonstrates the department's dedication to fostering a friendly and participatory learning environment that prioritizes student development and achievement.

Overall, the rubric adjustments indicated the faculties and lab instructors' dedication to ongoing development and altering teaching tools to match changing educational objectives. These modifications ensured the rubric remained a dynamic and useful tool for improving student learning and fostering scientific communication and analysis excellence.

In 2023, the faculty and lab instructors held a dedicated retreat to further improve and expand the rubric as part of the department's continued commitment to improving student learning outcomes and assessment tool quality. During the retreat, faculty members held in-depth talks to identify areas for improvement based on their teaching experiences and student feedback. As a result, numerous substantial revisions to the rubric were made to reflect changing educational goals and

improve alignment with professional and academic standards. Table 3 contains the grading rubric report for 2023.

One of the most significant improvements involved adding more precise requirements to the rubric. These changes gave more clarity and detail in expressing expectations for each area of the lab report. This increased degree of detail ensures that students understand what is required to achieve higher performance levels, allowing them to concentrate on meeting those criteria.

The remark area was also heavily changed to increase the uniformity and clarity of student feedback. A new tick-box system was implemented, allowing instructors to quickly and effectively identify common areas of strength or weakness. This system maintains consistency in instructor feedback while allowing personalized comments as needed. The tick-box approach also makes comments more accessible and actionable for students, allowing them to identify areas for growth better.

The report's requirements now include a "Materials and Methods" section to address the increased importance of scientific rigor and documentation. This new section highlights the need to carefully document the equipment, instruments, and materials used in investigations. Adding this component allows students to practice exact documentation, which is essential in academic research and professional lab settings. It also promotes a better grasp of how experimental techniques are designed and implemented.

Additionally, a "References" component was added to the rubric to emphasize the necessity of properly citing sources in scientific work. This update intends to inculcate the habit of using reputable references to support data interpretation and analysis while also teaching students about academic integrity and correct credit. By having a references area, the rubric encourages students to read scientific literature and develop the skills required to incorporate external knowledge into their work effectively.

These revisions reflect the department's commitment to maintaining a high standard of education and providing students with the tools they need to succeed in their academic and professional endeavors. The redesigned rubric improves the evaluation process and promotes important skills, including analytical thinking, scientific writing, and ethical research procedures.

After the updated rubric was approved, all lab coordinators were asked to regrade several previously submitted lab reports using the new criteria. This stage was critical to the validation process since it ensured that the modified rubric was effective and practical for evaluating student work. By regrading old reports, lab coordinators could directly compare the results of the new rubric to the prior version, discovering disparities and determining if the new criteria gave a more accurate and consistent evaluation of student achievement.

This exercise enabled lab coordinators to assess the clarity and applicability of the new standards, ensuring that they were simple to understand and apply. It also allowed for identifying potential areas of uncertainty or ambiguity in the rubric, which could be corrected before its full implementation. Comparing the grades and feedback from the old and new rubrics revealed how

the revisions affected the emphasis on essential report components, including findings, discussion, materials and techniques, and references.

Table 3. Grading rubric for laboratory reports 2023

Section	Grading Rubric Description	Petroleum Engineering Lab Report Guidelines	Rubric Points
Abstract	Conveys a sense of the full report concisely and effectively	☐ Give the full sense of the report. ☐ Present brief and straight-to-the-point details (100-250 words). ☐ Details include a summary of the lab objectives, the data presented, and the major conclusion. ☐ *Written at the end after you finalize your results.*	15
Introduction	• Successfully establishes the scientific concept of the lab • Effectively presents the objectives and purpose of the lab	☐ Define the subject of the report. ☐ Outline the objective and significance of the experiment. ☐ Provide the reader with sufficient background to understand the entire report. ☐ Literature review. ☐ *Answer the questions WHAT, WHY, HOW.* ☐ Word count around 300 – 500 words.	15
Materials and Methods	• How you performed your experiment • Write only what you did, not what results you got	☐ The procedure of the experiment. ☐ Equations used in the calculation. ☐ Picture or sketch of the equipment. ☐ Materials be used. ☐ Experimental condition.	5
Results and Discussion	• Presents verbal findings clearly and with sufficient support • Successfully integrates verbal and visual representation • Backs up the statement with reference to appropriate findings • Provides sufficient and logical explanation for the statement	☐ Present the various data collected in the form of figures and tables. Refer to the caption number within the body text and discuss its content. ☐ Interpret and compare data to the book, literature, class notes, or common sense. ☐ Include uncertainty in results using error analysis. ☐ Explain errors in measurement and calculations. ☐ Analyze possible reasons for inconsistencies. Specify what caused the errors and indicate what might have caused the errors. ☐ Explain how the methods could be improved. ☐ Note the main limitations that are relevant to the interpretation of the results. REMINDERS ☐ No need to show sample calculations ☐ **Do not manipulate data to fit the theory.**	30
Conclusion	Convincingly describes what has been learned in the lab	☐ Summarize the lab report in a few sentences. ☐ Include the main findings and state whether the results support or contradict the hypothesis. ☐ Reiterate what you learned from the experiment and how you understood this learning. ☐ Write the conclusion as bullet points.	15
References	• Show your understanding of the topic. • Gives supporting evidence for your ideas, arguments, and opinions.	☐ Minimum two references and exclude the manual and personal communication with the faculty/lab coordinator. ☐ Website addresses and unpublished results are not acceptable references. ☐ Cite references in the text or figure or table captions by placing the author's last name and the year of publication in parentheses.	5

Presentation	• Citations and references adhere to the proper format • The format of tables and figures is correct • The report is written in a scientific style: clear and to the point • Grammar and spelling are correct • Nomenclature	☐ Lab report length no more than 10 pages. ☐ Paragraphs are justified. ☐ Consistent in the format of all figures and tables. Label x and y axes, legends, column box heads, parts of diagrams, titles, etc., with the correct unit. ☐ Figures and tables should be numbered and referenced in the report's text, and the reference should be in bold letters. ☐ Citations and references adhere to the proper format. ☐ Single-spaced lines, Times New Roman 12 for the text, Times New Roman 12 Bold for the title sections. Font for the figures and tables captions, **Times New Roman 9 Bold** ☐ All the reported numbers are higher than one to be rounded to **two decimal points.** ☐ Consistency in presenting equations. ☐ *Italic* font for *nomenclature* and *symbols*. ☐ Grammar and spelling are correct. REMINDERS ☐ Avoid sub-headings.	15
Total Score			**100**

Tool grading rubric

	Score					
Student Preparation Level	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Analysis: Interpretation of data, numbers, tables, and graphs	No answer	Mostly wrong Major mistake No understanding	Several major mistakes Limited understanding	Minimum acceptable work Many minor mistakes Some understanding	Good level of understanding An adequate level of work Minor mistake	Exemplary work No mistake Well-organized Excellent understanding

Furthermore, this method revealed important insights into how the amended rubric could improve student feedback. Lab coordinators reported that the updated comment area and tick-box approach improved their ability to make specific, actionable comments, enabling better uniformity in the feedback process. This uniformity also ensured that students from diverse lab sections and instructors received fair assessments and helpful feedback.

The grading exercise also functioned as a training opportunity for lab coordinators, introducing them to the new rubric and assuring a shared grasp of its criteria and implementation. This step was critical in ensuring fairness and dependability in the grading process when the rubric was formally approved for use in all courses with lab a component.

Overall, the grading process validated the updated rubric's effectiveness while reinforcing the department's commitment to continual development and providing students with a transparent, fair, and helpful learning environment.

Example of Laboratory Experiments

An example of the lab experiments that students carry out during their study is demonstrated in this section. This experiment is carried out to compare the concentration of corrosion inhibitors at different fluid types, ambient temperature, and pressure, High Temperature and High Pressure (HTHP), and static versus dynamic corrosion. Students are given a laboratory manual containing information on the experiment's background, required equipment, safety precautions, procedures, and how to analyze data. Figure 1 shows the type of fluids for the corrosion experiments. The apparatus for the corrosion tester can be seen in Figure 2.

Figure 3 illustrates the flow procedure students must follow when undertaking experimental activity. Figure 4 depicts the gathered results of corrosion plates before and after primary and secondary actual testing using potassium chloride (KCl) as an example.

Figure 1. Types of fluids for the experiments

Operational Specification:

Maximum Pressure: 5,000 PSI (34.5 MPa)

Maximum Temperature: 400°F (200°C)

Temperature Accuracy: ±0.5°C

Capacity: 4 sample bottles of 150 mL each

Agitator Speed Range: 0 - 100 RPM

Figure 2. OFITE HTHP corrosion tester

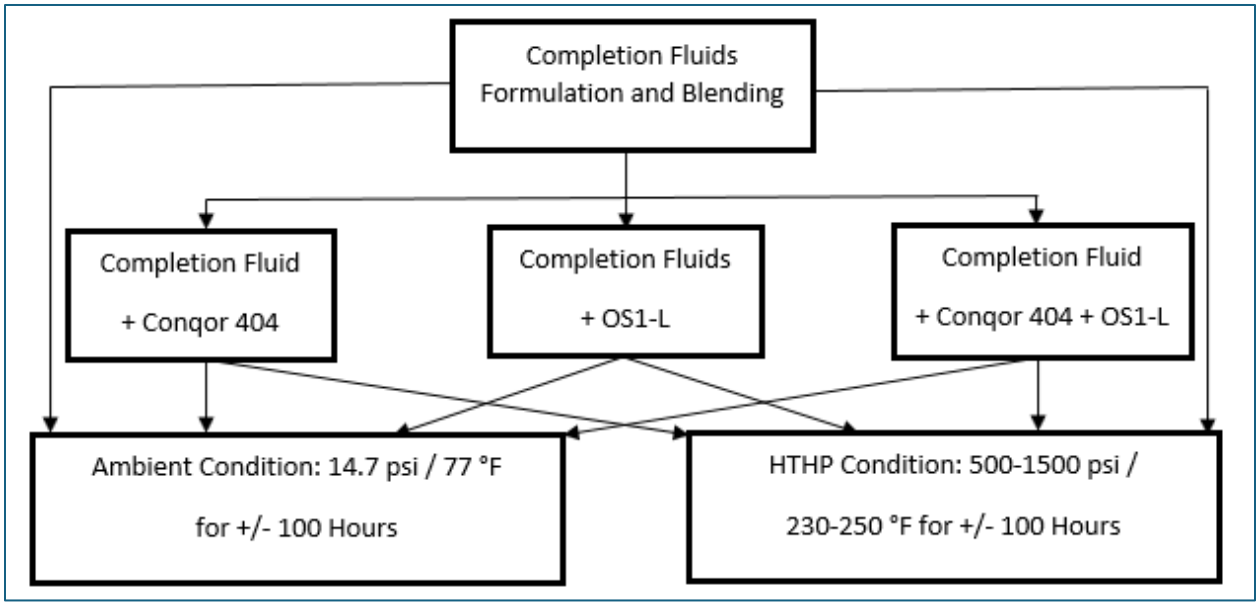

Figure 3. Flow process of the corrosion ring test

a. Before b. After

Figure 4. Corrosion plates in potassium chloride (KCl)

Results and Discussions:

During the transition of the rubrics applied, the grades of random students from two courses (PETE 225 and PETE 325) have been tracked to evaluate the effect of implementing a new set of guidelines. Table 4 displays the lab report scores for 10 experiments and the improvement over the years between 2019 and 2024. In addition, the grades of one student from the year 2017, which was before the start of the implementation of the new rubrics, are listed to set the base of the comparison. The average of the 10 experiments and the percentage increase over the years between 2019 and 2024 for the same students (A, B, C, and D) are used for comparison as shown in Table 5.

Table 4. Lab Report Scores Tracking

Participant	Year	Code	Lab Report #										Average
			1	2	3	4	5	6	7	8	9	10	
Student X	2017	325	85	88	84	85	85	81	86	93	93	92	87.2
Student A	2019	225	73	84	89	89	85	85	96	96	96	96	88.9
Student B	2020	225	84	85	85	85	86	86	86	86	91	91	86.5
Student C	2021	225	81	85	90	90	95	95	94	94	89	89	90.2
Student D	2022	225	78	86	90	90	90	90	91	91	88	88	88.2
Student A	2021	325	100	87	87	92	92	90	94	94	100	100	93.6
Student B	2022	325	100	90	90	90	90	97	90	90	86	86	90.9
Student C	2023	325	95	93	93	100	100	100	97	97	100	100	97.5
Student D	2024	325	97	85	85	85	90	90	97	97	100	100	92.6

Table 5. Determining the percentage increase over the period relative to the course taken.

Participant	Year	Code	Grades	
			Average	% Increase
Student X	2017	325	87.2	-
Student A	2019	225	88.9	5.02
	2021	325	93.6	
Student B	2020	225	86.5	4.84
	2022	325	90.9	
Student C	2021	225	90.2	7.49
	2023	325	97.5	
Student D	2022	225	88.2	4.75
	2024	325	92.6	

It is evident that between 2021 and 2023, during which significant, precise, and scientific changes were made to the rubric, the most significant variation and percentage increase, recorded at 7.49%, occurred with Student C. The results highlight the ability of students already engaged in technical writing to adapt effectively and demonstrate a high level of sophistication. However, the figures between 2019-2022 and 2022-2024 show a constant increase due to the user's

awareness of the base requirements of the technical report. Figure 5 depicts overall progress relative to the rubrics grading for different subjects. The results show how well students who are previously involved in technical writing do not only adjust to different writing tasks but also improve their analytical and communicating abilities. Their mastery helps them to logically organize their arguments, clearly present difficult ideas, and smoothly include data interpretation into their reports.

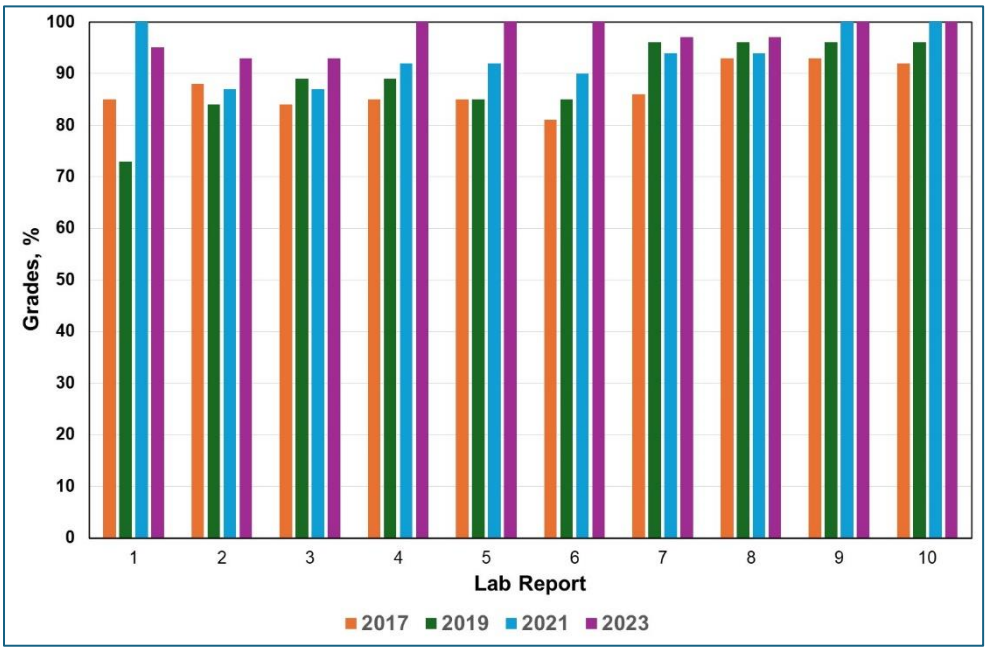

Figure 5. Overall progress is relative to rubrics grading for different subjects at different periods

Students' overall progress concerning grading rubrics across subjects and periods demonstrates how their abilities and knowledge evolve in response to changes in curriculum, instructional methods, and assessment criteria. This is a useful statistic for understanding student development across many courses and time spans. Instructors can gain insights into the success of their teaching approaches, identify areas where students require extra support, and ensure that grading criteria fit with desired learning outcomes by tracking changes in rubric expectations and analyzing how students' performances evolve.

Conclusion

The use of rubrics to help students prepare technical reports has produced favorable results. The organized rubric helped students adapt to the practice of generating reports independently. Students reported that the rubric clarified the requirements for technical reporting and helped them understand how to format their work. More precise instructions were suggested to improve the rubric's usefulness and usability, specifically about what should be included in specific parts. The rubric will be revised and evaluated in future semesters to ensure it remains an effective student learning and development tool.

The results also show that students with prior experience in technical writing do not just adapt easily to different writing tasks—they also sharpen their ability to think critically and communicate more effectively. Having a standard report format at the program level makes it easier for students to keep track of their work and make changes as they study. By following the same structure every time, they get better at organizing their thoughts, making facts easy to understand, and writing technically over time. This consistency lets them work on improving their analysis and communication instead of figuring out how to format their work correctly. Therefore, as students' progress through their education, they become better writers who are confident in their abilities.

References

1. L. D. Feisel and A. J. Rosa, "The Role of the Laboratory in Undergraduate Engineering Education", *Journal of Engineering Education*, Vol. 94, No. 1, 2005.
2. Criteria-for-accrediting-engineering-programs-2024-2025, ABET Engineering Accreditation Commission, https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/
3. N. Reid and I. Shah, "The Role of Laboratory Work in University Chemistry," *Chemistry Education Research and Practice*, Vol. 8, No. 2, 2007.
4. J. R. Brown, S. G. Wettstein, D. J. Hacker, "Rubric Development for Technical Reports in Chemical Engineering Unit Operations Laboratory Courses," *2023 ASEE Annual Conference & Exposition*, Baltimore, Maryland, June 2023.
5. C. Wallwey, T. Milburn, and B. Morin, "Scaffolding Technical Writing Within a First-Year Engineering Lab Experience," *2021 ASEE Virtual Annual Conference*, Virtual Conference, 10.18260/1-2—37696, July 2021.
6. N. Gnanapragasam, "Client-Focused Technical Writing through Laboratory Report Preparations in Geotechnical Engineering: A Case Study," *2023 ASEE Annual Conference & Exposition*, Baltimore, Maryland, 10.18260/1-2—43207, June 2023.
7. A. Retnanto, N. Alyafei, M. Fadlelmula, and A. Sheharyar, "The Impact of Practical Experiences on the Development of Petroleum Engineering Education," *SPE Annual Technical Conference and Exhibition, Society of Petroleum Engineers*, Virtual, October 26-29, 2020.
8. L. C. Rosenthal, "Writing Across the Curriculum: Chemistry Lab Reports," *J. Chem. Ed*, Vol. 64, No. 12, 1987.
9. I. Gravé, "Improving Technical Writing Skills Through Lab Reports," *2019 ASEE Annual Conference & Exposition*, Tampa, Florida. 10.18260/1-2—32951, June 2019.
10. L. Corneal, "A Guided Approach to Technical Report Writing for Undergraduate Engineering Students," *2015 ASEE Annual Conference & Exposition*, Seattle, Washington, June 2015.
11. C. Hubka, E. Chi, Y. Chen, V. Svihla, J. Gomez, A. Datye, and T. Mallette, "A Writing in the Disciplines Approach to Technical Report Writing in Chemical Engineering Laboratory Courses," *2024 ASEE Annual Conference & Exposition*, Tampa, Florida 10.18260/1-2—32019, June 2019.
12. R. Jamshidi, K, Wright, P. Slaboch, "Enhancement of Students' Technical Writing through a Combination of Classroom Activities," *2020 ASEE Virtual Annual Conference,* June 2020.

13. B. M. Smyser and S. Tariq, "After Lab Ends: How Students Analyze and Interpret Experimental Data," *2016 ASEE Annual Conference & Exposition*, New Orleans, Louisiana, June 2016.
14. M. Kiniry and E. Stranski, "Sequencing Expository Writing: A Recursive Approach," *College Composition and Communication*, Vol. 36, No. 2, 1985
15. M. Fadlelmula, & N. Alyafei, and A. Retnanto, "Enhancing Petroleum-Engineering Education through Active Student Engagement, Hands-On Experience, and Technology Integration," *2024 ASEE Annual Conference & Exposition*, Portland, Oregon, 10.18260/1-2—47313, June 2024.
16. A. Retnanto, N. Alyafei, M. Fadlelmula, and S. H. Khan, "Utilizing Virtual Reality to Fortify Professional Skills in Engineering Education," *2023 ASEE Annual Conference & Exposition*, Baltimore, Maryland. 10.18260/1-2—44596, June 2023.
17. D. Kim and F. Howes, "Areas of Improvement and Difficulty with Lab Report Writing in the Lower-Division Engineering Laboratory Courses across Three Universities," *2023 ASEE Annual Conference & Exposition*, Baltimore, Maryland. 10.18260/1-2—38622, June 2023.