Using Generative AI for a Graduate Level Capstone Course Design—a Case Study

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Abstract

This WIP paper aims at exploring the pros and cons of using the newly released, advanced generative artificial intelligence (AI) tool, ChatGPT, to design the curriculum for a Capstone course, which is completed towards the end of the Master of Engineering Technical Management (METM), a 21-month online graduate program for working professionals in the engineering technical management fields [1].

Although generative AI technology has been around for over a decade, one could even trace relevant research back to the 1960s [2], it was the release of ChatGPT, an AI-powered language model developed by OpenAI, that brought this innovative technology into the limelight and allowed general population to access it, disrupting not only the technology sector (e.g., IT), but more recently, the academic world in terms of content generation from both the students and faculty perspectives.

This WIP paper will not dive deep into the technicality of generative AI technology- that is out of the scope of this study; but instead, it will focus on the experimental application of ChatGPT in the academic setting, to be more specific, its aid in instructional and course design.

The METM program curriculum offers courses that focus on Project Management, Strategic Planning and Management, Financial Resource Management, etc., that are included in the Engineering Management Body of Knowledge (EMBOK)[3]. At the conclusion of the METM program, students must research, design, and showcase a real-world project that requires comprehensive application of the knowledge they have learned throughout the program, in order to bring significant impact to the stakeholders of their chosen organizations.

The Capstone course spans over two semesters, Fall (Capstone I) and Spring (Capstone II); it was first offered in 2019, and in 2023, the fifth student cohort started their Capstone project. The program has been continuously evaluating and improving its courses based on stakeholder feedback, industry demands, while upholding its academic rigor. Until today, Capstone has been through three iterations of revamps: Capstone 1.0 restructured the original, Capstone 2.0 rebalanced industry-academic focus [4], and Capstone 3.0 was an instructional redesign of learning modules, which were all done through human input (subject matter expert and learners). As the course matures, fine tuning the assessments (project deliverables) has become the focus of improvement.

This WIP paper will use a case study approach to find insights in using ChatGPT to design the Capstone course. Starting from the creating the grading rubrics for one course deliverable, Project Charter, given grounding parameters to the prompt (course level, learner characteristics, generic grading categories, etc.); then, dissecting the thought process of each sub criterion to develop details of the rubric; then, asking ChatGPT to create study plan (topics, resources, activities) to achieve the high marks of the grading criteria; note that for each step, human input from Capstone faculty and instructional designer will be fed into ChatGPT to refine

the prompts until a better result is generated before proceeding to the next step. Then, repeat the process for other course deliverables.

This study will keep the log of the process (prompts, refinements) mentioned above and take notes of the pros and cons of ChatGPT's application in the course design tasks, and discuss the limitations of this approach. The result of this study will potentially lay a clearer path for other courses that would like to give this innovative technology a try for course development/improvement. For future study, we would also like to apply similar techniques to the development of new courses within the METM program.

Keywords: ***Generative AI, Instructional Design, Capstone project, Engineering Research.***

Background

The Master of Engineering Technical Management (METM) is an online graduate program geared towards working professionals in the engineering technical management fields. Students complete four semesters (21 months) of lock-step course work that totals up to 30 credit hours, while having the flexibility of balancing work and life responsibilities. In the first two semesters, students take courses that help them to understand and lead themselves better, and learn skills such as project management, data-driven decision making, financial decision making, as well as practical tools that help them manage technical teams at the workplace. As they progress in the program, they will learn to transition into a leadership mindset that looks at the entire organization as the big picture to prepare their next promotion to a senior manager or executive position. During the last two semesters, students will take Capstone Project I & Capstone Project II, two sequential courses in which students are expected to apply what they have learned throughout the METM program to resolve an issue or discover a new process/technology that could bring tangible impact to their organizations. Students must propose the value of their projects, gain buy-ins from their stakeholders, request resources (funds, time, manpower, etc.), create a well-rounded project plan and keep their stakeholders updated through the project proposal, plan, manage, and execution process. See Appendix A for deliverables of Capstone I.

This course has been proven to be one of the most rewarding experiences of the METM program, because of its comprehensiveness, complexity, and value-generating nature. And the Capstone faculty and program leadership team have been continuously improving the course in terms of structure, teaching materials, etc. since it's first offered in 2018.

Chat Generative Pre-trained Transformer (ChatGPT) is an Artificial Intelligent (AI) language model developed by OpenAI. Since 2018, it has gone through four iterations of development, from GPT-1 to GPT4 [5]. When the authors asked how ChatGPT defined itself, it added, "It is designed to generate human-like text based on the input it receives, specifically built to understand and produce text that can mimic human writing styles across various genres and topics" [6]. ChatGPT (GPT-3) made its public debut in late 2022, it did not immediately strike the academic world as applicable but was more seen as a "chatbot" in customer service industries or a content-generation tool for writers when it took over the social media back then [7]. OpenAI announced in 2023 that ChatGPT (GPT-4) could directly search the internet, breaking its previous versions' limitation of only access to data before September 2021 [8].

Theoretical Framework

ChatGPT has quickly grown to impact other industries such as business, entertainment, healthcare, as well as the educational field. A few rounds of literature review show that this technology raises a series of research questions such as educators and students' awareness, attitude, level of trust towards using such tools to complete school assignments (creative writing, coding, etc.) [9][10] [11]; other studies surveyed the concerns regarding ethics, academic integrity, equity of accessibility, new opportunities such tools present [12][13], as well as policies and guidelines provided by universities [14]. While the majority of research focus is given to students' use and how to address the associated risks and concerns, relatively less focus is shed on its use for instructional design purposes [15] [16]. The authors are curious about the other side of the story: Can it assist us educators as a "subject matter expert", with its access to and "comprehension" of a vast library of knowledge? And how can we leverage its evolving power in curriculum and course design? This paper attempts to answer these research questions and fill in the gap in the current literature on teaching use cases of generative AI tools, more specifically, ChatGPT. The continuous improvement cycle of the courses in the METM program provides an ideal sandbox, and the Capstone Project course is chosen as the participant for this investigation.

Methodology

Creswell defines case study as "...a qualitative design in which the researcher explores in depth a program, event, activity, process, or one or more individuals." [17] The case study strategy has been widely used in research fields such as economics, political science, psychology, and education [18]. This paper uses a case study approach, the unit of analysis is the capability of this innovative tool, and the intended result is to explore and report the process and fitness of using generative AI (ChatGPT) for a graduate level Capstone course design. The uniqueness of the research question justifies the use of a single case to explore this instance[19] .

The rule of thumb in the instructional design world is called "backward design", in which the instructor or designer starts from the learning objectives of the course, and builds lectures, activities, and assessments in alignment with these objectives [20] [21]. Grounded by this principle, this study builds upon the objective of achieving outstanding scores for an assignment by dissecting the requirements of the course and expectations from the instructor, and strategizing effective and appropriate learning plans in order to achieve these expectations. The authors/researchers, a Capstone faculty and an instructional designer, use one course deliverable as the "guinea pig" to go through the steps described below. This process involves writing a prompt in ChatGPT (4.0), generating a response, reviewing and validating response (human input), making modifications to the original prompts to regenerate response if needed, the goal is to design usable grading rubrics, learning objectives, learning activities, research learning resources, etc.; data, including prompts, ChatGPT responses, human input, are reported in this paper. Details of the process are discussed in the Results & Discussion section, and the complete ChatGPT outputs are included in the Appendices.

Basic Steps

The steps are summarized in Figure 1 below:

- Step 1. Create a grading rubric for one course deliverable given grounding parameters to the prompt (course level, learner characteristics, generic grading categories, etc.).
- Step 2. Dissect the thought process of each sub-criterion to develop details of the rubric.
- Step 3. Create a feasible study plan for students in order for them to exceed expectations for the deliverable.
- Step 4. Repeat the above process for other course deliverables.

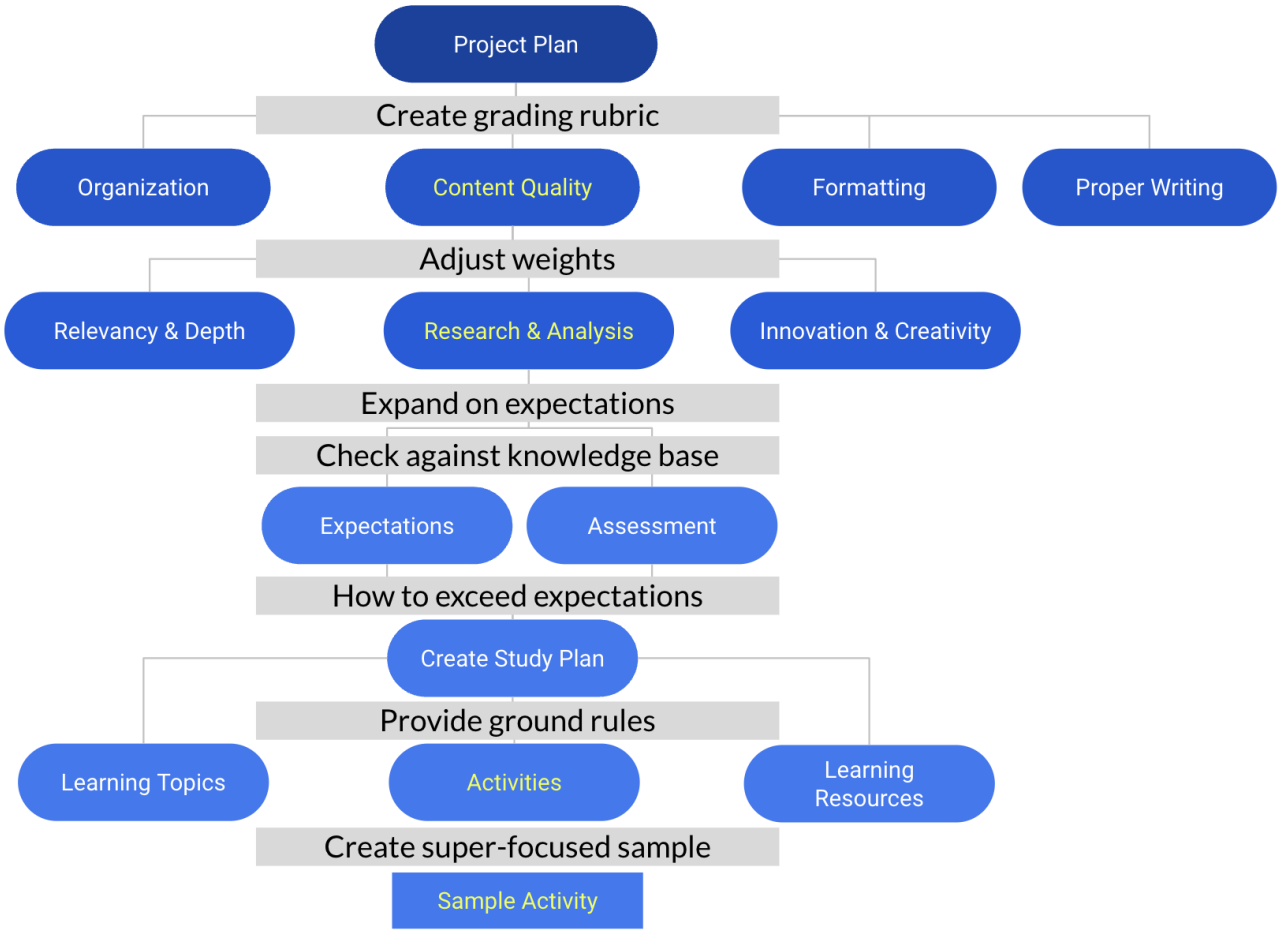

Figure 1. Basic steps of this research.

Results & Discussions

Step 1. Create a grading rubric for one course deliverable given grounding parameters to the prompt.

Prompt 1.1: Basic requirements

"Create a 100-point grading rubric for a written assignment, "Project Charter", that focus on the following four major criteria: organization, content quality, proper writing, formatting. The assignment is completed by working professionals in the engineering and technical sectors for a graduate-level Capstone Project course."

Result 1.1: [See Appendix 1.1 for complete ChatGPT response]

ChatGPT created a grading rubric as prompted, with "Scoring Guide" specifying the percentage of each category, for example, "Exceptional work; exceeds expectations in all areas" will earn 90% of the marks, while "Needs improvement; does not meet the required standards in several areas" earns below 60 Points. However, the weights of the four major criteria were not satisfactory; too much weight was given to Formatting while not enough on Content Quality: Organization (25 Points); Content Quality (30 Points); Proper Writing (20 Points); Formatting (25 Points).

Prompt 1.2: instructor modification

"Could you modify the weights on the four major criteria and regenerate the response? For a graduate level course, you are giving too much weight Formatting and Organization, not enough on Content Quality."

Result 1.2: [See Appendix 1.2 for complete ChatGPT response]

The modified response redistributed the 100 points: Content Quality (40 Points), Organization (20 Points); ; Proper Writing (25 Points); Formatting (15 Points), while keeping other components the same.

Implication of Step 1:

Instructors need to specify rubric's weights as they see fit instead of leaving them at ChatGPT's discretion.

Step 2. Dissect the thought process of each sub-criterion to develop details of the rubric.

In Result 1.2, under the Content Quality criterion, there are the following sub-categories:

- Relevance and Depth (20 Points):** Content must be directly relevant to the **project goals**, demonstrating a deep understanding of the **project's significance, objectives, and the problem it aims to solve**.
- Research and Analysis (15 Points):** Exhibits thorough research and analysis, including **stakeholder analysis, risk assessment, and feasibility studies**.
- Innovation and Creativity (5 Points):** Presents **original approaches, methods, or implementation, with creative solutions** to potential problems clearly outlined and justified.

Because the Capstone Project is a project-based, research-grounded course, Step 2 focused on asking for detailed expectations of these categories while specifying their weights based on the nature of the course. The following prompt was given regarding *Content Quality* (40 Points):

Prompt 2.1: Expansion with clear attributions.

"Please expand on the expectations for *Content Quality* criterion, while adjusting the weights to: Relevance and Depth (5 Points), Research and Analysis (30 Points), Innovation and Creativity (5 Points)."

Result 2.1: [See Appendix 2.1 for complete ChatGPT response]

ChatGPT responded, "**Expectations**: This aspect now carries the most weight, highlighting the graduate-level expectation for rigorous, in-depth research and analytical work. Students are expected to conduct comprehensive **literature reviews, data analysis, stakeholder analysis, risk assessments, and feasibility studies**." It also summarized the "**Assessments**: The evaluation will focus on … The quality, relevance, and integration of research sources will also be assessed, along with the student's ability to identify and evaluate risks, constraints, and assumptions in the project planning and execution phases."

After reviewing this response, it seemed to the instructor that ChatGPT understood the rigor of this course, as mentioned Prompt 1.1, . However, were the elements to be evaluated in the Project Plan deliverable sufficiently comprehensive? To answer this question, another modification was made to the response.

Prompt 2.2. Reality check and modify.

"Check this answer against the Engineering Management Body of Knowledge (EMBOK) and tell me if the "Expectations" section of the "Research and Analysis" section contains all required elements in the perspective of a project manager, if not, modify the response above."

Result 2.2 [See Appendix 2.2 for complete ChatGPT response]

The **Revised Expectations** for *Research and Analysis* (30 Points) contained these elements, which were more grounded within the EMBOK spectrum. No further modifications were done to this prompt.

- Comprehensive Project Planning and Execution Analysis.
- Stakeholder Engagement and Communication Strategies.
- Risk Management and Mitigation Strategies.
- Cost-Benefit Analysis and Financial Feasibility.
- Quality Assurance and Control Measures.
- Sustainability and Environmental Impact Consideration.

Implications of Step 2:

Instructors need to validate the output of ChatGPT against expert knowledge.

Step 3. Create a feasible study plan based on expectations for the deliverables.

Prompt 3.1. Basic requirement.

"What should our students learn in order to write the above-mentioned '*Stakeholder Engagement and Communication Strategies*' section? The goal is to exceed the expectations of the instructor. List learning topics, learning resources, activities."

Result 3.1. [See Appendix 3.1 for complete ChatGPT response]

ChatGPT gave an outline of the study plan as requested. The *Learning Topics* are provided in bullet points of learning objectives and techniques to master in regards to stakeholder

identification, engagement, communications, etc., which was a good list to start with. Under *Learning Resources- Textbooks and Academic Journals*, it recommended the book, "Project Management: The Managerial Process" by Erik Larson and Clifford Gray, which was very relevant after talking to a Project Management Expert, that he would choose this as the textbook for his course. Other items tended to be more on the generic side, such as *Case Studies*, it said, "Analyzing real-world project management case studies that focus on stakeholder engagement can provide practical insights and lessons learned.", which required more drilling down to reach the level of course design materials.

Under *Activities*, one item caught the eyes of the authors: "Role-Playing Scenarios: Participate in role-playing exercises to simulate stakeholder meetings and communication scenarios, focusing on negotiation, conflict resolution, and consensus-building." provide comprehensive insights into stakeholder management and communication strategies in projects. METM program does have a Persuasive Communication course [22] that goes hand-in-hand with the Capstone I course, that aims at coaching students on their communication skills to stakeholders to persuade them in the desirable directions (gain buy-ins, get approved for resources, etc.). With this background in mind, the drill down prompt was interested in developing feasible, specific activities to facilitate learning.

Prompt 3.2. Drilling down the details.

"Could you design a few learning activities for the above mentioned "Role-Playing Scenarios: Participate in role-playing exercises to simulate stakeholder meetings and communication scenarios, focusing on negotiation, conflict resolution, and consensus-building."? Please be mindful to design the activities for students who are working professionals in the engineering and technical industry, and each activity should take no longer than 30 minutes to complete. There should be a mix of online and in-person activities to allow flexibility. "

Result 3.2 [See Appendix 3.2 for complete ChatGPT response]

ChatGPT listed four activities, along with their delivery formats, objectives, procedures, and time allowance. We could have stopped at this step, but the authors would like to get inspiration on how to develop this instrument, thus the following prompt was fed into ChatGPT.

Prompt 3.3 More restrictions apply.

"Develop a detailed script for the role-play in "Activity 1: Virtual Stakeholder Negotiation Simulation" mentioned above, keep in mind that the role-play must be based on a real-life workplace scenario, and it requires critical thinking, good communication skills, as well as emotional intelligence in order to reach a win-win solution. Participants of this role-play should be able to act out this script within 15 minutes. "

Result 3.3 [See Appendix 3.3 for complete ChatGPT response]

ChatGPT did a good job laying out one sample role-play scenario, which included two participants, a Project Manager and a Senior Company Executive of an engineering company, working on a high visibility renewable energy project. The Project Manager needed to request additional resources from the cost-driven Executive; a negotiation must take place to ensure successful project delivery before the deadline. The preparation and script for this scenario did

include considerations of various project management elements, such as project details, resources, financial status, priorities, and opportunity cost, etc., which makes it a relevant activity to facilitate learning the Project Plan topic and an applicable tool to use in real life.

Implications of Step 3:

The sky's the limit here. The quality and alignment of the course design lies in the hands of the instructor- the more well-written of the prompts, the more relevant and effective the course resources, activities are to serve the learning objectives.

Step 4. Repeat the above process for other course deliverables.

In the steps above, the authors developed grading rubric for one of the many deliverables of Capstone I course. By repeating these steps for other deliverables, a set of materials could be developed for the entire course.

Conclusions

Based on the above results and discussions, ChatGPT, one of the many forms of the generative AI that excels in conversational interactions, appears to be a good assistant in the Capstone Project course design process, in terms of developing specific grading rubric, establishing relevant requirements and expectations from the subject matter expert's perspective, proposing appropriate study plan, and designing student activities to achieve key learning outcomes. However, this iterative process cautions on adopting all the content generated by ChatGPT- implications obtained from this study demonstrated that human input is crucial to identifying knowledge gaps, missing elements, and creating consistency and alignment within the course. This tool shall be used as a source of ideas, and adopters shall take into consideration of ethical and legal (e.g. copyrights) concerns as well as the integrity of research; it is essential to validate AI's answers, credit the resources, and involve other subject matter experts in the review, design, and evaluation process.

There are many potential paths for future research, one of them is to continue investigating the Capstone course elements in detail, such as customized design for an activity (e.g. Business Case Presentation), or for other assignments (e.g. Decision Making Report), and explore its capability of designing a complete course; then, use this AI-designed course as a prototype to develop other courses in the METM program. From trial and error, this research can produce effective prompt templates to share with various stakeholders involved in course/curriculum design. Looking ahead, the authors see the formation of a learning community that shares reusable prompts library and best practices of use cases and design experience, thus, gradually and gracefully embracing generative AI applications into the educational field for both learners and instructors across all disciplines.

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Appendices

Appendix A. Capstone I (TCMT 631) Deliverable Schedule

Description	Points
Project Proposal	50
Literature Review for Business Case Development	100
Submit PowerPoint slides for Business Case Presentation to Communication professor.	n/a
Business Case Presentation (Capstone & Communication faculty and industry sponsor)	100
Project Charter *Should be signed by your industry sponsor as commitment of resources toward your project and authorization of work.	100
Methodology	150
Submit PowerPoint slides for Project Plan to Communication professor	n/a
Project Plan Presentation (Capstone & Communication faculty and industry sponsor)	100
Project Plan	200
Midterm Reflection	50
TOTAL TCMT631. Capstone I	850

Appendix 1.1.

Creating a comprehensive 100-point grading rubric for a "Project Charter" assignment in a graduate-level Capstone Project course, especially designed for working professionals in the engineering and technical sectors, requires a detailed consideration of the specific criteria mentioned. Below, the rubric is divided into the four major criteria: Organization, Content Quality, Proper Writing, and Formatting, with each criterion allocated a certain number of points based on its significance and complexity.

Organization (25 Points)

- **Clarity and Logical Flow (10 Points):** The document should have a clear, logical flow from introduction to conclusion, making it easy for the reader to follow the project's goals and methodologies.
- **Structure and Coherence (10 Points):** The assignment should be well-structured with clearly defined sections (e.g., Executive Summary, Objectives, Scope, Background), each contributing to the overall coherence of the charter.
- **Integration of Elements (5 Points):** All parts of the charter should be integrated effectively, with each section smoothly transitioning to the next, showing how they contribute to the project’s objectives.

Content Quality (30 Points)

- **Relevance and Depth (15 Points):** The content should be directly relevant to the project goals, showing a deep understanding of the project’s significance, objectives, and the problem it aims to solve.

- **Research and Analysis (10 Points):** Demonstrates thorough research and analysis of the project topic, including stakeholder analysis, risk assessment, and feasibility studies.
- **Innovation and Creativity (5 Points):** Shows originality in approach, methods, or implementation. Creative solutions to potential problems are clearly outlined and justified.

Proper Writing (20 Points)

- **Grammar and Punctuation (10 Points):** The assignment should be free from grammatical errors and punctuation mistakes, demonstrating professional writing ability.
- **Clarity and Precision (10 Points):** The language used should be clear and precise, with technical terms appropriately explained or defined to ensure understanding by both technical and non-technical readers.

Formatting (25 Points)

- **Adherence to Guidelines (10 Points):** The document strictly adheres to the formatting guidelines provided, including font size, margins, and spacing.
- **Use of Visuals and Appendices (10 Points):** Effective use of visuals (charts, graphs, tables) that are properly labeled and referenced in the text. Appendices are used appropriately for supplementary information.
- **Citations and References (5 Points):** All sources of information, data, or graphics are accurately cited in the text and properly formatted in the reference list.

Scoring Guide

- **91-100 Points:** Exceptional work; exceeds expectations in all areas.
- **81-90 Points:** Strong work; meets and occasionally exceeds expectations.
- **71-80 Points:** Good work; meets expectations but with minor issues in some areas.
- **61-70 Points:** Satisfactory; meets minimum expectations with noticeable areas for improvement.
- **Below 60 Points:** Needs improvement; does not meet the required standards in several areas.

This rubric ensures a balanced evaluation of the essential aspects of a project charter, catering to the specific needs and expectations of working professionals in the engineering and technical sectors. It emphasizes not just the technical and content quality, but also the importance of clear communication and professional presentation.

Appendix 1.2.

Adjusting the weights to emphasize Content Quality over Organization and Formatting for a "Project Charter" assignment in a graduate-level Capstone Project course for working professionals in the engineering and technical sectors, we'll redistribute the points to better reflect the importance of each criterion.

Content Quality (40 Points)

- **Relevance and Depth (20 Points):** Content must be directly relevant to the project goals, demonstrating a deep understanding of the project's significance, objectives, and the problem it aims to solve.
- **Research and Analysis (15 Points):** Exhibits thorough research and analysis, including stakeholder analysis, risk assessment, and feasibility studies.
- **Innovation and Creativity (5 Points):** Presents original approaches, methods, or implementation, with creative solutions to potential problems clearly outlined and justified.

Organization (20 Points)

- **Clarity and Logical Flow (8 Points):** The document should exhibit a clear, logical flow, making it easy to follow the project's goals and methodologies.
- **Structure and Coherence (7 Points):** Well-structured with defined sections (e.g., Executive Summary, Objectives, Scope), contributing to the overall coherence.
- **Integration of Elements (5 Points):** Effective integration of all parts, with smooth transitions and clear contribution to the project's objectives.

Proper Writing (25 Points)

- **Grammar and Punctuation (12 Points):** Free from grammatical errors and punctuation mistakes, demonstrating professional writing ability.
- **Clarity and Precision (13 Points):** Uses clear and precise language, with technical terms appropriately explained or defined for all readers.

Formatting (15 Points)

- **Adherence to Guidelines (5 Points):** Strict adherence to the provided formatting guidelines, including font size, margins, and spacing.
- **Use of Visuals and Appendices (7 Points):** Effective use of visuals that are properly labeled and referenced. Appendices are used appropriately for supplementary information.
- **Citations and References (3 Points):** Accurate citations and properly formatted references for all sources of information, data, or graphics.

Scoring Guide

- **91-100 Points:** Exceptional; exceeds all expectations with superior depth, analysis, and presentation.
- **81-90 Points:** Strong; meets and occasionally exceeds expectations with minor areas for improvement.
- **71-80 Points:** Good; meets most expectations with some areas lacking depth or clarity.
- **61-70 Points:** Satisfactory; meets the basic requirements but has several areas for improvement.
- **Below 60 Points:** Needs significant improvement; does not meet the standards in multiple key areas.

This revised rubric places greater emphasis on the substantive content and analytical depth expected in graduate-level work, while still acknowledging the importance of writing quality and professional presentation standards.

Appendix 2.1.

Adjusting the weights within the "Content Quality" criterion for a "Project Charter" in a graduate-level Capstone Project course, especially for working professionals in engineering and technical sectors, reflects a significant emphasis on "Research and Analysis." This adjustment indicates a prioritization of the ability to conduct deep, comprehensive research and critical analysis over other aspects. Here's an expanded view of the expectations for each sub-criterion under "Content Quality," aligning with the new weights.

Content Quality (40 Points Total)

1. Relevance and Depth (5 Points)

- **Expectations:** The project charter must clearly identify and articulate the problem it intends to address, ensuring that the project's goals are directly aligned with solving this problem or addressing a specific need within the engineering or technical field. The relevance of the

project to current challenges in the sector must be evident, but given the lower weight, this criterion focuses on the presence of this alignment rather than its exhaustive exploration.

- **Assessment:** Evaluators will look for a concise yet effective presentation of the project's significance, ensuring that the proposed project is meaningful and has a clear objective that matches industry needs or advances academic understanding in the specific area.

2. Research and Analysis (30 Points)

- **Expectations:** This aspect now carries the most weight, highlighting the graduate-level expectation for rigorous, in-depth research and analytical work. Students are expected to conduct comprehensive literature reviews, data analysis, stakeholder analysis, risk assessments, and feasibility studies. The analysis should not only be thorough but also critical, evaluating different perspectives, potential impacts, and the sustainability of proposed solutions. The ability to synthesize complex information and present it in a coherent, logical manner is key.

- **Assessment:** The evaluation will focus on the breadth and depth of the research conducted, the application of appropriate methodologies, the critical perspective on the findings, and the ability to draw relevant, actionable conclusions from the analysis. The quality, relevance, and integration of research sources will also be assessed, along with the student's ability to identify and evaluate risks, constraints, and assumptions in the project planning and execution phases.

3. Innovation and Creativity (5 Points)

- **Expectations:** Despite the lower weight, innovation and creativity remain crucial, reflecting the need for novel solutions and approaches in tackling the project's challenges. This criterion assesses the student's ability to think beyond conventional solutions, proposing new methods, technologies, or strategies that offer potential improvements over existing solutions. Creativity in problem-solving, methodology, and the application of technology is emphasized, particularly in how these innovative ideas can realistically be implemented within the project's scope.

- **Assessment:** Evaluators will look for originality in the proposed solutions or approaches and how these ideas contribute to the project's goals in a practical, feasible manner. The emphasis will be on innovation that is not just theoretically interesting but also viable and beneficial in the project's context.

Conclusion

With the adjusted weights, the "Content Quality" criterion now significantly emphasizes the importance of "Research and Analysis" in developing a project charter, reflecting the expectations for graduate-level work in engineering and technical fields to be underpinned by solid research and critical thinking. This shift acknowledges the central role that detailed analytical work plays in informing effective, innovative solutions to complex problems, while still recognizing the importance of relevance and creative thinking in the formulation of a project charter.

Appendix 2.2

The Engineering Management Body of Knowledge (EMBOK) provides a comprehensive framework that outlines the key knowledge areas essential for effective engineering management. This framework includes aspects of project management, technical management, leadership, and strategic planning, among others. When aligning the "Expectations" section of the "Research and Analysis" criterion with the EMBOK perspective, especially for a project manager role, it's important to ensure that it encompasses not just the technical and analytical

aspects of research but also elements that are crucial for project planning, execution, and management.

The original "Expectations" section focused on comprehensive literature reviews, data analysis, stakeholder analysis, risk assessments, and feasibility studies. These are indeed critical for in-depth research and analysis. However, from a project management perspective as guided by the EMBOK, additional elements should also be considered:

Revised Expectations for Research and Analysis (30 Points)

- **Comprehensive Project Planning and Execution Analysis:** Beyond traditional research, this includes the application of project management principles, methodologies, and tools to plan, execute, and monitor the project. It involves setting clear objectives, defining work breakdown structures, and establishing project timelines.

- **Stakeholder Engagement and Communication Strategies:** An in-depth analysis should also cover strategies for engaging with stakeholders, including identifying stakeholder needs, expectations, and potential impacts on the project. Effective communication plans that address how to keep stakeholders informed and involved throughout the project lifecycle are essential.

- **Risk Management and Mitigation Strategies:** While risk assessment is mentioned, it's vital to also include the development of comprehensive risk management plans that detail risk mitigation, avoidance, transfer, and acceptance strategies. This involves not only identifying potential risks but also prioritizing them based on their impact and likelihood.

- **Cost-Benefit Analysis and Financial Feasibility:** Projects require a thorough financial analysis to ensure viability. This includes conducting cost-benefit analyses, estimating project costs, and identifying funding sources and financial risks. It ensures that the project delivers value and is financially feasible.

- **Quality Assurance and Control Measures:** The analysis should incorporate quality management strategies, including the development of quality metrics, standards, and control measures to ensure the project's outputs meet the required standards and stakeholder expectations.

- **Sustainability and Environmental Impact Consideration:** Especially relevant in engineering and technical projects, this involves assessing the project's environmental impact and ensuring that solutions are sustainable and adhere to relevant environmental regulations and best practices.

Conclusion

Adjusting the expectations for the "Research and Analysis" section to include these elements ensures alignment with the EMBOK framework, particularly from a project management perspective. It recognizes the importance of integrating project management principles with technical research and analysis, highlighting the multifaceted role of project managers in ensuring project success not only through in-depth technical analysis but also through effective planning, stakeholder engagement, risk management, financial analysis, quality assurance, and sustainability considerations. This comprehensive approach is crucial for preparing engineering and technical professionals for the complexities of managing capstone projects and future real-world engineering projects.

Appendix 3.1

To excel in writing the "Stakeholder Engagement and Communication Strategies" section of a project charter, students must grasp a range of topics that cover the principles of stakeholder

analysis, engagement techniques, and effective communication strategies. This knowledge will not only help them meet but exceed the expectations of instructors by demonstrating a comprehensive understanding and application of these concepts in their project charters. Here's a structured approach to learning these essential skills:

Learning Topics

1. **Stakeholder Identification and Analysis**
   - Understanding who stakeholders are (e.g., project team, customers, sponsors, community) and their potential impact on the project.
   - Techniques for identifying stakeholders' needs, interests, and influence.
2. **Stakeholder Engagement Strategies**
   - Developing engagement plans tailored to stakeholder needs and project goals.
   - Techniques for building and maintaining stakeholder relationships.
   - Managing stakeholder expectations and resolving conflicts.
3. **Effective Communication Skills**
   - Principles of clear, concise, and effective communication.
   - Developing a communication plan that addresses the frequency, methods, and content of communication for different stakeholder groups.
4. **Tools and Techniques for Stakeholder Engagement**
   - Utilizing tools such as stakeholder maps, power/interest grids, and engagement matrices.
   - Best practices for virtual and face-to-face engagement activities.
5. **Monitoring and Adjusting Stakeholder Engagement**
   - Techniques for gathering feedback from stakeholders.
   - Strategies for adapting engagement plans based on stakeholder feedback and project evolution.

Learning Resources

- **Textbooks and Academic Journals**: Books such as "Project Management: The Managerial Process" by Erik Larson and Clifford Gray provide comprehensive insights into stakeholder management and communication strategies in projects.
- **Online Courses**: Platforms like Coursera, edX, and LinkedIn Learning offer courses on project management, stakeholder engagement, and effective communication tailored to various levels of expertise.
- **Professional Organizations**: Resources and workshops provided by organizations such as the Project Management Institute (PMI) can offer both foundational knowledge and advanced techniques in stakeholder management.
- **Case Studies**: Analyzing real-world project management case studies that focus on stakeholder engagement can provide practical insights and lessons learned.

Activities

1. **Stakeholder Mapping Workshops**: Engage in workshops or simulations to practice identifying stakeholders and analyzing their influence and interest in a project.
2. **Role-Playing Scenarios**: Participate in role-playing exercises to simulate stakeholder meetings and communication scenarios, focusing on negotiation, conflict resolution, and consensus-building.
3. **Communication Plan Development**: Task students with creating comprehensive communication plans for hypothetical projects, detailing how they would communicate with different stakeholder groups.

4. **Peer Review Sessions**: Encourage students to review and critique each other's stakeholder engagement strategies and communication plans, fostering a collaborative learning environment and exposing them to diverse approaches and perspectives.

5. **Guest Speaker Sessions**: Invite experienced project managers to share their experiences, challenges, and best practices in stakeholder engagement and communication.

By covering these learning topics through a combination of theoretical study, practical application, and reflection on real-world examples, students can develop a deep understanding of stakeholder engagement and communication strategies. This comprehensive approach will equip them with the skills necessary to exceed instructor expectations and effectively manage stakeholder relationships in their capstone projects and future professional endeavors.

Appendix 3.2

Designing role-playing activities that cater to working professionals in the engineering and technical industry involves creating scenarios that are both relevant to their field and practical in terms of time commitment. Here are several role-playing exercises designed to enhance skills in negotiation, conflict resolution, and consensus-building. Each activity is structured to be completed within 30 minutes, offering a mix of online and in-person formats for flexibility.

Activity 1: Virtual Stakeholder Negotiation Simulation

Objective: Improve negotiation skills with a focus on project scope and resource allocation.

Format: Online, using video conferencing tools.

Procedure:

1. **Preparation (5 minutes):** Participants receive a brief scenario via email where they are project managers negotiating additional resources for a critical project phase with a company executive (played by another participant).

2. **Role-Playing (15 minutes):** In breakout rooms, participants engage in a negotiation, with one assuming the role of the project manager and the other the company executive. They must discuss project needs, limitations, and propose mutually beneficial solutions.

3. **Feedback and Reflection (10 minutes):** Rejoin the main room for a facilitated discussion on negotiation strategies, challenges encountered, and solutions proposed. Participants share their insights and receive feedback.

Activity 2: In-Person Conflict Resolution Workshop

Objective: Practice conflict resolution techniques in project team settings.

Format: In-person, using a meeting room.

Procedure:

1. **Scenario Assignment (5 minutes):** Participants are given a scenario where two team members have conflicting ideas about a project's technical direction.

2. **Role-Playing (15 minutes):** In pairs, participants act out the scenario, focusing on applying conflict resolution strategies to reach an agreement. One plays the project manager, and the other plays a team member.

3. **Group Discussion (10 minutes):** Gather as a group to discuss the approaches taken to resolve the conflict, highlighting effective strategies and areas for improvement.

Activity 3: Online Consensus-Building Challenge

Objective: Enhance consensus-building skills among project stakeholders with diverse interests.

Format: Online, utilizing collaborative tools like Miro or Google Docs for real-time collaboration.

Procedure:

1. **Briefing (5 minutes):** Participants receive a project scenario involving multiple stakeholders (e.g., engineering, marketing, finance) with differing priorities.
2. **Collaborative Task (15 minutes):** In small groups in a shared document or board, participants role-play the stakeholders and must draft a project plan that addresses each stakeholder's top priorities.
3. **Debrief (10 minutes):** Groups present their consensus plan in a plenary session, discussing the negotiation process, compromises made, and how consensus was achieved.

Activity 4: Quick-Fire Negotiation Rounds

Objective: Practice rapid negotiation skills in time-sensitive situations.

Format: Both online and in-person, using a timer to keep track.

Procedure:

1. **Scenario Distribution (2 minutes):** Each participant receives a different, brief scenario where they need to negotiate project terms with a client or supplier.
2. **Negotiation Rounds (20 minutes):** Participants pair up and have 5 minutes per round to negotiate, aiming to reach an agreement before time expires. Rotate partners after each round to experience different scenarios.
3. **Reflection (8 minutes):** Group discussion on negotiation tactics, challenges faced in time-pressured situations, and learning points from each round.

These activities are designed to be engaging and directly applicable to the challenges faced by professionals in the engineering and technical sectors, providing them with practical skills in stakeholder engagement that can be immediately applied to their work contexts.

Appendix 3.3

Activity 1: Virtual Stakeholder Negotiation Simulation - Detailed Script

Scenario Background:

You are a project manager (Participant A) for an engineering firm working on a high-profile renewable energy project. The project is at a critical juncture, requiring additional resources to meet an upcoming deadline. Unfortunately, the project budget is tight, and any additional resources need approval from a senior company executive (Participant B), who is known for their fiscal conservatism and emphasis on cost-efficiency.

Objective:

Negotiate with the senior executive to secure additional resources (either manpower, time extension, or budget increase) needed to ensure the project meets its deadline without compromising quality or safety standards.

Roles:

- **Participant A**: Project Manager
- **Participant B**: Senior Company Executive

Script:

Preparation (Before the Role-Play Begins):

- Participant A reviews the project details, including specific needs (e.g., two additional engineers for a month, a 10% budget increase), the justification for these resources, and potential compromises.

- Participant B reviews the company's financial status, priorities, and potential counter-offers or alternatives to direct resource allocation.

Start of Role-Play:

Participant A (Project Manager): Begins the meeting with a greeting and quickly moves to present the current project status, highlighting recent successes and the critical need for additional resources to overcome an unforeseen challenge.

Participant B (Senior Company Executive): Acknowledges the project manager's concerns but expresses reservations about the budget, asking for a detailed justification of the resource request and how it aligns with the company's financial constraints.

Participant A: Offers a concise overview of the technical challenge, the analysis performed to determine the need for additional resources, and the potential impact on the project timeline and deliverables if these resources are not secured.

Participant B: Questions the project manager on alternative solutions that were considered, emphasizing the need to think creatively about problem-solving within existing constraints.

Participant A: Proposes a compromise, suggesting a phased approach to resource allocation, starting with the most critical needs first. Also mentions the possibility of reallocating resources from less critical projects or exploring cost-saving measures in other areas to offset the additional expenses.

Participant B: Expresses appreciation for the creative thinking, asking for a detailed plan on how the proposed compromise could be implemented, including timelines, cost implications, and how the project manager plans to manage the reallocated resources effectively.

Participant A: Provides a high-level overview of the proposed plan, ensuring to communicate the benefits not only to the project but also to the company's broader goals, such as maintaining a competitive edge in renewable energy and meeting client expectations.

Participant B: Offers conditional approval for the additional resources, requesting a formal proposal that includes all discussed elements and a commitment to regular updates on the project's progress and resource utilization.

End of Role-Play:

Debrief (After the Role-Play Ends):

- Participants discuss the negotiation process, focusing on what strategies worked well and what could be improved.

- They reflect on the importance of preparation, clear communication, understanding the other party's priorities, and emotional intelligence in reaching a win-win solution.

- Feedback is provided on how to effectively use compromise and creative problem-solving in negotiations.

Duration: 15 minutes

This script is designed to challenge participants to think critically, communicate effectively, and use emotional intelligence to negotiate successfully. It simulates a real-life scenario that requires a deep understanding of both the project needs and the company's constraints, encouraging a balanced and innovative approach to problem-solving.