



Decision Sciences Institute

2025 Annual Pedagogy Conference

June 10 – 11

Virtual

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Students' Perception of Critical Thinking in the Age of AI

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ABSTRACT

Artificial intelligence is making education more personalized, with teaching methodologies that are not even imagined. Many benefits can be delivered via AI, such as catering to student learning needs and offering personalized learning materials and instant feedback so students can advance at their own speed. AI is transforming students' learning and teachers' pedagogical approaches. However, AI's inclusion in education poses equally fundamental questions of learning outcomes, particularly critical thinking.

Critical thinking, once an important part of university life, includes the process of learning to search for information, analyze evidence, identify patterns, and build arguments. They are even more necessary now than they ever have been in the digital world, as learners find themselves on a web of ever-more nuanced information. With the advent of AI, ranging from intelligent tutoring systems to language models, there has been a dynamic new to learning and teaching that might facilitate or detract from student critical thinking.

The literature contains mixed findings on using technology for critical thinking. Some report AI contributes to critical thinking, while others suggest AI is a barrier to critical thinking. In this study, we examined undergraduate students' experiences using AI tools in their studies, focusing on critical thinking skills and the benefits and challenges encountered during the learning process. Data will be collected in a four-year public university. A mixed-method study was used. Using a survey explored students' learning experiences with AI. Students are given an online survey containing questions asking about their experience using AI for learning and their perceptions of skills gains and losses with AI. The qualitative method involves interviewing 10 students about their learning stories on AI use.

This work contributes to the emerging literature on AI in education by examining students' views on AI and critical thinking. The results of this study offer insights for curriculum revision.

KEYWORDS: AI, Critical Thinking, Learning

INTRODUCTION

Educational environments have experienced a fundamental shift in traditional learning paradigms due to the swift adoption of artificial intelligence technologies. Educational students from all levels now have access to adaptive learning platforms and advanced language models like ChatGPT and Claude as AI tools become more widely available ((Kasneci et al., 2023) et al. 2023(Rajabi et al., 2024)). The introduction of these technologies creates exceptional learning possibilities, yet they

prompt important considerations regarding their effect on students' cognitive growth, especially in critical thinking skills development (Larson et al., 2024).

Education values critical thinking, which involves analyzing, evaluating and synthesizing information to develop reasoned judgments as one of its primary outcomes (Facione, 2023). This skill transcends academic boundaries to become an essential ability for understanding today's intricate information environment. Educators and researchers voice mounting apprehension about AI systems' ability to generate human-like text and solve complex problems because these technologies could either support or detrimentally impact students' development of independent critical thinking abilities (Cotton et al., 2024) (Stokel-Walker, 2022). An important aspect of individual critical thinking is that it has both cognitive and affective components (Glaser, 1941). This is significant, as it implies that successful critical thinking requires not only being able to do the cognitive work but also having the interest and inclination to do so, building on reflexivity, embodiment, and emotion (Lindebaum & Fleming, 2024) (Lindebaum & Fleming, 2024).

This study explores the complex interactions between AI technologies and the development of students' critical thinking abilities. The investigation aims to determine the connections between different AI usage patterns and multiple critical thinking aspects such as analytical reasoning capabilities, evidence evaluation methods, bias recognition skills, and metacognitive awareness abilities (Dwyer, 2017). This study addresses current educational demands by examining student interactions with AI tools while exploring how these interactions influence cognitive processes and identifying effective educational strategies to utilize AI while protecting critical thinking development (Suriano et al., 2025).

This study's impact reaches beyond current teaching methods and practices. The integration of AI across professional and civic life demands an understanding of critical thinking development in an AI-enhanced world to prepare students as thoughtful citizens and professionals (Selwyn, 2022). To develop effective curricula and teaching strategies for this technological revolution, institutions, alongside educators and policymakers, must utilize evidence-based insights (Mintz et al., 2023)(OECD, 2023).

1. How do students' perceptions of AI tools influence their critical thinking?
2. What pedagogical strategies effectively promote critical thinking skills in learning environments, given the prevalence of AI tools?

LITERATURE REVIEW

Critical Thinking: Definitions and Frameworks

In a seminal study on critical thinking and education in 1941, Edward Glaser defines critical thinking as follows: "The ability to think critically, as conceived in this volume, involves three things: Critical thinking demands a thoughtful approach to evaluating the problems and subjects encountered through one's experiences. Critical thinking demands continuous examination of all knowledge claims based on supporting evidence and their logical conclusions. The process commonly involves problem recognition capabilities, finding practical solutions for those problems, collecting and organizing relevant information, identifying implicit assumptions and values, utilizing language with precision and discrimination, interpreting data correctly, evaluating evidence and arguments, detecting logical connections between propositions, establishing justified conclusions and generalizations, testing the validity of those conclusions and generalizations, restructuring belief systems through broader experience, and making precise assessments about various aspects of daily life (Glaser 1941).

Higher education has always considered critical thinking as a fundamental component of intellectual development. Facione's 2020 definition of critical thinking describes it as a purposeful, self-regulatory judgment that leads to interpretation, analysis, evaluation inference and explanation of evidence-based conceptual methodological criteriological or contextual considerations supporting that judgment. The multidimensional conceptualization demonstrates that critical

thinking requires both cognitive abilities and dispositional qualities. Paul and Elder (2020) set forth a critical thinking model that incorporates thought elements (purpose, question, information, interpretation, concepts, assumptions, implications, point of view) together with intellectual standards (clarity, accuracy, precision, relevance, depth, breadth, logic, significance, fairness). Their research demonstrates that critical thinking develops through sequential stages, leading from basic unreflective thinking to the level of a master thinker.

AI Technologies in Educational Settings

AI technologies have rapidly expanded across the educational landscape, showing different levels of complexity and application potential. Zawacki-Richter et al. (2019) conducted a systematic review identifying four main clusters of AI applications in education: The four primary areas of AI application in education include profiling and prediction as well as assessment and evaluation along with adaptive systems and personalization and intelligent tutoring systems. Research in this field has primarily focused on technological development without sufficient pedagogical guidance, which has resulted in a disconnect between AI deployment and educational theory.

Holmes et al. Holmes et al. (2022) examined how AI ethics in education create conflicting demands between providing access and maintaining learner autonomy. While AI offers students improved access to educational resources, this advancement could limit their ability to cultivate independent problem-solving abilities. The development of critical thinking skills requires productive struggle with difficult content, which makes this tension especially relevant. A focus group session was held over two hours with forty computer science and engineering students, which addressed plagiarism concerns and appropriate ChatGPT usage together with assessment strategies. Students show a tendency to employ ChatGPT, while research highlights the necessity for clear usage guidelines along with increased classroom evaluations and compulsory usage reporting (Rajabi et al. 2024).

Previous Studies on Technology and Critical Thinking

The existing connection between technology and critical thinking has been explored prior to the emergence of today's AI tools. A meta-analysis performed by Swanson (2020) demonstrated that technology integration results in a moderate positive impact on critical thinking skills, according to multiple studies. The study showed that teaching methods greatly influence effectiveness because guided inquiry and problem-based learning produced better results than tool-centered methods. Cotton et al. Cotton et al. (2023) examined student ChatGPT usage patterns in various academic fields and discovered students mainly employed the tool for brainstorming and initial writing drafts instead of producing complete works. Many students who used artificial intelligence tools proceeded with critical evaluation and revision activities after initial use but showed variable levels of engagement depth. The authors call for an assessment design that utilizes AI insights to promote deep analysis of AI-created materials.

A 2023 study by Swart explored faculty viewpoints on AI-powered educational tools and discovered substantial apprehensions regarding AI's effect on student critical thinking skills. When AI alternatives were present, the faculty noticed that students became less willing to tackle complex conceptual material. Swart provided an account of novel teaching methods that shifted the role of AI to support students in developing critical analysis skills instead of taking over those skills.

METHODS

We employed a qualitative method to address the research questions. This approach involved interviewing 10 students about their experiences using AI in their learning and their perceptions of critical thinking. In qualitative research, a sample size of 10 is generally considered sufficient to identify key themes, as supported by prior studies. The interview questions focused on several

areas, including students' definitions of critical thinking, their use of AI tools, their confidence in applying critical thinking while using AI, the benefits and challenges they encountered when integrating AI into their learning, and any perceived changes in their problem-solving processes and skills. One example of an interview question is: How would you define critical thinking in your own words?

RESULT

Our preliminary analysis indicates that the majority of students have a positive sentiment toward AI. Several students mentioned that they use AI tools similarly to search engines. From a learning perspective, students are highly receptive to incorporating AI and expressed that professors should allow its use. Common use cases include checking concepts they do not understand, searching for ideas, grammar checking, and treating AI as a valuable learning companion. However, opinions are divided regarding critical thinking. Some students believe that AI enhances their critical thinking skills by supporting deeper analysis, while others feel it hinders critical thinking by fostering overreliance on AI tools. As AI continues to evolve, faculty are actively experimenting with its integration into their courses. Assessment methods for assignments, projects, and exams need to be adapted accordingly. Approaches such as incorporating more reflective essays and having students develop their own test questions are emerging as effective strategies.

CONCLUSION

Artificial intelligence is making education more personalized, with teaching methodologies that are not even imagined. Many benefits can be delivered via AI, such as catering to student learning needs and offering personalized learning materials and instant feedback so students can advance at their own speed. Our qualitative study shows various perspectives on AI use and critical thinking. Future studies will explore the factors that contribute to critical thinking.

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A Comparative Analysis of AI Tools in Answering Intermediate Accounting Exam Questions: ChatGPT, DeepSeek, Anthropic Claude, and Microsoft Copilot**ABSTRACT**

This study evaluates the performance of artificial intelligence models compared to human students in financial accounting education across various question formats. The goal of the study is to further the understanding of the use of AI in educational contexts, specifically in accounting. Four AI systems (Claude AI, ChatGPT, Microsoft Copilot, and Deepseek AI) were tested against student performance using multiple-choice, true/false, and fill-in-the-blank questions to assess their potential applications in accounting education. These findings demonstrate that current AI systems excel at structured, binary decision-making tasks but struggle with more complex, unstructured questions requiring nuanced explanations. While human students maintained consistent performance across all question types, AI systems showed extreme variability, suggesting fundamental limitations on question format to deliver correct answers. The study analyzes future directions for AI use in education and provides suggestions for implementations into the classroom.

Keywords: AI Tools ; Comparison; Accounting exam

1. Introduction:

AI is evolving and being integrated into daily life across various fields, including education. The accounting field has seen AI tools implemented extensively throughout the workforce to automate tasks and to guide staff. AI can be used similarly to aid both students and educators. Its uses range from creating outlines of lesson plans for educators to making personalized learning experiences for students. The practicality of these tools being implemented into classrooms in their current state is still being researched. This study conducts a comparative analysis of five prominent AI tools—ChatGPT, DeepSeek, Anthropic Claude, Microsoft Copilot, and Google Gemini—in answering intermediate accounting exam questions. By comparing the AI tools' performance against students in answering various question formats—multiple-choice, true/false, and fill-in-the-blank—this research aims to identify the current strengths and limitations of AI tools for their use in accounting education.

The integration of AI into professional settings has created shifts in workforce requirements and educational priorities. Accounting firms are implementing AI tools to automate routine tasks that were traditionally performed by entry-level staff (Kokina & davenport, 2017). This technological transformation warrants a reevaluation of the accounting education to ensure graduates possess the needed skills to perform the new entry-level work in these firms.

Currently most educators have pushed back on the use of AI tools in the classroom. What many don't realize is that AI also demonstrates potential to enhance learning experiences for students and educators. Studies such as Özdemir et al., 2024 have analyzed AI tools' ability to recognize a student's learning style. This would be the first step in developing personalized learning experiences for students using AI tools which would benefit both students and educators.

While extensive research has examined AI applications in accounting practice, surprisingly little research has focused on comparing AI systems performance against accounting students on academic examinations. Specifically, research about how question structure and formats influence AI's performance comparatively to students' performance.

This research addresses these gaps by comparing the performance of multiple AI platforms (Claude AI, ChatGPT, Microsoft Copilot, and Deepseek AI) against human accounting students on standardized assessments over multiple-choice, true/false, and fill-in-the-blank question formats. Our research plans to answer the following questions:

1. How does AI performance compare to human student performance across different accounting assessment formats?
2. What patterns emerge in AI capabilities when addressing structured versus unstructured accounting questions?
3. What are the implications of these performance patterns for accounting education curriculum design?

By answering these questions, our goal is to encourage further research into the use of AI tools in the accounting education field. This approach will acknowledge AI's current limitations

while providing evidence-based insights for curriculum development to prepare students and educators for an AI-integrated education.

This study provides data-backed insight into the evolving relationship between AI and accounting education by comparing AI and human performance across question formats. We will identify AI tools' strengths and weaknesses when answering questions depending on formats and structure which will provide insight for future upgrades to AI technology and their implementation into accounting education. Educators can also use this information if they plan use AI tools in their current state to create lesson plans or generate practice problems for students.

In this study we find that while human performance was remarkably consistent across question formats, AI's performance was heavily dependent on the formatting of the question. It appeared that AI performance got worse as question formats became less structured in nature. In the most structured format (true/false) AI outperformed human students whereas students outperformed AI tools in fill-in-the-blank questions significantly. This is a key distinguishment when exploring how AI tools process and answer accounting questions.

This finding suggests that AI tools in their current state should be utilized more as complementary resources rather than a comprehensive replacement for school instructors. It suggests that educators should leverage AI for simpler tasks and emphasize more higher-level critical thinking and complex reasoning skills in the classroom. This enables students to become familiar with the evolution of the accounting fieldwork that has already embraced the use of AI to automate simpler tasks.

Our paper contributes to prior literature in several ways: Our comparative analysis of four AI tools—ChatGPT, DeepSeek AI, Claude AI, and Microsoft Copilot—versus human performance across question formats of multiple-choice, true/false, and fill-in-the-blank allows us to assess AI's ability to answer accounting questions. While some studies such as Kokina & Davenport, 2017 have researched AI applications in the accounting industry, few studies have compared results of AI tools in answering exam questions. We aim to bring provide research into the uses of AI in accounting education specifically which differentiates our study from many others.

Comparative analyses of AI tools and humans have been conducted in the past. Herath et al., 2025 compares student's responses to essay question to GPT models ChatGPT and Bard. Our study takes a similar approach to this but offers a comparison between a larger variety of AI models and question formats. We aim to determine the differences in usefulness of AI tools between types of questions such as multiple-choice, true/false, and fill-in-the-blank where Herath et al. focuses on answering only essay questions. Identifying the strengths and weaknesses of AI in accounting education will help educators adapt learning environments around AI use and allow students to prioritize skills AI struggles to possess.

Our study differentiates itself from other studies that provide research on implementation of AI into higher education as well. Pisica et al., 2023 provides academics' opinions on the pros and cons of implementing AI into higher education. The study concludes

with recommendations on implementing AI and future research directions to aid educators who are transitioning to allowing AI in higher education settings. Our study aims to provide quantitative findings to go along with the qualitative research that studies such as Pisica et al., 2023 provide. The quantitative data we provide can be used by educators and AI developers alike to assess the strengths and weaknesses and potential develop an AI tool specifically for classroom environments.

2. Literature Review

AI Tools and Business School Students' Performance

Studies have analyzed AI's impact when used in business education. Katenova & Turmaganbetova, 2024 examines how effective students at KIMEP University in Kazakhstan feel AI is in business education. The study included teaching 150 undergraduate business students who were in finance courses how to utilize AI technology. Surveys were administered at the beginning and end of the semester to assess if the students felt it was helpful or not. The survey questions about the use of AI and aimed to judge how the students' perceptions changed once they were taught how to use AI.

The results showed that many students were optimistic about AI in education (Katenova & Turmaganbetova, 2024). The study found that students believe AI can provide guidance as effectively as human instructors and that students generally do not support university restrictions on AI. This shows that students believe AI should be a tool that universities embrace rather than restrict or discourage. Katenova & Turmaganbetova 2024 also concluded that there were more advantages than disadvantages for using AI in business education but suggested that ethical guidelines be developed for it to be implemented into academic settings.

This study is important because it focuses on the students' point of view. Getting students engaged and teaching them in new ways that they find interesting is an important element of education. This is a sometimes-overlooked benefit of AI in education that can influence students to want to learn and help them to feel like they are acquiring skills they will use in their future jobs. One thing the study could have done better was assess the students' performance in their studies when using AI tools vs when not using AI tools. While it is

important to learn about the students' sentiment, future studies should analyze whether the students are learning more when utilizing AI platforms in their education.

Using AI Tools in Business School Education

Sağın et al., 2024 analyzes how AI can be used in business school education and discusses the potential benefits for both students and educators. The authors aim to increase awareness of the use of AI tools and provide recommendations for their implementation into educational settings. They describe the current state of AI use in education is chaotic, with some embracing AI tools and others heavily restricting their use.

Sağın et al., 2024 states that AI can greatly benefit educators with creating coursework and structuring classes for students. AI can create learning objectives for students and can be used to develop curriculum that revolves around these objectives and helps students to achieve these goals. This saves time with the administrative tasks which allows educators to focus more on their students. The authors also state educators can use AI to brainstorm ideas on how to best teach their students while still meeting the learning objectives for the class. This allows educators to bring new material and experiment to find what their students resonate with the best. AI also can be used to grade students' work which can reduce bias in grading and provide more personalized feedback for students (Sağın et al., 2024).

Educators are not the only ones who benefit from the use of AI in business education. Sağın et al., 2024 states that students can get personalized learning experiences that are tailored to their individual needs. Students that need assistance understanding content or do not speak the language of the educator can use AI to personalize the material, or for real-time translation (Sağın et al., 2024). By utilizing AI to explain the material in different ways AI can help students learn in whatever way is best for them. Students will also benefit from timely grading of assignments and less bias in grading if educators utilize AI (Sağın et al., 2024).

Sağın et al., 2024 recommends educators take the time to become AI literate and to begin using AI to reduce workload in education before implementing it into education. Adopting a positive approach to technological change and discussing the use of AI tools openly with students are great ways to transition a classroom into utilizing AI (Sağın et al., 2024).

Implementing more critical-thinking assignments into the classroom and setting clear rules and guidelines on the use of AI are great ways to ensure students use AI correctly and are still engaging in the material.

This article is important because it defines clear benefits for both students and educators in using AI in educational contexts. It is important to encourage educators to embrace the growing use of AI technology instead of attempting to restrict it entirely. Demonstrating the benefits for both the students and the educators and providing recommendations on how to implement AI will assist the business education field with the transition into using AI in classrooms. Future studies should analyze students' results in retaining material when using AI to learn vs students who do not use AI.

Using AI Tools in Accounting Studies

Özdemir et al., 2024 is a study on AI's ability to improve accounting education by recognizing a student's learning style based on the Kolb Learning Style Inventory. ChatGPT, Gemini, and Copilot were given each student's information and were asked to categorize the student's learning style. When compared with the students' actual learning styles, ChatGPT scored the best at 90.9% followed by both Gemini and Copilot at 72.72% accuracy (Özdemir et al., 2024). This shows promise that AI can be used to identify students' learning styles which is the first step in developing personalized learning experiences for students.

Özdemir et al. found that the AI models were dependent on the prompts they were given and produced better results when provided with more detailed prompts. This is a limitation in the use of AI currently that could be improved if an AI model was adapted for the specific purpose of creating personalized learning experiences for students. Another limitation is that AI struggles to retain prompt information over extended conversations (Özdemir et al., 2024). Despite these limitations, Özdemir et al. conclude their study by stating AI tools show promise for supporting personalized learning but human oversight is essential for now. Future research should be conducted to assess practice classroom integration and developing curriculum for students using AI tools.

This study is important as it demonstrates AI's potential to be used to develop personalized learning experiences for students. ChatGPT has already demonstrated remarkable accuracy in determining students' learning styles in this study which is a crucial step in developing personalized experiences. AI tools could be developed specifically to be integrated into education with the purpose of identifying each student's learning style and present the learning material in a way that supports that individual's learning. Our study aims to contribute valuable research that will similarly advance the development of AI-powered personalized learning solutions in educational settings.

3. Methodology

We first administered an Intermediate financial accounting exam to seventy-nine students in the Schmidthorst College of Business at Bowling Green State University. Of these students, twenty-five were seniors, fifty-one were juniors, and three were sophomores. The class was predominantly male with fifty-three students and twenty-six female students. Sixty-four of the students were seeking a degree in accounting at the university while the other fifteen students were seeking degrees in finance. Students had one hour and thirty minutes to complete the exam which had thirty-six questions. If a student ran out of time when completing the exam, their computer automatically ended their attempt and scored what the student managed to complete.

The test bank included twenty-two multiple-choice, eight true/false, and four fill-in-the-blank questions. We covered a comprehensive range of topics to test students' understanding of fundamental financial accounting principles. Students were evaluated on their knowledge of the historical cost principle, asset valuation techniques, and preparation of journal entries. Other topics tested included cash vs. accrual accounting, accrued expenses, and depreciation. Students were instructed to give their best effort as the exam was counted towards their grade in the class.

The students' scores were automatically generated by McGrawHill Connect and each score was reviewed for accuracy. Partial credit was awarded for fill-in-the-blank questions, but not for

multiple-choice or true/false. We tested the AI tools by converting the exam to a Microsoft Word document and uploading the file to each AI model with the instructions to answer each question. We then graded each AI tool's exam by hand using the same scoring metrics and prepared the comparative analysis.

4. Results

Figure 1

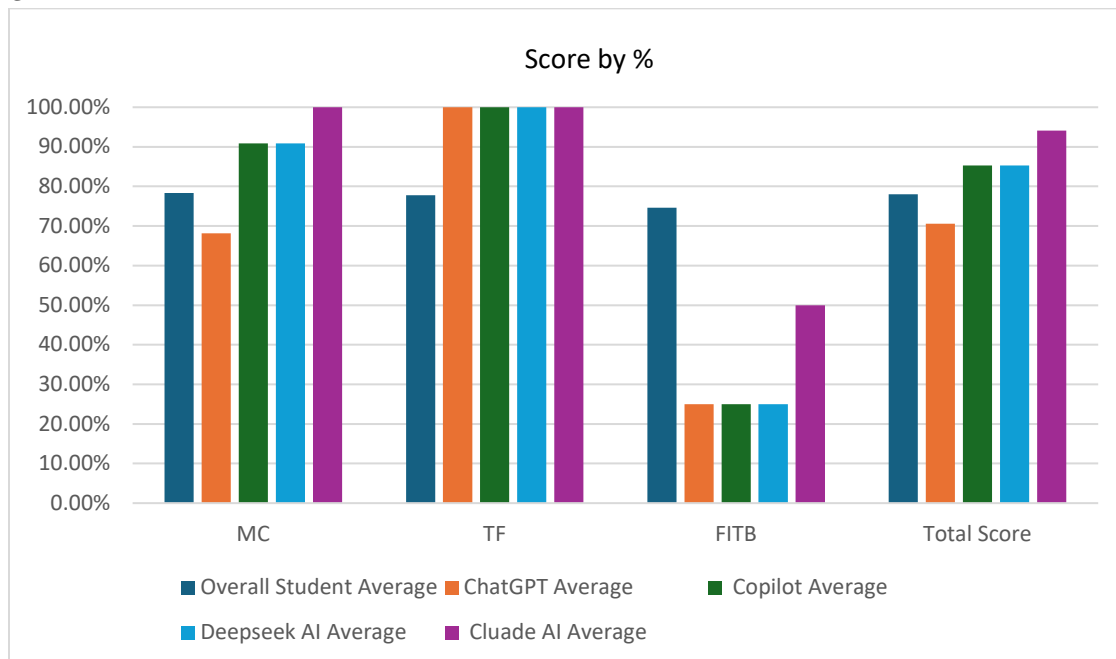


Figure 2

	Overall Student Average	ChatGPT Average	Copilot Average	Deepseek AI Average	Cluade AI Average
MC	78.35%	68.18%	90.91%	90.91%	100.00%
TF	77.80%	100.00%	100.00%	100.00%	100.00%
FITB	74.64%	25.00%	25.00%	25.00%	50.00%
Total Score	78.00%	70.59%	85.29%	85.29%	94.12%

Figure 3

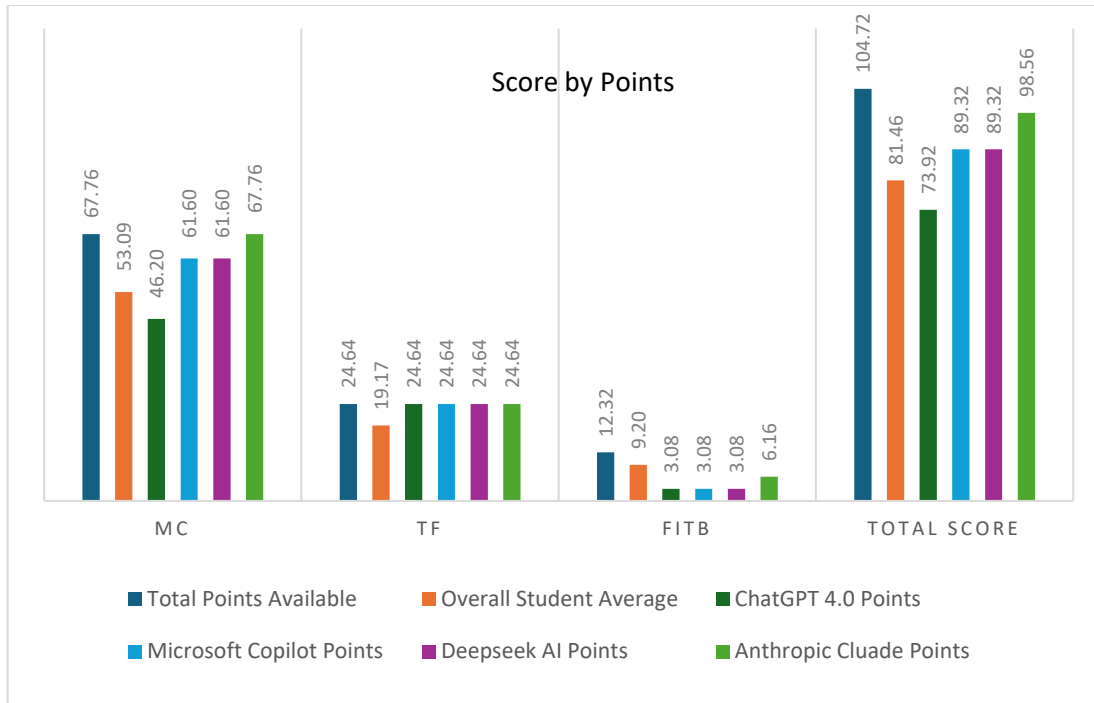


Figure 4

	Total Points Available	Overall Student Average	ChatGPT 4.0 Points	Microsoft Copilot Point	Deepseek AI Point	Anthropic Cluade Points
MC	67.76	53.09	46.20	61.60	61.60	67.76
TF	24.64	19.17	24.64	24.64	24.64	24.64
FITB	12.32	9.20	3.08	3.08	3.08	6.16
Total Score	104.72	81.46	73.92	89.32	89.32	98.56

Figure 5

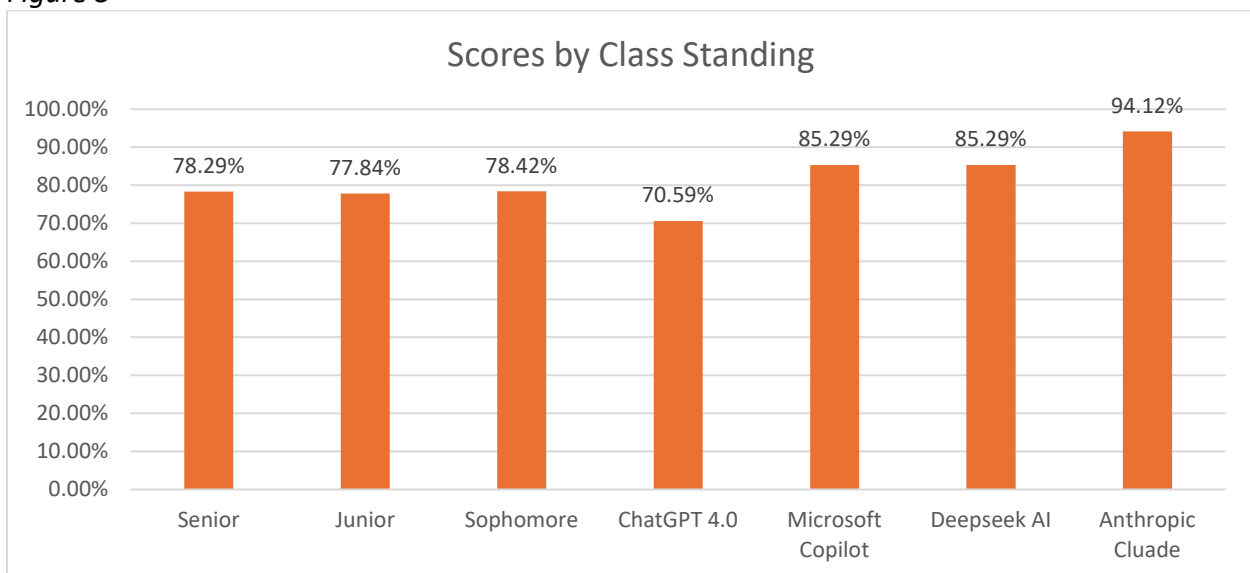


Figure 6

	Average Exam Score	Count
Senior	78.29%	25
Junior	77.84%	51
Sophomore	78.42%	3
ChatGPT 4.0	70.59%	N/A
Microsoft Copilot	85.29%	N/A
Deepseek AI	85.29%	N/A
Anthropic Cluade	94.12%	N/A

Figure 7

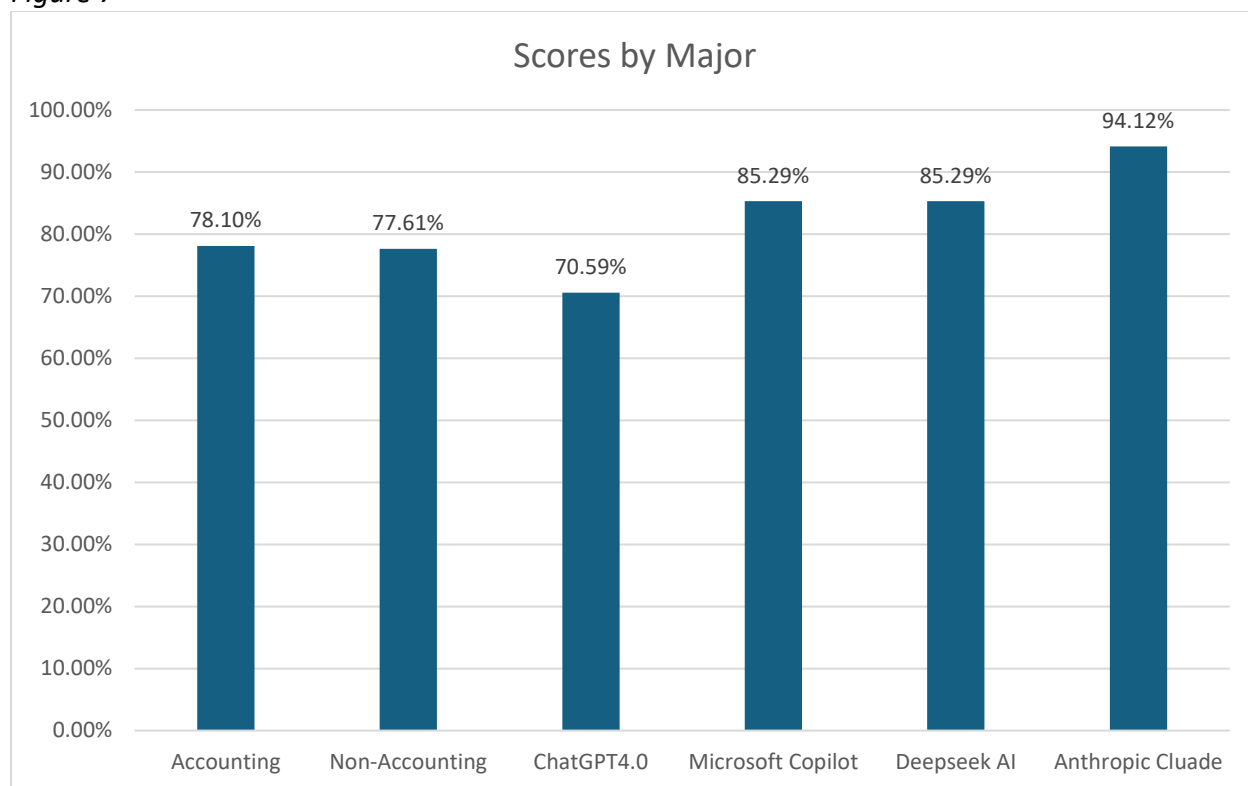


Figure 8

	Average Exam Score	Count
Accounting	78.10%	64
Non-Accounting	77.61%	15
ChatGPT4.0	70.59%	N/A
Microsoft Copilot	85.29%	N/A
Deepseek AI	85.29%	N/A
Anthropic Cluade	94.12%	N/A

Figure 9

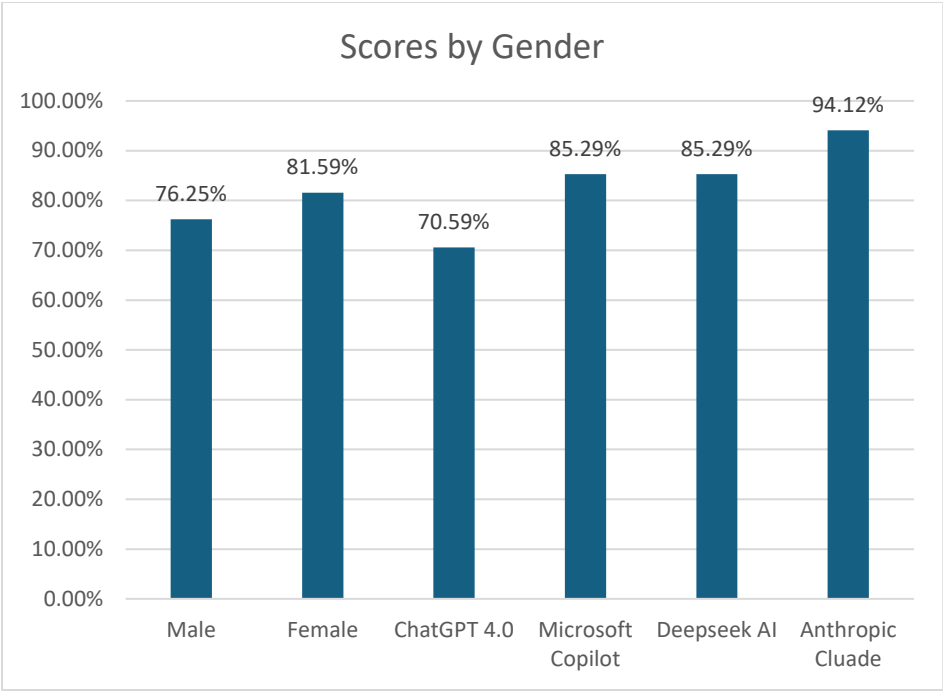


Figure 10

	Average Exam Score	Count
Male	76.25%	53
Female	81.59%	26
ChatGPT 4.0	70.59%	N/A
Microsoft Copilot	85.29%	N/A
Deepseek AI	85.29%	N/A
Anthropic Cluade	94.12%	N/A

Multiple-Choice Questions Performance Analysis

The multiple-choice section reveals significant variations in performance across different AI models and human students. The student performance of 78.35% serves as a baseline to evaluate AI capabilities against human performance. ChatGPT's performance of 68.18% represents the lowest score among all participants, falling 10.17% below the student average. This suggests potential limitations in ChatGPT's ability to process complex financial accounting multiple choice questions.

In contrast, Copilot and Deepseek AI both achieved identical scores of 90.91%, outperforming the student average by 12.56%. This identical performance might indicate similar underlying architectural approaches to processing multiple choice questions in financial accounting contexts. The consistency between these two models suggests ChatGPT may be falling behind other models when it comes to processing certain complex multiple-choice questions.

Claude AI achieved a perfect score of 100% on the multiple-choice section, exceeding the student average by 21.65%. This superior performance demonstrates an advanced capability to distinguish between subtle variations in financial accounting concepts when presented with defined choice sets.

True/False Assessment Analysis

The true/false section demonstrates a remarkable consistency among AI models, with all four systems (ChatGPT, Copilot, Deepseek AI, and Claude AI) achieving perfect scores of 100%. This uniform performance contrasts with the student average of 77.80%, representing a 22.2% gap between human and AI performance. This suggests that AI is well-suited for answering binary classification questions such as true/false problems.

Student performance in this section (77.80%) closely mirrors their multiple-choice performance (78.35%), indicating consistent human comprehension across different types of structured questions. The 0.55 percentage point difference between these two formats for students suggests that human understanding of financial accounting concepts remains relatively stable regardless of whether the question format is binary or multiple choice.

Fill-in-the-Blank Analysis

The fill-in-the-blank questions present the largest gap between human and AI participants. The student average of 74.64% stands in sharp contrast to the low AI scores. ChatGPT, Copilot, and Deepseek AI all scored 25%, representing a 49.64 percentage point deficit compared to human performance. This substantial gap suggests fundamental limitations

in current AI systems' ability to generate detailed, contextual explanations of financial accounting concepts.

Claude AI's performance of 50%, while higher than other AI models, still falls 24.64 percentage points below the student average. While this is substantially closer to human performance than other models, it still suggests a weakness in AI's ability to answer more complex and less structured questions such as fill-in-the-blank problems.

Cross-Format Performance Analysis

Examining performance patterns across question types reveals distinct characteristics for both AI and human participants. Student performance showed remarkable consistency across all formats:

- Multiple Choice: 78.35%
- True/False: 77.80%
- Fill-in-the-Blank: 74.64%

This consistency, with only a 3.71% spread between highest and lowest scores, suggests the students' performance was not dependent on question type. AI performance, however, showed extreme variability depending on the question format. Taking Claude AI as an example:

- Multiple Choice: 100%
- True/False: 100%
- Fill-in-the-blank: 50%

This 50% spread between structured and unstructured questions indicates that current AI capabilities are highly format dependent. Similar patterns emerge for other AI models, with even more dramatic spreads:

- ChatGPT: 100% to 25% (75% spread)
- Copilot: 100% to 25% (75% spread)

- Deepseek AI: 100% to 25% (75% spread)

When analyzing the relationship between AI model performance and question complexity, a clear pattern emerges. Performance decreases as questions require more sophisticated responses:

1. Binary decisions (True/False): Universal perfect performance
2. Multiple choice selection: High but variable performance (68.18% to 100%)
3. Open-ended explanation: Significant underperformance (25% to 50%)

This pattern holds true across all AI models tested, suggesting a fundamental characteristic of current AI technology rather than a limitation of any specific implementation.

5. Discussion

Strengths and Weaknesses of AI Tools in Accounting Education

Claude AI

Claude AI outperformed the other AI models in both multiple choice (100%) and fill-in-the-blank question formats (50%). It also scored a 100% on the true/false question format. This shows that Claude AI is exceptional at structured question formats when answering intermediate level accounting questions. Although it only scored a 50% on the fill-in-the-blank questions, it outperformed other GPT models by 25%. This indicates that Claude AI may be a more versatile tool for answering different question types. In fill-in-the-blank questions Claude AI still fell well short of human performance which indicates that unstructured questions are still a weakness of the platform.

ChatGPT

ChatGPT scored a perfect 100% on true/false questions which put it in line with the other GPT tools and above human performance for true/false questions. This demonstrates that ChatGPT performs well with binary classification tasks and is strong in very structured questions. ChatGPT's performance falls short of human performance for multiple-choice and fill-in-the-blank questions. This indicates that as question formats become less structured, or more complex, we see a decrease in overall performance from ChatGPT. We also see ChatGPT perform the lowest between AI models for both multiple choice (68.18%) and fill-in-the-blank (25%) which shows they may be falling behind in processing complex questions between other AI models.

Microsoft Copilot

Copilot scored above human performance in both true/false (100%) and multiple-choice (90.91%) question formats. This strong performance means Copilot is on par with other GPT models when it comes to binary classification tasks, and it may be ahead of other models for multiple-choice questions such as ChatGPT. The biggest weakness of Copilot is fill-in-the-blank questions (25%). This complex question format shows that once again GPT models do not yet perform to the level of humans when it comes to generating nuanced responses that require understanding context.

Deepseek AI

Deepseek AI also scored above human performance in both true/false (100%) and multiple-choice (90.91%) questions. This shows Deepseek has similar strengths to Microsoft Copilot in the sense that it performs exceptionally on binary classification tasks and simpler question formats. It fell short on fill-in-the-blank questions at a score of 25%, putting it in line with the majority of the other GPT platforms for this question type. This large gap between its performance on true/false questions and fill-in-the-blank questions demonstrates that its performance is highly dependent on question formatting unlike human performance which is more consistent.

Cross-Tool Comparison

The consistent pattern across all AI tools suggests a fundamental limitation in current AI technology rather than deficiencies in specific implementations. They demonstrated strong performance in binary and structured questions but weak performance in unstructured ones. While Claude demonstrated marginally better capability in generating explanations, all tools exhibited similar format-dependent performance characteristics. This indicates that accounting education should approach all current AI tools as complementary resources rather than comprehensive learning solutions, with Claude potentially offering slightly more balanced assistance across different learning contexts.

6. Implications for Accounting Education

The comparative analysis between humans and GPT models show us that AI is still behind humans when it comes to critical thinking and complex reasoning skills. Human performance on unstructured questions that require more variables and complexity are ahead of AI, but AI has shown that it may have surpassed the average student's performance on simpler, more structured questions.

Educators in the accounting education field can take advantage of this by encouraging more critical thinking and complex reasoning in the classroom. Assigning more short-answer, fill-in-the-blank, and application-based questions in the classroom can help build essential skills that students will need in the workforce. This also helps ensure students are putting effort into learning the material rather than using AI to complete questions for them.

As students master introductory topics of accounting and move onto more advanced concepts, educators should begin implementing AI into the classroom. For example, introductory accounting courses can restrict AI use to encourage students to build a foundation. Then, intermediate or advanced accounting courses should begin teaching students to utilize AI to accomplish the simpler tasks while also interpreting and analyzing the results

from the use of AI. This gives students the ability to utilize AI as a tool and move onto more complex topics and critical thinking exercises.

As students continue through their accounting education, they should experience a closer resemblance to the work they will be performing in their careers. In public accounting audit firms, companies have begun implementing AI to automate simple tasks that would previously have been done by incoming staff. This has led to incoming staff members starting out in a more review-focused role those senior auditors previously occupied. Without the experience of reviewing and analyzing AI work in the classroom, auditors may struggle to perform staff-level work unless the current accounting curriculum evolves with the industry.

The accounting industry is evolving, and it is important that accounting education adapts along with it. Further research on AI's abilities in accounting education should be conducted as AI continues to evolve and influence the accounting industry. Furthermore, studies should highlight where humans can complement AI in the accounting industry to identify skills we should be developing in accounting students.

7. Future Directions

We expect AI to continue to improve in answering accounting questions. One area of improvement we expect to see is AI's ability to answer more advanced accounting questions. While the questions we provided to the AI models were at the level of a college intermediate accounting class, we expect AI to be able to answer more advanced questions with the same or greater accuracy in the future. This could come as AI models are implemented into the accounting field and gain more experience with advanced accounting concepts or may be due to these models being adapted for use in accounting education.

Another area of improvement we expect to see is AI's ability to answer more complex and less structured questions such as fill-in-the-blank or short answer questions. This is where we saw a large gap between the AI models and human performance. One reason the AI platforms may struggle with these more complex formats is they lack real-world application experience. Textbook knowledge could be limiting AI's ability to answer questions because it is

attempting to apply rigid accounting principles and rules to problems that require reasoning and application skills. As the use of AI in the accounting field increases, we expect to see the gap between AI and human performance on these questions close.

8. Conclusion:

This comparative analysis reveals the stark contrast of strengths and weaknesses between humans and AI models when answering assessment questions of varying formats. While human students performed remarkably consistent across all question types, AI performance varied based on question structuring. True/false and multiple-choice problems are less complex questions and AI was able to outperform human students, but fill-in-the-blank questions were more complex and proved challenging for the AI models tested in this study.

AI performance varying on complexity reveals that AI is still limited in its ability to demonstrate sophisticated reasoning and contextual interpretation. The recognition of this weakness is crucial for the implementation of AI into accounting education. Students should be focusing on development of these critical skills that AI cannot currently replicate. Allowing students to focus on their critical thinking and reasoning skills also better prepares them for the evolving accounting industry workplace environment where AI has taken over the more simple, entry-level tasks.

We recommend that educators take an adaptive approach to AI in accounting education rather than resist or restrict the technology in the classroom. AI should be viewed as a tool that students should be taught how to utilize before entering the workforce and each student should be encouraged to explore how AI can complement their strengths and weaknesses. The goal of implementing AI into accounting education is to create a synergized model where human creativity and machine efficiency are combined to enhance financial analysis, auditing, and strategic decision-making.

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AI-Powered Case Study Approach

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ABSTRACT

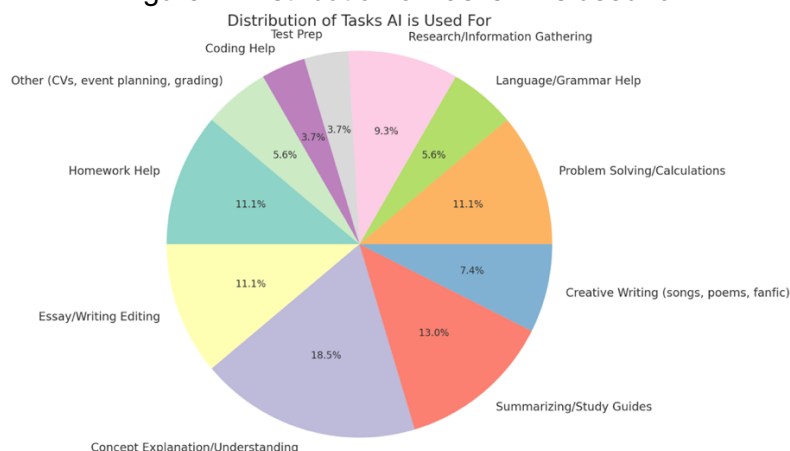
This article examines the integration of AI into traditional case studies and explores innovative teaching activities. AI-powered learning experiences will help students develop essential skills for the AI-driven workplace. Additionally, we address ethical concerns and provide recommendations to support faculty engagement and adoption of AI in education.

KEYWORDS: AI(artificial intelligence), case study, business education, pedagogy, ethics

INTRODUCTION

Artificial intelligence has been rapidly expanding across various sectors of life. Both Reuters (2023, February 1) and Lee et al. (2024) highlight that Generative AI tools such as ChatGPT, DALL·E, and Microsoft Copilot have emerged as transformative technologies in numerous fields, including higher education. According to Samala et al. (2024) and McDonald et al. (2024), Generative AI enhances creativity in higher education, streamlines administrative tasks such as grading and feedback, and provides scalable support for large classes. For instance, integrating ChatGPT into learning management systems like Blackboard or Canvas enables 24/7 student support by answering common questions, offering explanations, and generating quiz questions. Our student survey, conducted at a local high school, reveals that 40.5% of participants regularly use AI for schoolwork and learning. The most common uses include understanding concepts, summarizing information, and writing essays.

Figure 1: Distribution of Tasks AI is used for



This article examines the integration of AI into one of the most widely used teaching methods in business education—the case study approach. Specifically, we will explore the detailed construction of a finance case study, the role of AI in its integration, and the ethical and pedagogical considerations involved.

AI-INTEGRATED CASE STUDY

Case studies serve as a fundamental component of business education, allowing students to bridge the gap between theoretical concepts and real-world applications. AI has the potential to enhance traditional case studies by introducing dynamic simulations that adapt based on student decisions. AI-driven platforms can generate branching scenarios, where outcomes shift in response to students' choices, creating a more interactive and immersive learning experience.

In this article, I present a detailed profitability case analysis—*Hawthorn Business Profitability Analysis* (included in the appendix)—designed for undergraduate students enrolled in an introductory corporate finance course. My primary objective is to integrate AI-driven features into the case study to enrich the student learning experience. This integration leverages readily available AI tools while minimizing technical complexities for both students and faculty. Building on the original case, we will explore AI-integrated teaching activities that enhance engagement, foster critical thinking, and improve analytical skills.

AI-Powered Financial Scenario Simulation

First, we can integrate an AI-powered financial scenario simulation to enhance students' ability to analyze the financial implications of different working capital policies. The primary learning objective is to enable students to assess how various working capital strategies impact key financial metrics. Using AI-driven financial modeling tools, students can simulate and visualize the balance sheet, income statement, and key financial ratios for different working capital policies. By adjusting key assumptions—such as inventory levels, credit terms, and cash reserves—AI can forecast potential effects on sales, profitability, and liquidity. This hands-on approach helps students develop a deeper understanding of financial decision-making in dynamic business environments.

Technical requirement: students will need Excel with AI plugins, or Python scripts, or Power BI / Tableau for Visualization.

AI-Enhanced Decision-Making Debate

Second activity is to adopt AI-enhanced decision-making debate (role playing). This activity aims to develop critical thinking and decision-making skills by engaging students in a debate on financial strategies. Through role-playing, students will evaluate financial policies from diverse perspectives and make data-driven decisions with AI support. Students assume roles of finance committee members (e.g., CEO, CFO, marketing VP, banker). AI acts as a "financial consultant" providing real-time recommendations and risk assessments for each proposed policy. Teams debate which policy to adopt based on AI-generated projections.

Technical requirement: ChatGPT or Google Gemini can be utilized directly for financial perspectives.

AI-Enhanced Risk-Return Tradeoff Analysis

The third possible activity is AI-enhanced risk-return tradeoff analysis. This activity aims to teach students financial risk assessment by exploring the relationship between risk and return under different capital structure scenarios. Students will input various capital structure scenarios into an AI model, which will compute risk-adjusted returns for each scenario. The AI tool will then generate visual representations of risk-return tradeoffs, helping students analyze how different financing decisions impact financial performance and risk exposure.

Technical requirement: Students can use Monte Carlo Simulation (Python: NumPy, SciPy), Riskalyze AI for Risk Assessment, and Power BI / Tableau for Visualization.

AI-Assisted Business Report and Presentations

In the final stage, students can create AI-assisted business reports and presentations. This activity aims to enhance business writing and communication skills by integrating AI into the creation of professional reports and presentations. AI tools (e.g., GPT-4 or Jasper) can assist in writing executive summaries, financial analyses, and recommendations. AI-generated PowerPoint slides with data visualization will enhance student presentations.

Technical requirement: The tools may include ChatGPT / Jasper AI for report editing, Beautiful.ai for AI-powered presentations, and Yoodli AI for speech coaching.

In the most recent survey conducted by AACSB on the use of Gen AI, OpenAI's ChatGPT stands out as the most widely used AI platform among faculty for both teaching and research, with an impressive 96 percent and 95 percent of respondents. Faculty shared other platforms, not included in the survey, that they use in their work. Some of these AI platforms are specifically designed for academics.

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|---------------------|-------------|------------------|
| ■ Adobe Firefly | ■ Grammarly | ■ Paperpal |
| ■ Aithor | ■ Jenni AI | ■ Poe |
| ■ Consensus | ■ Julius AI | ■ Quilbot |
| ■ Elephas | ■ Krea.ai | ■ ResearchRabbit |
| ■ Elicit | ■ Llama | ■ SciteAI |
| ■ Google NotebookLM | ■ Merlin AI | ■ Superhuman |
| ■ HeyGen | ■ Otter.ai | ■ Undermind |
| | ■ Paperpal | |

Source: <https://www.aacsb.edu/insights/reports/2025/genai-adoption-in-business-schools-deans-and-faculty-respond>

ETHICAL CONCERNS

Brynjolfsson, E., & McAfee, A. (2017) discusses AI's impact on industries, including education. Floridi, L. (2021) uncovers ethical considerations and regulatory frameworks for AI in education. One of the foremost ethical concerns in using AI in business education is data privacy. AI systems rely heavily on data to function effectively, often collecting and analyzing personal information about students' learning behaviors, performance metrics, and even biometric data in some cases. This raises significant privacy concerns regarding how data is collected, stored, and used.

In addition, while AI can enhance efficiency and provide valuable insights, over-reliance on AI tools may undermine the development of critical thinking and human judgment. Business education aims to cultivate analytical and strategic decision-making skills, but if students become too dependent on AI for answers, they may not fully engage in the cognitive processes required for deep learning.

Faculty must strike a balance between leveraging AI for efficiency and maintaining traditional pedagogical methods that foster critical thinking. Encouraging students to question AI-generated outputs and consider alternative perspectives is essential for developing well-rounded business leaders.

FACULTY BUY IN

Alijemely (2024) pointed out that many studies have focused on training students for AI usage, but the literature focused on faculty training is very limited. Both faculty and institutions face to some challenges implementing AI. One of the biggest challenges is about the faculty readiness. Effective integration of AI into business education depends on the readiness of faculty members to adopt and utilize AI tools. Many educators may lack the technical expertise required to implement AI technologies effectively, leading to resistance or suboptimal use of these tools.

Faculty and institutions are seeking solutions actively. Rather than focusing on technical programming, a more accessible approach is to start with real-world AI applications in business, for example, AI in stock market predictions and AI in supply chain forecasting. One key consideration is that faculty do not need to code to use AI in business education but instead explore open-source AI solutions. Providing professional development opportunities, such as workshops, seminars, and collaborations with AI experts, is essential for building faculty competence and confidence in using AI, for example, live demonstration of AI tools and hands on AI case study. University or accreditation agency, such as AACSB, can roll out AI certification program for faculty who successfully completed AI for business education training program.

CONCLUSION

While AI offers numerous advantages, it should not replace traditional teaching methods entirely. Business education thrives on human interaction, mentorship, and experiential learning, which cannot be fully replicated by AI. Our approach illustrates an easy to adopt example for business school faculty to introduce AI into classroom, by transforming a traditional case study into an AI-integrated one. Finding the right balance between AI and traditional pedagogy is key to maximizing the benefits of both approaches.

APPENDIX

Hawthorne Business Profitability Analysis

In late September 1990, Billy Edwards, vice president of finance for Hawthorne Business Instruments, was preparing for the October meeting of the finance committee. He examined various sources of funds available to finance the company's capital expansion and reviewed the company's financial statements (see Exhibit 1) with an eye toward establishing a new working capital policy.

Hawthorne Business Instruments was founded in 1952 by Tessie Barnes to produce manual typewriters. Through the 1950s and 1960s, the company grew at a rapid pace, expanding its product line to include manual calculators and other business instruments. But the company's

growth then stagnated until the late 1970s, when electric typewriters and calculators replaced their manual counterparts as the company's major products. Hawthorne Business has expanded rapidly since 1978, when its first plant was established in Raleigh, North Carolina, to produce a new generation of business instruments. The company placed two other plants on line in 1988, one in Richmond, Virginia, and another in South Carolina.

Hawthorne Business' major problem has been increasing production fast enough to meet the demand for its products. The company's capacity has been expanded steadily since 1988, but it has often lost sales because of insufficient production. Recognizing this problem, Jeanette Amoroso, president and chief executive officer, called a meeting of the finance committee to consider ways to increase production and to review financing alternatives proposed by Mr. Edwards. The meeting was attended by Jeanette Amoroso, president; Billy Edwards, vice president of finance; Courtney Cole, vice president of marketing; and Evan Weinstein, director and banker.

Courtney Cole reported that the company needs a new plant to produce enough typewriters and calculators to meet market demand. She also said that the company will have to diversify into the mini and desk computer field in the near future because its major competitors have expanded their product line to include this product since 1986. Evan Weinstein agreed that it is important for Hawthorne Business to expand its production capacity, but he indicated that it would be very difficult to obtain long-term debt financing at the present time. Because the company's debt ratio is the same as the industry average, he felt that long-term lenders would demand a healthy risk premium on the new debt. He proposed that the capital expansion be financed by a new issue of common stock.

Jeanette Amoroso interrupted at this point and stated that a common stock offering was perhaps out of the question for two reasons. First, the sale of new common stock is not desirable because it was currently selling in the over-the-counter market at \$12 per share, which is at least a three-year low. Second, most current stockholders are not in a position to purchase additional common stock, and the sale of new common stock to outsiders would produce a significant dilution of earnings and control.

Exhibit 1
Hawthorne Business Instruments Financial Data
for Year-Ending August 30, 1990

Midwest Business		Percent of Total	Industry Averages
A. Balance Sheet			
Current assets	\$4,320,000	40%	30%
Net fixed assets	<u>6,480,000</u>	<u>60%</u>	<u>70%</u>
Total assets	\$10,800,000	100%	100%
	=====	====	====
Current liabilities (8%)	\$1,404,000	13%	13%
Long-term debt (10%)	4,320,000	40%	40%
Common equity	<u>5,076,000</u>	<u>47%</u>	<u>47%</u>

Total liabilities & common equity	\$10,800,000	100%	100%
	=====	=====	=====
B. Income Statement			
Sales	\$14,400,000		
Operating expenses	<u>12,240,000</u>		
Earnings before interest & taxes	\$2,160,000		
Interest	<u>544,320</u>		
Taxable income	\$1,615,680		
Taxes (50%)	<u>807,840</u>		
Earnings after taxes	\$807,840		
	=====		
C. Key Ratios			
Current ratio	3.08x		2.31x
Return on common equity	15.92%		13.85%
Operating expenses to sales	85.0%		85.0%
Debt to total assets	53.0%		53.0%

Billy Edwards, who has responsibility for accounting and finance, entered the discussion at this point and stated that other financing alternatives such as leasing and the reduction of dividend payments were probably also out of the question. Restrictions in the company's long-term debt agreements made lease financing practically impossible. The company cannot reduce its dividend payments drastically without risking further declines in its stock price. Thus, Mr. Edwards said that the best way to obtain funds for the company's capital expansion would be in the working capital area. Current liabilities might be increased and/or current assets might be decreased to produce the necessary funds.

Mr. Edwards proposed three working capital policies for consideration: (1) a conservative policy that would maintain the current working capital structure; (2) an intermediate policy that calls for reducing current assets to the industry average percentage with no change in current liabilities; and (3) a liberal policy that calls for reducing current assets by 20 percent and increasing current liabilities by 20 percent. Long-term debt and common equity would be maintained at present levels under all of these policies. The intermediate policy is expected to increase sales by 5 percent, and the liberal policy is expected to increase sales by 10 percent. All finance committee members except Billy Edwards indicated apprehension about any change in working capital policy, but agreed to postpone the final decision on this matter until Mr. Edwards could prepare a more detailed analysis of the possibilities.

Questions:

1. Prepare an exhibit that will show (a) the balance sheet, (b) the income statement, and (c) the key ratios for each policy.
2. As current ratio is a measure of liquidity adequacy, does it mean the higher the current ratio, the better position the company is in?
3. Discuss the risk-return tradeoff among the alternative policies.
4. Which of the three alternatives should Mr. Edwards recommend at the next meeting?

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<https://www.nber.org/digest/202412/workplace-adoption-generative-ai>

DECISION SCIENCES INSTITUTE

Student Access to Remote Learning Technologies – Beyond the Pandemic

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ABSTRACT

This paper examines the experiences in higher education regarding student access to learning and communications technologies following the 2020 transition to emergency remote learning. It also examines current thinking about potential remedies for the student access problem.

KEYWORDS: Remote Education. Learning Technology. Student Access.

INTRODUCTION – THE TRANSITION TO REMOTE LEARNING

The onset of the COVID-19 pandemic in the spring of 2020 required schools, colleges, and universities worldwide to transition to some form of remote education. (Foss, 2020) Prior to the pandemic, almost a third of college students in the United States had enrolled in at least one online course, often mixed in with in-person courses. At the same time, many instructors had already developed online teaching skills. (Gallagher & Palmer, 2020, Nguyen, 2015) However, online learning was not the rule until the pandemic made it so. As a result, early assessments of the effectiveness of educational efforts at university levels were mixed; some instructors and courses fared better during this time than others. (Chattaraj & Vijayaraghavan, 2021) These early outcomes are not surprising. What occurred was essentially a massive pedagogical experiment without the development of a carefully constructed experimental design, an evaluation by an Institutional Review Board, or the use of a control group. (Zimmerman, 2020)

Fortunately, a substantial amount of data gathering occurred after the fact as educators shared their experiences, best practices, informal assessments, and formal research outcomes. Such data gathering will be essential in assessing the consequences of the remote learning that took place during the pandemic and in the years that followed. This paper will specifically examine the issue of student access to remote and online learning technologies.

That many students lacked access to technology was of course observed long before 2020. However, the broad transition to remote learning – even though it was not permanent – made the technology access issue more visible and more urgent. (Peter, 2024) Even now that in-classroom learning has resumed at most universities and colleges, student access to technology remains an issue to be dealt with.

LEARNING AND COMMUNICATIONS PLATFORMS FOR REMOTE LEARNING

The transition to emergency remote learning in 2020 was made possible by the availability of a variety of internet-based platforms, applications, and technologies. Remote learning requires its digital infrastructure to accomplish several tasks: to upload and store educational content and to subsequently distribute it to students; to accept student work, which may include individual or group assignments or responses to exams and quizzes; and to communicate synchronously and asynchronously among instructors and students. Universities have long deployed learning management systems such as BlackBoard, Moodle, and Canvas, which have evolved over time

to accomplish many of these tasks, in particular the distribution of learning materials. In addition, these platforms permit integration with a broad range of third-party applications to add features and functions. (Fox et al, 2020; Khanal, 2021)

Audio and video conferencing applications have been used to provide synchronous communication modes that were often not provided by the learning management systems themselves. (Fox et al, 2020) The best-known conferencing applications include Zoom, Cisco Webex, Microsoft Teams, and Skype. All these conferencing applications experienced tremendous increases in usage following closures of institutions worldwide and the transition to remote learning and remote work in the spring of 2020. (Turk, 2020)

It is important to recognize that the transition to remote learning in response to the pandemic forced universities to quickly adopt a broader range of digital technologies than they used before. The investments in these technologies may continue as the conveniences afforded by them may be difficult to give up. For this reason, universities should carefully consider the consequences of the use of these technologies on the educational process, in particular the issue of the accessibility of these online tools.

STUDENT ACCESS TO REMOTE LEARNING TECHNOLOGIES DURING THE PANDEMIC

The issue of access concerns students' ability to interact with the technology platforms and digital content that comprise remote learning. Educational equity issues at elementary and high school levels were well documented following the outbreak of the pandemic. It was clear from the outset that low-income students and students of color engaged less regularly in remote learning than their peers. Explanations for these disparities include difficulties in accessing technology and the network; additional responsibilities at home; and excessive stress caused by the pandemic and associated changes in family employment. (Barnum & Bryan, 2020.) In the time since, similar disparities have been uncovered for students in higher education.

The good news is that most of today's students in higher education have obtained fluency with modern computer and communication technologies from a young age. These students are accustomed to using mobile devices, instant messaging, and social media. This familiarity with computers and online platforms helped ease their transition to remote learning. Indeed, a study of Greek undergraduate students following the transition showed that the most significant change to their usage of smartphones and computers related directly to online learning. Other digital usage continued as before. (Kamarianos et al, 2020)

While in the United States access to the Internet using computers and smartphones is quite high overall, hurdles to such access can still occur. For instance, low-income families may have equipment with which to access the Internet but may still be unable to do so due to unpaid provider bills, very old or even broken equipment, limits or caps on their data plans, or because students are required to share access to either equipment (limiting time) or bandwidth (limiting capacity) with family members. (Barber et al, 2021) Gonzales et al refer to this issue as "technology maintenance," which studies the stability of digital access: even though technology ownership is nearly universal, individuals may have difficulty maintaining access to the network. (Gonzales et al, 2020) As a result, these students end up "under-connected." (Katz et al, 2021) This is by no means solely an income issue. Access to broadband technologies is also lower for students living in rural parts of the United States as opposed to those living in urban areas. (Boerngen & Rickard, 2021; Kang, 2020)

These barriers to access to technology were confirmed by studies performed at the outset of the pandemic. An analysis performed in early 2020 found that nearly one-third of undergraduate students from low-income families suffered lack of access to technology, which was three times higher than students from wealthier families. What is interesting here is that the students did not find familiarity with these tools a significant barrier to online learning, suggesting that access to technology and bandwidth were specific issues here. (Soria et al, 2020) Another 2020 study found that underrepresented minority students and first-generation students were the most negatively affected by the transition to remote learning due to technology access issues. (Barber et al, 2021) A mid-2020 survey found that 44% of students expected at least occasional connectivity problems. (Means & Neisler, 2020)

At the start of the pandemic, access to the network was further limited when public network access (in campus libraries, community centers, or even coffee shops) disappeared for a substantial period as these facilities were closed for some time. The students most in need of this public network access to connect with remote education were significantly affected. (Kang, 2020)

Finally, when students would attempt to access online education through their smartphones, they often encountered substantial difficulties when using these devices to watch lectures, complete assignments, take exams, or write papers. (Fox et al, 2020) While some colleges and universities have attempted to provide students with laptop rentals and broadband access (often supported by the FCC Keep Americans Connected Pledge), these efforts were not consistent across higher education. (Barber et al, 2021; Grandinetti, 2022; Heitz et al, 2020; Kang, 2020)

THE POST-PANDEMIC SEARCH FOR SOLUTIONS

The COVID-19 pandemic served to more broadly expose the problems of student access to online learning. (Peter, 2024) When the pandemic abated in 2023, online learning options remained popular with universities and students, and the student access issue persisted. A study performed in 2023 found that 40% of surveyed students experienced stress due to unstable internet connections while 22% did not have a proper device (computer or laptop) needed for accessing online course content. At this time federal COVID-19 relief funds to alleviate these issues were ended. (Bharadwaj et al, 2023) A follow-up study in 2024 showed that internet connectivity challenges persisted. (Bharadwaj et al, 2024) These findings suggest that instructors may want to provide these under-connected students with course materials that can be downloaded and then accessed offline.

The increased visibility of the student access issue did spur calls for the accelerated development of solutions to the problem. The National Standards for Quality Online Learning (2025) recommends that equitable access to online programs be established through options such as “personal wi-fi access, access to physical locations with hardware and internet access, community partnerships, etc.”

A more comprehensive solution for student access and educational success was named Digital Equity, which refers to “fair access to technology, digital tools, and the internet for all students, regardless of their socio-economic background, geographic location, or other distinguishing factors.” (Peter, 2024) This approach recognizes the need to go beyond mere technology access to include various forms of support for the students so that they develop digital literacy skills and the meaningful use of digital tools to enhance student learning. Digital Equity recommends that educators collaborate with government policymakers, community

organizations, and the private sector to develop holistic solutions to improve student learning opportunities. This approach not only includes access to high-speed internet and the provision of equipment for students, but also the sharing of resources and best practices among educators. (Peter, 2024)

This holistic approach beyond mere technology access is shared by DaVinci (2023), who argues that persistent gaps in student outcomes for minority students and those from low-income backgrounds need to be addressed with measures that incorporate the effective deployment of educational technology as only “an element of a solution.” (DaVinci, 2023) Effective teacher training on active and adaptive learning pedagogies and the consistent use of clear course structures are recommended in addition to the equitable access to technology.

Bharadwaj et al (2024) advocate for evidence-based teaching practices to promote student learning. This approach focuses on student access to data and other online resources, as well as on active learning, student collaboration, and the development of an inclusive learning environment. Institutional support for instructors would be essential for implementing such practices.

REMOTE LEARNING ACCESS – LESSONS LEARNED

The transition to remote learning both exacerbated and made visible the digital divide felt by low-income students. In addition to experiencing barriers to digital access of learning content, these students were also more likely to face more distracting home environments and economic hardship. Looking at how economic inequalities affected access to education, Watermeyer et al argue that “COVID-19 has thus not only forced change but revealed quite how much such change is overdue.” (Watermeyer et al, 2020) To ensure equity in access to online education, continuing to assist these students – with technology and broadband access, but also with academic and interpersonal support services – will help these students succeed even after the pandemic subsided. (Barber et al, 2021; Soria et al, 2020)

Such enhanced support should not be limited to students. Given the importance of information and communication technologies in today’s economy and society, it is vital that instructors across the disciplines be educated on how to use these well. Instructors should be provided with the tools, knowledge, and support for using these technologies in their courses so that online education techniques become a standard part of instructor competencies. (DePaul, 2022; Fox et al, 2020; Ikebuchi, 2023; König et al, 2020)

Basic student access to remote learning has been recognized as an important issue for educational institutions and governments to address. While doing so, attention should also be paid to some less visible but still significant sub-topics related to access to learning. First, remote and online learning efforts need to be mindful of supporting access to education to students with disabilities. Remote learning accommodations for these students include closed captioning, descriptive video, document readers, and accessible design of web resources. In the rushed transition to emergency remote learning, some accessibility accommodations were not provided, and such deficiencies need to be addressed (Heitz et al, 2020; Ikebuchi, 2023)

Second, it must be noted that these access issues are not limited to the United States. Worldwide, students from less developed, impoverished, remote, or rural areas lack access to internet connectivity or even to electricity. (Aristovnik et al, 2020; Bozkurt et al, 2020; Erlam et al, 2021)

Finally, the transition to remote learning also exposed another aspect of access to technology: the digital infrastructure and support structures at educational institutions vary greatly. Some instructors have access to more advanced resources and support than others. The lack of access to learning management platforms, other forms of software, and institutional support and guidance undoubtedly affected the quality of the remote learning efforts for instructors. (Alqabbani et al, 2021; Damşa et al, 2021; Langford & Damşa, 2020)

Given all these aspects of access to education, it is not surprising that this issue was identified as “the most salient negative aspect directly related to emergency remote teaching.” (Rapanta et al, 2021)

CONCLUSION

Limitations in accessing technology and the network are known to have a direct effect on the student learning process. As Luong & Arnold put it succinctly: “Access to technology is equivalent to access to education in the context of remote learning during the shutdown of schools.” (Luong & Arnold, 2020) Students without sufficient access are less likely to develop the skills needed to be successful in digital environments (such as the ability to effectively search for information, use various applications, and produce various forms of digital content). This combination of insufficient access and reduced skills has the potential to reduce a student’s learning outcomes. (Katz et al, 2021) Early studies on remote learning at the K-12 level have shown that the challenges encountered by these students accessing education can have negative effects on their academic performance. The long-term effects of this issue – such as the ability of these students to complete higher education – have yet to become clear. (Barber et al, 2021) It is possible that long-term effects will also be found for students at the college and university level.

A recent UNESCO report that examined the pandemic experiences of Higher Education Institutions (HEI) in Latin America put it clearly: “The resumption of face-to-face activities at HEIs should be seen as an opportunity to rethink and, to the extent possible, redesign the teaching and learning processes, taking advantage of the lessons that the intensive use of technology may have entailed, and paying special attention to equity and inclusion.” (UNESCO-IESALC, 2020)

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DECISION SCIENCES INSTITUTE

An Accounting Model Curriculum and Case Studies with Interactive Web-Based Lab Tool

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ABSTRACT

These instructional resources paper presents a modern approach for integrating accounting data analytics, advanced visualization content, and lab sessions into the accounting information systems course. The proposed course model includes core components with LAB sessions as an additional practical application, to support the experiential learning model. The core components include an instructor textbook and Tableau Desktop tool. The support components include weekly lab projects that build towards the final project. The course learning objectives facilitate students: (1) developing different advanced analytics to support digitally driven business decisions, (2) cultivating an interest in accounting analytics models by integrating professional performance business models into curriculum, (3) developing competence in the use of a professionally developed web interactive self-developed lab tool. The proposed course model not only meets analytical needs, but also teaches students how the relevant tools can be used to improve businesses' decision-making and respond to inquiries using a modern approach.

I. INTRODUCTION

Accountants can help their clients adapt to the “new normal” post-pandemic environment by identifying new disruptive technologies such as Blockchain (Qasim and Kharbat 2020), Artificial Intelligence (AI), and Robotic Process Automation (RPA) to achieve long-term productivity gains while enhancing cybersecurity (Brooks 2020). With AI-enabled tools, accountants can spend less time gathering, correlating, and summarizing information, and more time analyzing, evaluating, and predicting the results or implications of the assembled information and data. Intelligent Process Automation (IPA), analytics, and AI are collectively driving the transformation of the audit process. Accounting programs must modernize/update their curricula to incorporate the necessary skills that are driving accounting firms to hire over 30 percent non-accountants (AICPA 2021). There are “significant gaps between what practice is demanding and what students are learning in accounting programs” (Vien 2021).

Accounting programs must ensure they have the faculty necessary to successfully implement a modernized/updated curriculum. To appeal to high school and college students, perceptions of the certified public accountant (CPA) must evolve from being associated with

accounting, auditing, and tax preparation, to viewing CPAs as strategic business advisors and potential entrepreneurs (Dawkins 2019). A report from the American Accounting Association's (AAA) Joint Curriculum Task Force noted that "surveys of financial executives... confirm that accountants are expected to integrate traditional accounting within a broad management context and to collaborate with other managers to improve organizational performance, including strategy implementation" (Lawson et al. 2014).

Required Skills for Future Accounting Professionals – Digital Transformation and Innovation.

Intelligent technology is shaping the future of accounting by impacting the types of jobs that will become available. Advanced systems will handle repetitive work, while humans will deal more with analysis and become the crucial link between data and clients. Richardson and Watson (2021) note that "while computers can facilitate the development of dashboards, accountants are still needed to figure out what needs to be communicated, how it needs to be communicated, and then to help design the dashboards." Technology will continue to impact the role of the modern accountant and the demand for accountants in the future. Modern Accountants must understand new integrated accounting technologies and advanced analysis techniques, and develop skills in areas such as managerial accounting, data analytics, and advanced financial reporting.

Accountants of the future will not need to be experts in both data analytics and accounting, but they should "have a bit of knowledge of both" (Drew 2018). Surveys of accounting professionals have found that they find data analytics training to be valuable, but STEM designated training to be unnecessary (Moore and Felo 2021). While employers place the greatest value on Microsoft Excel and basic spreadsheet skills (Garnsey, Doganaksoy and Phelan 2019), a vast majority of students have already used Excel and consider themselves proficient in the use of spreadsheets (Cheng, Sapkota and Yurko 2021). Far fewer students have used or consider themselves proficient in the visual analytics platform Tableau. A review of data analytics cases in the accounting education literature also reveals that the majority of cases use Excel as the principal tool, and that few cover extraction and data preparation (Raschke and Charron 2021).

Tableau is a useful tool that enables working professionals to perform data visualization without the need for coding in R or Python. O'Brien and Stone (2020) note that Big Four accounting firms consider data visualization to be a "core technology skill" for analytics. Accounting educators must ensure that their students possess these analytics skills.

We present a model for incorporating data analytics into the Accounting Information Systems course. A difficulty noted in the relevant literature is that accounting professors lack the training to incorporate data analytics into the classroom (Dow, Jacknis and Watson 2021). Despite these difficulties, there have been calls for accounting educators to make "major curriculum changes" to prevent academia from falling too far behind the industry in technological terms (Polimeni and Burke 2021).

This proposed model helps to ease analytics into the curriculum by incorporating a professionally developed interactive web-based lab tool. The lab tool includes assignments along with instructional videos to help students as they learn how to visualize data in Tableau. Three final projects are proposed for instructors to choose from, using open data sources.

Further, students will not be required to download data, as all data sets are accessed online using Tableau's Application Programming Interface (API).

II. RELATED LITERATURE

Recent studies in the accounting literature field have sought to guide educators on how to add data analytics into the accounting curriculum. Qasim, Issa, Refae and Sannella (2020) recommend incorporating data analytics into existing courses (called an "integrated curriculum"), rather than creating a stand-alone data analytics course. Dow et al. (2021) recommend "phasing in" the integrated curriculum, beginning with expanded data analytics focus in the Accounting Information Systems (AIS) course. Dzurainin, Jones and Olvera (2018) surveyed faculty members and found broad support for a hybrid approach, where analytics are both incorporated into existing courses and offered as a standalone course. Tapis and Priya (2020) suggest that the best way to comply with Standard A5 of the Association to Advance Collegiate Schools of Business is for a stand-alone data analytics course to be implemented, alongside methods that can assess changes in students' adaptability and agility.

Numerous other papers offer data analytics case studies to help instructors add data analytics into existing courses. Weirich, Tschakert and Kozlowski (2018) and Cunningham and Stein (2018) both present case studies for use in auditing classes that incorporate Tableau. Chan and Kogan (2016) present a data analytics case for use in auditing classes, using the open-source programming software R instead of Tableau. O'Brien and Stone (2020) offer a Tableau teaching case that also incorporates answering basic client questions and presenting deliverables. Shawver and Shawver (2020) provide a data analytics case designed to be completed in groups, combining data analytics instruction with the opportunity to gain experience in teamwork and communication.

The literature in this area also provides examples of data analytics case studies for use in managerial and tax classes. Hoelscher and Mortimer (2018) and Kokina, Pachamanova and Corbett (2017) offer Tableau-based case studies for use in managerial accounting classes, with an emphasis on business consulting. While fewer accounting faculty members feel the need to integrate data analytics into tax courses (Ballou, Heitger and Stoel 2018), Sledgianowski, Petra, Pelaez and Zhu (2021) offer a Tableau case study that can be used in either a tax or AIS course. Cheng and Varadharajan (2021) present a case that studies interstate migration patterns – a topic that is of interest to students considering future employment options – and their case can also be used in either AIS or tax courses.

Our model incorporates data analytics training into the existing AIS course curriculum. While we concur that data analytics should be infused throughout the various accounting courses, the AIS course is a natural starting point for institutions that are just beginning to add analytics to their curriculum. Reacting to survey responses from accounting employers, Garnsey et al. (2019) recommend adding Tableau into the AIS curriculum. A survey of AIS educators also found broad support for adding a second AIS course into the curriculum (Badua, Sharifi and Watkins 2011). While expanding the AIS course or developing a stand-alone data analytics course may be prudent in the future, incorporating analytics into existing AIS courses is definitely an important first step for universities.

Dow et al. (2021) also note the difficulty in creating an integrated curriculum, as instructors with a lack of understanding of accounting topics feel overwhelmed by the extra effort required to incorporate data analytics. Shmidt, Riley and Church (2020) suggest that Status Quo Bias Theory explains accountants' resistance to moving beyond Excel for data analytics. Zhang, Dai and Vasarhelyi (2018) note the lack of qualified faculty members is a problem, but suggest, "digital media made available on the Internet is probably the major equalizer." In this paper, we embrace this equalizer. Our model curriculum includes a lab aspect that can help ease data analytics into the accounting curriculum – the integrated web tool utilized as part of the proposed curriculum includes tutorial videos and instructions for how to access open data sets using Tableau, and create data visualizations.

III. INTRODUCTION TO THE ACCOUNTING INFORMATION TECHNOLOGY COURSE MODEL

Learning Objectives

The proposed accounting information course model includes core components with lab sessions for additional practical application to support the experiential learning model. The core components include an instructor textbook and Tableau Desktop authoring tools. The support components include weekly lab projects, which build towards the final project. The course learning objectives facilitates students: (1) developing different advanced analytics to support the driven-digital business decision, (2) cultivating an interest in accounting analytics models by incorporating professional performance business models into the curriculum, (3) developing competence in a professionally developed web interactive self-developed lab tool.

The Accounting Information Technology Course Model

The Core Components

The Accounting Information Technology textbook. Textbooks are central to the traditional AIS course, and we recommend Accounting Information Systems (3E), Richardson, Teeter, and Terrell (McGraw Hill 2021), ISBN 978-1-259-96953-9. The software lists are included, such as the Tableau for Students License:

<https://www.tableau.com/academic/students>,

Our course model covers the following objectives:

- 1) Introduction to AIS and Firm Value,
- 2) Accountants as Business Analyst
- 3) Data Modeling
- 4) Data Analytics and Emerging Technologies in AIS
- 5) Emerging Technologies: Blockchain and AI Automation
- 6) Managing and Evaluating AIS
- 7) Information Security and Computer Fraud
- 8) Monitoring and Auditing AIS
- 9) The Balanced Scorecard Business Model Canvas, and Business Value of Information
- 10) Evaluating AIS Investments

11) Final Project: Executive Interactive Dashboard as the response to given Business Questions

Beyond the textbook content, instructors may also include other BI software for comparison such as **(a) Free Excel with Cheat Sheet for Students** (<https://www.educba.com/matrix-in-excel/>), **(b) Power BI Students License** <https://powerbi.microsoft.com/en-us/diad/>

Tableau Authoring Tools

The Support Components

1. Weekly homework

Week 1: Accountants as Business Analysts, Accounting Information Systems, Why Study AIS? Data versus Information, Role of Accountants in AIS, where do AIS Add Value to a Business?

Week 2: The Roles of the Accounting/Finance Functions in Business, Technology and Business Process, Business Model, Documentation, Value of Business Models, Business Process Model and Notation (BPMN) Standards Diagrams, Theory Good BPMN Standard, Example, Interactive Practice Case Studies

Week 3: Understanding the Purpose of Structure Models, Unified Modeling Language (UML) Classes, Association, Multiplicities, Practical Example of UML, Implementation of a Relational Database from a UML Class Diagram, Primary Keys, Foreign Keys, UML Relationship, Generalization Relationship, Aggregation Relationship, Compositions Relationship, Practical Example of UML with the Relationship Database Concept, Final Business Decision Requirements, Decision Categories, Business Rules

Week 4: Exam from Week 1 – 3 Objectives

Week 5: Big Data and Data Analytics, Benefits and Costs of Data Analytics, ETL (Extract, Transform, and Load), The Impact of Data Analytics on Business, AMPS Model, Audit Data Standards, Predictive, Prescriptive Data Analytics, Data Analytics in Accounting: Tools and Practice, Excel – Understanding Features for Data Analytics, Tableau – Understanding Features for Data Analytics, Microsoft Access Features for Data Analytics, Power BI – Understanding Features for Data Analytics

Week 6: The History of Blockchain, What Is Blockchain, Traditional vs Blockchain. Popular Cryptocurrency Applications, Types of Blockchain, Blockchain Technology Platforms What is Artificial Intelligence, Cognitive Technologies, Machine Learning, Neural Networks Types of Machines Learning Applications, Assessing Model Performance, AI in Accounting

Week 7: Exam from Week 5 – 6 Objectives

Week 8: Essential Control Concepts, Why Code of Ethics, Internal Controls, Committee of Sponsoring Organizations (COSO) Internal Control Framework, COSO Enterprise Risk Management Framework, Control Objectives for Information and Related Technologies (COBIT) Framework, COBIT Implications for IT Governance, Other Governance Frameworks, Related to Information Systems Management, and Security

Week 9: Information Security and System Integrity, Information Security Risks and Attacks, Encryption Methods, Authentication, Hashing Process and Message Digest, Digital Signature Cybersecurity Risk Management Framework by AICPA, Computer Fraud and Abuse, Computer Fraud Risk, Computer Fraud Schemes, General Data Protection Regulation, Vulnerability Assessment and Management, Disaster Recovery and Business

Week 10: Computer Hardware and Software, Operating Systems, Data Base Systems, Wireless Network, Computer-Assisted Audit Techniques (CAATs), Auditing through Computer Fraud Schemes and Red Flags

Week 11: The Balanced Scorecards, Learning & Growth Perspective, Process Perspective Customer Perspective, Financial Perspective, why a Balanced Scorecard, Generic Strategy Map Nature of Information Technology Investments, Roles of AIS/IT in Balanced Scorecard Framework, Summary of 3 IT Investment Categories, The Balanced Scorecard Management Process, IT Governance Institute Val IT Framework, Domains of Governance, Business Model Canvas, Business Model Integration

Week 12: Large IT Projects, Business Case for IT Initiatives, The Economic Justification Process, Assessing Business Requirements, Estimating Relevant Costs, Assessing Risks, Combining Benefits, Costs, and Risks, Capital Budgeting Financial Metrics, The Systems Development Life Cycle, Phases of the Systems Development life Cycle, Planning Phase Analysis Phase, Implementation Phase, Project Management Tools

Week 13: Final Project Class Presentation, LAB, and Vote to Select the Best Project for Class Presentation, Final Project Class Presentation, Tableau Dashboard – Business Case for Executive Business Decision

Week 14: Pre-Review for Exam from Week 8 – 14 Objectives

Week 15: Exam from Week 8 – 14 Objectives

2. The analytics weekly LAB class.

LAB Week 1 – Set Up the Foundation Work for our Final Project

Install Tableau, **Tableau for Students License** <https://www.tableau.com/academic/students>
Open the link with Data Source Elements, Open New File in Tableau and add the name for the file Lab1_Milestone. Connect to Data Source via Tableau, Create WK_PR_1, WK_PR_2, WK_PR_3, Create DS_PR_1, DS_PR_2, DS_PR_3, Create Story Line – Final_Project_AIS

Attached is my interactive video for all steps above: <https://youtu.be/5bdEsJwaLlk>

LAB Week 2 – Select Variables into our Worksheet.

Open WK_PR_1, Select the Variables: Borough, Total Grads % of cohort, Total Grads#, Drag and Drop off Borough Variable to the Column, Drag and Drop off Total Grads % of cohort to the Row, Drag and Drop off Total Grads# to the Row, Click on Borough Variable – Right Corner and Select “Show Filter” Option, Click on Total Grads % of cohort Variable – Right Corner and Select “Show Filter” Option, Click on Total Grads# Variable – Right Corner and Select “Show Filter” Option

Attached is my interactive video for all steps above: <https://youtu.be/OmUbKtW8Qv8>, Please repeat these tasks in Lab#2 for part 2 and 3 our final project

LAB Week 3 – Formatting Worksheet & Title

Open WK_PR_1, Format Worksheet – Shading, Borders, Fonts, Format Title – Color & Fonts
Attached is my interactive video for all steps above: <https://youtu.be/M4oD2oGni6I>, Please repeat these tasks in Lab#3 for part 2 and 3 our final project.

LAB Week 4 – Formatting Filters

Open WK_PR_1, Click on the right Corner “Borough” Filter and Select the option “Dropdown”, Click on the right Corner “Borough” Filter and Select “Format.”, Change the Color and Fonts in that Filter and all other Filters will be changed automatically.

Attached is my interactive video for all steps above: <https://youtu.be/aEX1ysXGqUQ>, Please repeat these tasks in Lab#4 for part 2 and 3 our final project

LAB Week 5 – Use Marks into Worksheet Sometimes Call “Cosmetics”

Open WK_PR_1. Select Marks then Color – Changes Here are Your Decision, Select Size – Changes Here are Your Decision, Select Label – Changes Here are Your Decision, Select Tooltip– Changes Here are Your Decision, Select Shape– Changes Here are Your Decision
Attached is my interactive video for all steps above: <https://youtu.be/zEQyAkIdNEw>, Please repeat these tasks in Lab#5 for part 2 and 3 our final project.

LAB Week 6 – Create Dashboard with Formatting

Open DS_PR_1, Click on the Floating Option, On the Top Menu Select Dashboard Then Select Format for Your Background, Drag and drop off the Worksheet that We completed in Lab#5, Click the Write Corner Each Object and Select “Formatting” to Polish Dashboard

Attached is my interactive video for all steps above: <https://youtu.be/6VjKWk45Hwg>, Please repeat these tasks in Lab#6 for part 2 and 3 our final project

LAB Week 7 – Dashboard – All Other Features

Open DS_PR_1, Select Objects Text, Select Objects Image, Select Objects Web Page, Select Object Download

Attached is my interactive video for all steps above: <https://youtu.be/9wWgetGvjIM>, Please repeat these tasks in Lab#7 for part 2 and 3 our final project.

LAB Week 8 – Story Line for Final Project with Formatting

Final Project AIS – Story Line, Top Menu – Select Format and All Features Can be change,

Click on the new story points and add two more for now but you will need to add in the final project for all three parts, Select DS_PR_1 and Drag and Drop off to your story line, You can add at the beginning of your Title Page

At the end you can add blank story point with your summary final project

Attached is my interactive video for all steps above: <https://youtu.be/lgQQvG9IABY>, Please repeat these tasks in Lab#8 for part 2 and 3 our final project.

LAB Week 9 – Advanced Options that We can add to our Worksheet.

Open WK_PR_1, Variable Borough Drag and Drop off to Object “Pages”, Format “Pages”, Full Interactive Worksheet – Move into Your Final Story Line

Attached is my interactive video for all steps above: <https://youtu.be/30z8ENNdXOM>, Please repeat these tasks in Lab#9 for part 2 and 3 our final project.

LAB Week 10 – Advanced Options that We can add to our Dashboard.

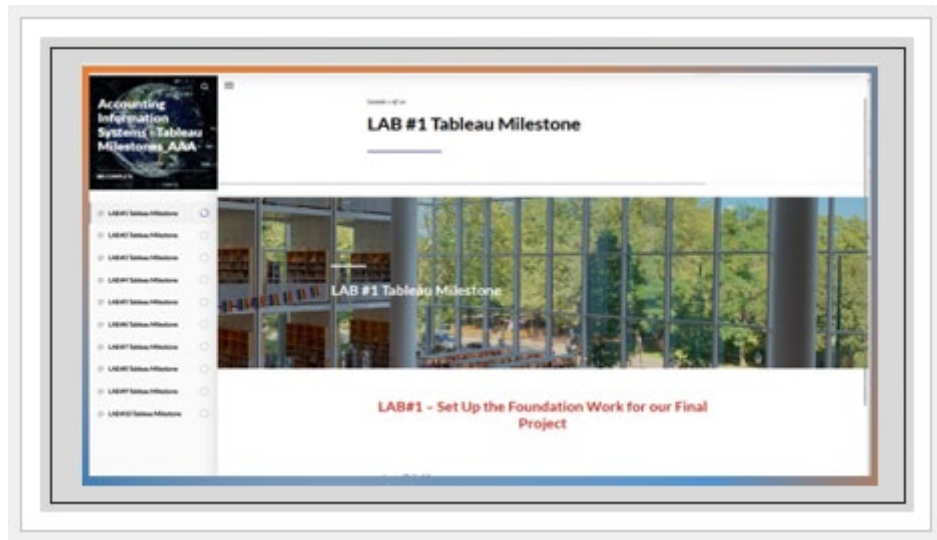
Open DS_PR_1, You Can Add more Worksheet to One Dashboard, Add Action Bottom, Set Up One Filter for All Part of Dashboard

Attached is my interactive video for all steps above: <https://youtu.be/Xih1JsoaQYc>, Please repeat these tasks in Lab#10 for part 2 and 3 our final project.

All Project Steps Together:

<https://youtube.com/playlist?list=PL1BsfaLpLrE1jsmbTCQnSDcQiNV3hio7v>

Figure I: Digital Tool Created by Author



Step 2: Using the total graduation rates variable, create a line chart that displays one line for each borough that illustrates each borough's graduation rate over time and includes: 1) a caption, 2) chart titles, 3) a legend.

Step 3: Using the provided dashboard, write an executive memo for the business in the given scenario by doing the following:

Step 4: Summarize the business question from the given scenario, including its relevance to the business.

Step 5: Summarize the following data from the given analysis: 1) Identify three project costs. Explain the significance of each project cost including the impact on the business. 2) Identify three milestones. Explain the significance of each milestone, including the impact on the business. 3) Identify one risk to the business. Summarize a mitigation plan to address the risk identified. 4) Identify one opportunity for business. 5) Recommend at least one action for the business based on the opportunity identified. 6) Justify your recommendation.

Project II (Case Study II): Create a prototype Tableau dashboard that includes the following variables by doing the following: school safety [Borough Name, AvgOfVio N]
Using Tableau, import the data sets from the web links provided, and create a screenshot that includes each of the following data sources in Tableau. All imported data file names must be renamed to start with your last name. The second option is to connect directly to the data sources and use them in Tableau.

Open Data Sources: 2010 – 2016 School Safety Report

<https://data.cityofnewyork.us/Education/2010-2016-School-Safety-Report/qybk-bjic>

Step 1: Create a worksheet for the sum of the average number of safety violations per building by borough, including a screenshot for each of the following: a) Identify the business question that relates to school safety and includes the correct variable choice. b) Select the correct filters for the data. c) Calculate the sum of the average number of safety violations per building by borough.

Step 2: Using the total graduation rates variable, create a line chart that displays one line for each borough that illustrates each borough's graduation rate over time and includes: 1) a caption, 2) chart titles, 3) a legend.

Step 3: Using the dashboard provided, write an executive memo for the business in the given scenario by doing the following:

Step 4: Summarize the business question from the given scenario, including its relevance to the business.

Step 5: Summarize the following data from the given analysis: 1) Identify three project costs. Explain the significance of each project cost including the impact on the business. 2) Identify three milestones. 3) Explain the significance of each milestone, including the impact on the business. 4) Identify one risk to the business. 5) Summarize a mitigation plan to address the risk identified. 6) Identify one opportunity for the business. 7) Recommend at least one action for the business to take based on the opportunity identified. 8) Justify your recommendation.

Project III (Case Study III):: Create a prototype Tableau dashboard that includes the variables: current energy usage [Borough, Consumption (KWH)], by doing the following:

Using Tableau, import the data sets from the web links provided, and create a screenshot that includes each of the following data sources in Tableau. All imported data file names must be renamed to start with your last name. The second option is to connect directly to data sources and use Tableau (Step-by-Step Instruction at the end of group project content).

Open Data Sources:

2010 – April 2020 Electric Consumptions and Cost <https://data.cityofnewyork.us/Housing-Development/Electric-Consumption-And-Cost-2010-April-2020-/jr24-e7cr>

Step 1: Create a worksheet for the sum of the average number of safety violations per building by borough. The worksheet must include a screenshot that addresses each of the following: a) Identify the business question that relates to energy consumption and includes the correct variable choice. b) Select the correct filters for the data. c) Calculate the average energy usage for each of the boroughs.

Step 2: Using the total graduation rates variable, create one line chart that displays one line for each borough that illustrates each borough's graduation rate over time and includes: a) a caption, b) chart titles, c) a legend.

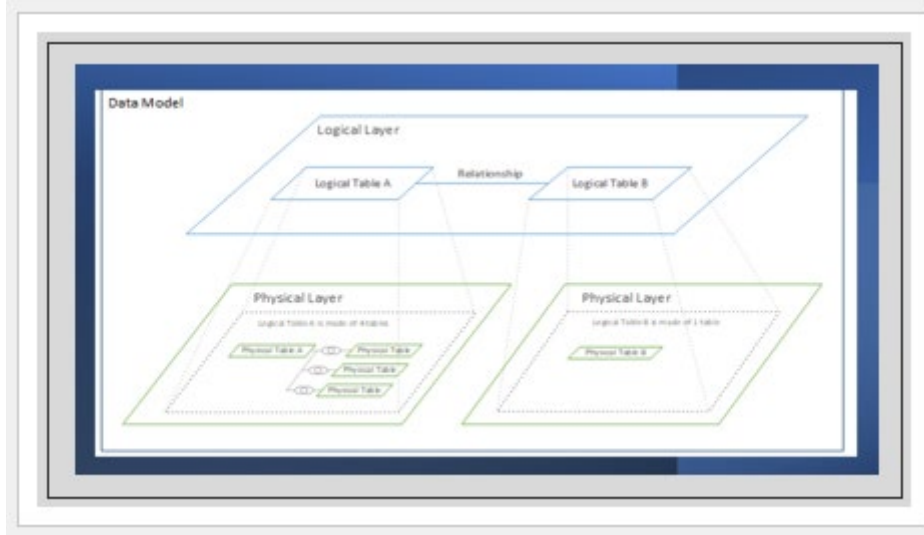
Step 3: Using the dashboard provided, write an executive memo for the business in the given scenario by doing the following:

Step 4: Summarize the business question from the given scenario, including its relevance to the business.

Step 5: Summarize the following data from the given analysis: 1) Identify three project costs. Explain the significance of each project cost including the impact on the business. 2) Identify three milestones. 3) Explain the significance of each milestone, including the impact on the business. 4) Identify one risk to the business. 5) Summarize a mitigation plan to address the risk identified. 6) Identify one opportunity for the business. 7) Recommend at least one action for the business to take based on the opportunity identified. 8) Justify your recommendation.

Understanding the Accounting Data Model with Tableau Authoring Tool

Figure III: Tableau Data Model



Source:

Available at: https://help.tableau.com/current/pro/desktop/en-us/datasource_datamodel.htm.

How Does Tableau Solve our Business Problems?

Tableau enables users to regain control of their data and minimize the impact of traditional technical dependencies. We can discover relationships and facts that are not at once clear through experimentation with data elements, and then visualize our data for the presentation. Users may combine multiple objects to create a unique interactive storyboard where we transfer and share all discovered knowledge using dashboards. Otherwise, it can show the path to their “nuggets of gold”. Finally, we can store our documents on the Tableau server and grant other users’ access to those documents or data sources.

Tableau provides drill down capability to the dashboard, allowing users to explore multidimensional data by navigating down to a more detailed level. With these, users can view both aggregated data and summary data. With user-defined triggers, users can explore deeper levels of data to allow more specific forms of analysis. Another benefit is that Tableau does not require programming skill, where users need to spend significant amounts of time writing code. This user-friendly tool gives more control to the user through features such as drag and drop feather, simple filtering options, data presentation, collaboration and sharing, live and in-memory data, built-in security, and mobile view.

Who Are the Tableau Target Users?

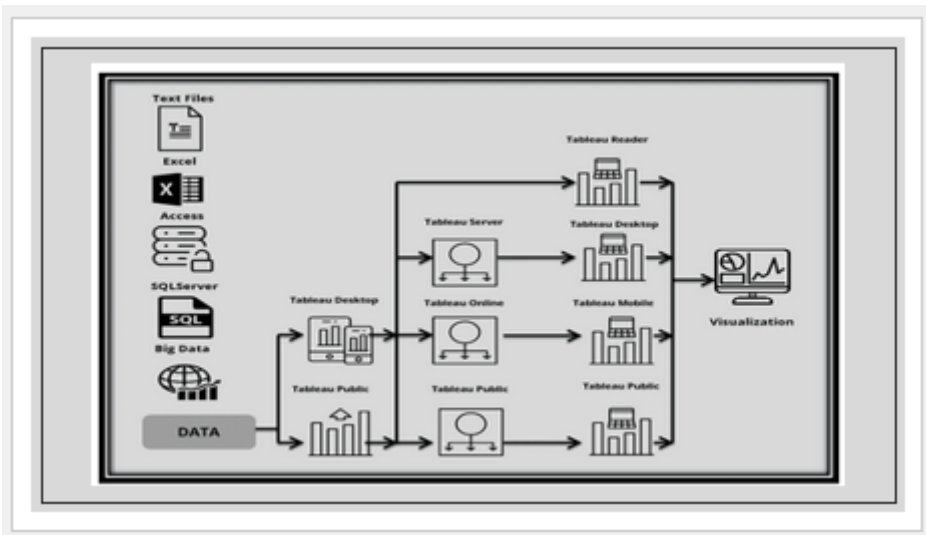
Managers – use the dashboards and storyboards to make informed and intelligent business decisions based on current data sources and trends.

Business Intelligence (BI) Experts – create interactive dashboards and storyboards.

Other Business Users – consume information that enables them to perform their jobs.

Data Scientist – comprehending and present data, collectively strengthening data scientist skill sets.

Figure IV: Tableau Solution – Big Picture



Source: Compiled by Authors

Tableau can retrieve and visualize data elements from a wide range of data sources such as:

1. Excel
2. Text and Comma-Separated Files [CSV]
3. Desktop Databases [Access]
4. Big Data [Cassandra, Hive, Hbase]
5. Enterprise Databases [Oracle and SQL Server]
6. Json File
7. Pivotal Greenplum
8. PostgreSQL
9. SAP HANA
10. Snowflake
11. TIBCO
12. Google Drive

Tableau provides over 70 data connectors.

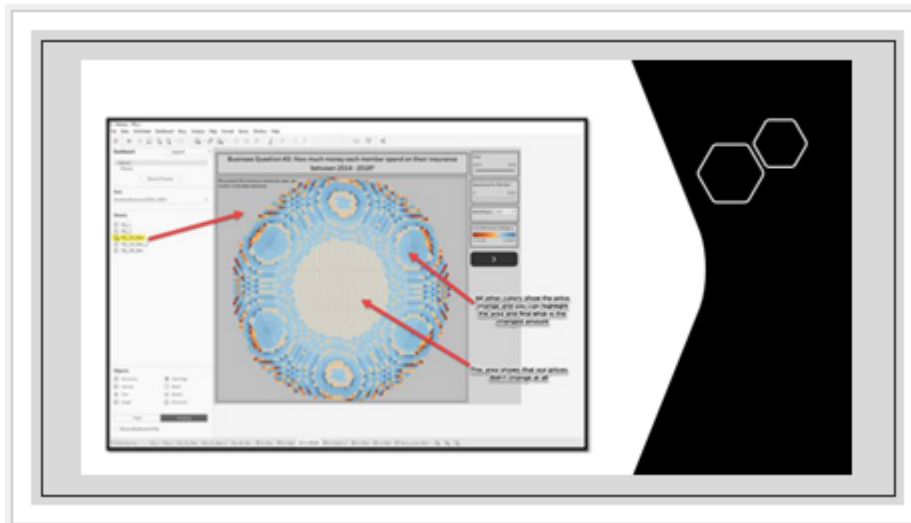
I. IMPLEMENTING THE MODEL THAT RESPONDS TO OUR THREE SELECTED BUSINESS QUESTIONS

We created the two dashboards in the previous lesson and are now going to design the final storyline product in Tableau that you can use for prescriptive analytics.

We have five business questions example and one more information dashboard in this scenario.

Dashboard 1: Business Question 1: How Much Money Did Each Member Spend on Their Insurance between 2014 -2015? – Maximum Values

Figure V: Final Dashboard – Response to Business Question 1



Source: *Author*.

In this practice, we are removing clusters, adding the variable “Cumulative Price Change,” and extending our research period from 2014 to 2018.

We are looking for visualization areas where the price does not change at all. Then collect the data for analysis and document the areas where the price has changed including the amount of each change.

You can select the data for your analysis and easily find the trend in both areas using the graph above. The system shows you all changes, so you do not need to create any pivot tables here. The other approach is to come back to our clustering with the same dashboard and the same business question.

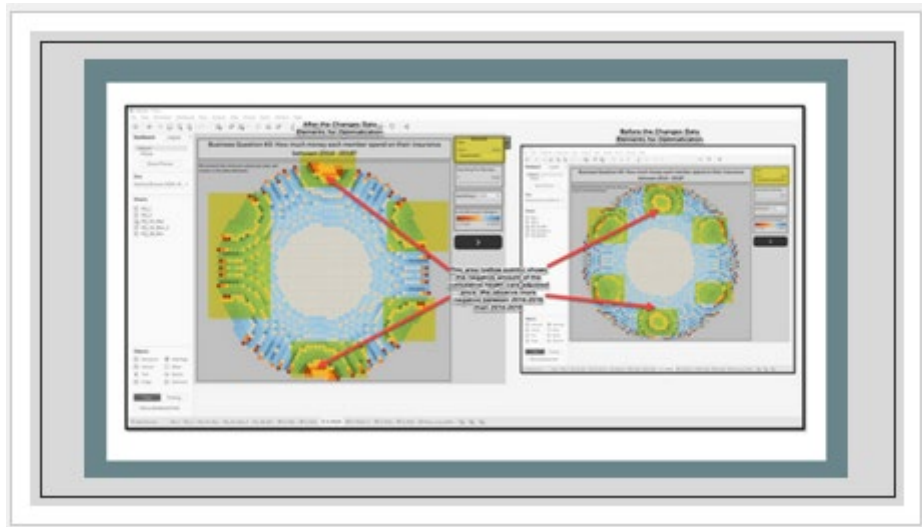
We are going to select the additional variable plan type “CDHP” – Consumer Directed Health Plan (a type of health plan that gives you more control of your health care expenses). A CDHP most often pairs with a Health Savings Account (HSA) or some other tax-advantaged account. We will observe in the population how many members have a CDHP type plan, and how many members do not have a CDHP but have another type of health care plan in our data elements. You can find on each color other information to extend your research through data including:

1. Plan Type
2. Year from
3. Year to
4. Price
5. Cumulative Price Change Adjusted Price
6. Cumulative Price Change Adjusted Price per 1000 members.

You can click on, and export the data you need for future reference, or your current investigation.

Dashboard 2: Business Question 2: What is the essential part of the health costs discussion in the public community?

Figure VI: Final Dashboard – Response to Business Question 2



Source: *Author*.

Now, you can continue to apply more deep knowledge of how to better optimize your outcome to discover new business insights. We can compare the years 2014-2016, 2014-2018, and 2014-2019. We can manipulate the data element spending per member and observe the different insights. We can change any available data for our optimization. We can change the year from 2015-2016 and see what we received on the visualization. We have marked in yellow the data elements that have been changed. You can more easily find the changes on our graph instead of the spreadsheet, even for calculating the difference or the percentage of these changes. Now, you can review your tables with the data, and quickly find the changes we have created here in our example. After completing these steps, you can summarize your observation: All negative amounts refer to HCCI category “Inpatient services” with the following HCCI subcategories: a) Medical, b) Mental Health, c) Hospice, d) Surgical Services. You can add to your business insight report your recommendations to investigate what the reason was for the changes observed in these categories between 2014 and 2016.

The potential of artificial intelligence and adjacent technologies is growing each day, and every business knows this is a critical part of their competitive strategy going forward. However, amidst all of the new opportunities that these technological advancements create, most companies are still grappling with the basic challenges in the technology landscape of implementing at scale and speed. Learn how AIP+, partnering Tableau, has accelerated clients’ transformation in a world where speed is the new key performance indicator (KPI) of business.

II. Tableau Introduction Features and Intermediate Features – Supplemental Digital Teaching Tool to our Article

Figure VII: Tableau Intermediate Features



Source: Author. Access. Available at: <http://thevirtualserver.com/TAB3/content/index.html#/>
Using this digital tool, you can learn about the Tableau installation, functions in Tableau, and Connecting to Data.

Figure VIII: Tableau Intermediate Visualization Features



Source: Author. Access. Available at: <http://thevirtualserver.com/TAB3/content/index.html#/>
Content includes: 1. Data Roles and Options, 2. Map Format, 3. Dates, Times, and Filtering, 4. Gantt Charts, 5. Visual Grouping, 6. Histograms, 7. Sets, Groups, 8. Sorting with Combinations.

9. Quick Table Calculations, 10. Secondary Table Calculations, 11. Trend Lines Options, 12. Reference Lines & Performance

III. CONCLUSION

These instructional resources paper presents a modern AIS course model that integrates a data analytics, visualization approach in response to a series of business questions, using the Tableau Desktop authoring tool. The support content includes a professionally developed digital teaching tool that you can use directly in your classroom. The model also includes weekly labs, homework, and a final project with three different choices of topic for your selection. The main learning objectives for students are (1) Introduction to AIS and Firm Value, (2) Accountants as Business Analyst, (3) Data Modeling, (4) Data Analytics and Emerging Technologies in AIS, (5) Emerging Technologies: Blockchain and AI Automation, (6) Managing and Evaluating AIS, (7) Information Security and Computer Fraud, (8) Monitoring and Auditing AIS, (9) The Balanced Scorecard Business Model Canvas, and Business Value of Information, (10) Evaluating AIS Investments, (11) Final Project: Executive Interactive Dashboard as the response to given Business Questions.

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TABLE 1: EXAMPLE OF COURSE SCHEDULE:

<u>Week No.</u>	<u>Topics</u>	<u>Assignments</u>
1.	<u>Introduction to the Course & AIS and Firm Value</u> Monday – Introduction to the Course Wednesday – AIS and Firm Value Accountants as Business Analysts Accounting Information Systems Why Study AIS? Data versus Information Role of Accountants in AIS Where do AIS Add Value to a Business? <u>Tableau Milestone Lab #1</u>	Ch. 1 Homework Quiz
2.	<u>Accountants as Business Analysts</u> <u>Monday:</u> The Roles of the Accounting/Finance Functions in Business Technology and Business Process Business Model Documentation Value of Business Models <u>Wednesday</u> BPMN Standards Diagrams Theory Good BPMN Standard Example Interactive Practice Case Studies <u>Tableau Milestone Lab #2</u>	Ch. 2 Homework Quiz
3.	<u>Data Modeling</u> <u>Monday:</u> Understand The Purpose of Structure Models Unified Modeling Language (UML) Classes, Association, Multiplicities Practical Example of UML	Ch. 3 Homework Quiz

	<u>Wednesday</u> Implementation a Relational Database from a UML Class Diagram Primary Keys Foreign Keys UML Relationship Generalization Relationship Aggregation Relationship Compositions Relationship Practical Example of UML with the Relationship Database Concept Final Business Decision Requirements Decision Categories Business Rules <u>Tableau Milestone Lab#3</u>	
4.	Examinations (Chapter 1 & 2 & 3) with all topic from week 1 through week 3	Exam 1
5.	<u>Data Analytics and Emerging Technologies in AIS</u> <u>Monday:</u> Big Data and Data Analytics Benefits and Costs of Data Analytics ETL (Extract, Transform, and Load) The Impact of Data Analytics on Business AMPS Model Audit Data Standards Predictive, Prescriptive Data Analytics <u>Wednesday</u> Data Analytics in Accounting: Tools and Practice Excel – Understanding Features for Data Analytics Table–u - Understanding Features for Data Analytics Microsoft Access Features for Data Analytics Power –I - Understanding Features for Data Analytics <u>Tableau Milestone Lab#4</u>	Ch. 10 & 11 Homework Quiz
6.	<u>Emerging Technologies: Blockchain and AI Automation</u>	Ch. 12

	<u>Monday:</u> The History of Blockchain What Is Blockchain Traditional vs Blockchain Popular Cryptocurrency Applications Types of Blockchain Blockchain Technology Platforms <u>Wednesday</u> What is Artificial Intelligence Cognitive Technologies Machine Learning Neural Networks Types of Machine Learning Applications Assessing Model Performance AI in Accounting <u>Tableau Milestone Lab#5</u>	Homework Quiz
7.	Midterm Examinations (Chapter 10,11,12)	Exam 2
	Spring Break	
8.	<u>Managing and Evaluating AIS</u> Accounting Information Systems and Internal Control <u>Monday:</u> Essential Control Concepts Why Code of Ethics Internal Controls COSO Internal Control Framework COSO Enterprise Risk Management Framework <u>Wednesday</u> COBIT Framework COBIT Implications for IT Governance Other Governance Frameworks Related to Information Systems Management And Security <u>Tableau Milestone Lab#6</u>	Ch. 13 Homework Quiz

9.	<u>Information Security and Computer Fraud</u> <u>Monday:</u> Information Security and System Integrity Information Security Risks and Attacks Encryption Methods Authentication Hashing Process and Message Digest Digital Signature <u>Wednesday</u> Cybersecurity Risk Management Framework by AICPA Computer Fraud and Abuse Computer Fraud Risk Computer Fraud Schemes General Data Protection Regulation Vulnerability Assessment and Management Disaster Recovery and Business <u>Tableau Milestone Lab#7</u>	Ch. 14 Homework Quiz
10.	<u>Monitoring and Auditing AIS</u> <u>Monday:</u> Computer Hardware and Software Operating Systems Data Base Systems Wireless Network <u>Wednesday</u> Computer-Assisted Audit Techniques (CAATs) Auditing through the Computer Fraud Schemes and Red Flags <u>Tableau Milestone Lab#8</u>	Ch. 15 Homework Quiz
11.	<u>The Balanced Scorecard, Business Model Canvas, and Business Value of Information Technology</u> <u>Monday:</u> The Balanced Scorecards Learning & Growth Perspective	Ch. 16 Homework Quiz

	Process Perspective Customer Perspective Financial Perspective Why a Balanced Scorecard Generic Strategy Map <u>Wednesday</u> Nature of Information Technology Investments Roles of AIS/IT in Balanced Scorecard Framework Summary of 3 IT Investment Categories The Balanced Scorecard Management Process IT Governance Institute Val IT Framework Domains of Governance Business Model Canvas Business Model Integration <u>Tableau Milestone Lab#9</u>	
12.	<u>Evaluating AIS Investments</u> Systems Development <u>Monday:</u> Large IT Projects Business Case for IT Initiatives The Economic Justification Process Assessing Business Requirements Estimating Relevant Costs Assessing Risks Combining Benefits, Costs, and Risks Capital Budgeting Financial Metrics <u>Wednesday</u> The Systems Development Life Cycle Phases of the Systems Development life Cycle Planning Phase Analysis Phase Implementation Phase Project Management Tools <u>Tableau Milestone Lab#10</u>	Ch. 17 & 18 Homework Quiz
13.	<u>Monday:</u> Final Project Class Presentation	

	LAB and Vote to Select the Best Project for Class Presentation on Wednesday <u>Wednesday</u> Final Project Class Presentation Tableau Dashboard - Business Case for Executive Business Decision	
14.	<u>Review before Final Exam – (Ch 13,14,15,16,17,18)</u>	<u>Exam 3</u>
15.	Final Examinations (Ch 13,14,15,16,17,18)	<u>Exam 3</u>

DECISION SCIENCES INSTITUTE**Transforming Decision Sciences Education Through AI and Agile: A Case Study of Project-Based Learning in Technology Management**

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ABSTRACT

The rapid evolution of technology demands innovative approaches in decision sciences education to prepare students for dynamic, technology-driven workplaces. This paper examines how the integration of Artificial Intelligence (AI) tools and Agile methodologies can address three critical challenges in business education: curricula that lag technological advancements, limited opportunities for hands-on skill application, and constrained academic timeframes. Through detailed analysis of two case studies from a Management and Systems graduate program—an AI-driven media analysis tool developed for the United Nations International Computing Centre (UNICC) and a series of AI-focused capstone projects—we demonstrate how this integrated approach enhances curriculum relevance, expands practical skill development, and optimizes learning within semester constraints. Our findings reveal that AI-based projects achieved significantly higher client satisfaction ratings (45.3% vs. 29.8% "A" ratings) and publication-worthiness (26.6% vs. 6.4%) compared to traditional approaches. Additionally, the implementation of Agile methodologies fostered student adaptability, engagement, and efficient project execution. This research contributes to the evolving discourse on technology integration in business education and offers a practical framework for educators seeking to incorporate tomorrow's tools and methodologies in decision sciences curricula.

KEYWORDS: Artificial Intelligence (AI), Agile Methodologies, STEM Education, Project-Based Learning, Generative AI, Technology Management

INTRODUCTION

The swift advancement of technology has significantly changed global industries, highlighting important shortcomings in traditional educational methods, particularly in STEM (Science, Technology, Engineering, and Mathematics) and product development. Existing teaching approaches frequently fail to align with the fast-evolving industry requirements, resulting in students being ill-equipped to face real-world challenges. Three main factors contribute to this gap: obsolete curricula, insufficient opportunities for practical application, and constrained learning experiences due to limited time in academic programs.

First, many academic programs find it challenging to keep curricula up-to-date with the latest technological advancements and industry trends. While industry innovations emerge rapidly, programs delivered in the traditional approach can lag, resulting in a gap between the skills students learn and those required in modern workplaces. Second, there is a growing need for practical, hands-on experiences in educational settings. Without sufficient application of

technology in real-world scenarios, students often lack the industry-relevant skills that are critical for career readiness. Finally, limited time within academic programs, typically structured into short academic semesters - further constrains opportunities for meaningful, transformative learning. Given these time constraints, educational institutions must maximize the use of advanced tools and methodologies to offer efficient, high-impact learning.

In response to these challenges, this study explores the integration of Artificial Intelligence (AI) tools and Agile methodologies in STEM and product management education. Agile's iterative and incremental approach offers adaptability and engagement through practical problem-solving, while AI can support personalized, industry-relevant learning by automating tasks, offering real-time feedback, and enhancing the practical application of theoretical knowledge, as well as providing innovative solutions that students can explore as the basis for capstone projects. This study examines case studies from a Management and Systems graduate program, including the development of an AI-driven media analysis tool for the United Nations International Computing Centre (UNICC). This research explores how AI and Agile methodologies can maintain up-to-date curricula, enhance practical application opportunities, and optimize learning within limited timeframes, offering a viable model for contemporary educational frameworks in STEM and product management.

The capstone experience is meant to exercise as many of the skills and knowledge developed during the preceding education as possible. There is often an opportunity to work on real-world problems that have an immediate impact on the post-graduation employment of students. In other words, it prepares them for real-world work. Given that the education provided by the Management and Systems graduate program was primarily professional and not academic in nature, the capstone was necessarily an applied project. In all cases, the capstone was an individual effort, as required by the university for graduate degrees. Due to the nature of the program, we required the application of technology to solve a business problem for a real-world client. Program faculty assist students in finding clients and designing projects that fit those conditions. The advent of generative AI made both the design of technology projects much more accessible and able to be completed within the three months of the capstone semester, serving as both the technological basis for the project and assisting in completing it. We further introduced Agile as a preferred methodology for AI development and the project management approach to execute these projects.

Problem Statement

STEM and product management education face three primary challenges: keeping curricula up-to-date with technological advancements, increasing opportunities for practical technology application, and managing limited time in master's programs to provide meaningful learning experiences.

First, keeping curricula current with the latest technological advancements remains a significant challenge. As industries rapidly evolve, academic programs often struggle to align their content with the most relevant skills needed in the workforce. This gap between industry demands and academic offerings can leave students ill-equipped for the fast-paced technological environment awaiting them after graduation.

Second, the need to increase **opportunities for practical technology application** has become more pressing. Although theoretical knowledge forms a foundational component of education, students frequently lack real-world, hands-on experience. This absence of practical

application hinders their ability to transition effectively into professional roles, where experiential knowledge is essential for success.

Finally, time constraints within a master's programs—which typically last two years or less—limit the scope of transformative learning experiences. Given these tight timeframes, educational institutions are increasingly challenged to incorporate cutting-edge methodologies, such as Agile practices and Generative AI (GenAI), to optimize learning.

These challenges underscore the urgent need for educational frameworks that are adaptable, practical, and time-efficient, ensuring students are prepared to meet industry expectations.

Proposed Solution

To bridge the gap between traditional education and the rapidly evolving demands of STEM and product management fields, this paper propose an integrated framework that combines Artificial Intelligence (AI) and Agile methodologies. This approach is designed to synchronize academic theory with industry practices, creating an adaptive learning environment aligned with real-world needs.

Typically, each client and problem must be identified by the capstone student and approved by faculty as appropriate. It serves as the foundation for their individual three-month project. Our innovation focuses on utilizing AI, particularly Generative AI, for most project technologies, while also introducing Agile methodology to ensure project success execution. These are the basis for our first case study.

For clients who have more ambitious projects than can be expected from one student in a three-month, semester-long project, we devised a different approach. If the client's project is complex, we engaged a product manager to design individual capstone projects around the final product so that they fit the capstone experience model described above and deliver an acceptable product to the client. In most cases, this required the client specifications to be broken into multiple smaller projects, each becoming a capstone project that the students work on as a team, with one of the students' projects being the integration of the pieces into a whole. This required students to work as a team while also working on their own individual capstones. It could also become the basis, as we did in our current case, for a competition sponsored by the client. This last approach has a number of unique elements: (1) introduction of group work in a capstone framework that only allows for individual contributions; (2) opportunity to demonstrate real-world competition between firms, which is often present in the students' work environment; (3) opportunities to engage major sponsors of the program in competitions that allow them to look at talent graduating from our university, which is a major source of employment for the students.

This model was successfully applied to a typical client-driven initiative and is the basis for our second case study. The United Nations International Computing Centre (UNICC) presented our program with a challenge to develop an AI-driven media analysis tool that could detect and inform on the level of harm news articles and postings caused to vulnerable populations.

Research Questions

The research questions are structured to address each challenge:

Research Question 1: *How can AI and agile integration help STEM and product management curricula stay up-to-date with rapid technological changes?*

Research Question 2: *To what extent does the use of AI and Agile methodologies in academic projects enhance opportunities for hands-on, practical technology application?*

Research Question 3: *Can AI and Agile methodologies optimize learning experiences to deliver high-impact outcomes within the limited timeframes of academic programs?*

By addressing these questions, the study aims to reveal how AI and Agile methodologies can be leveraged to create an educational framework that not only bridges the gap between theory and practice but also meets the evolving needs of both students and the modern workforce.

LITERATURE REVIEW

Artificial Intelligence (AI) and Agile methodologies are increasingly central to addressing the educational challenges faced in STEM and product management domains. These fields are rapidly evolving, demanding that educational frameworks adapt to provide practical, industry-relevant skills and foster adaptable learning environments. Existing literature underscores the potential of AI and Agile, both individually and in combination, to transform STEM education by enhancing engagement, fostering critical thinking, and accelerating skill development.

Luckin et al. (2022) introduce the concept of “AI Readiness,” which emphasizes the need for educators to integrate AI effectively into educational settings. Their seven-step framework outlines how AI tools, such as automated grading and personalized learning systems, can optimize student outcomes by adjusting content to individual abilities. By fostering collaboration between AI systems and human educators, AI-driven solutions enable iterative, Agile methodologies that create flexible learning environments aligned with the fast-evolving demands of modern industries.

Recent studies further emphasize the transformative role of AI-driven tools in enhancing educational experiences, particularly through chatbots as intelligent assistants in classroom settings. Chen, Jensen, Albert, Gupta, and Lee (2023) explored the use of AI chatbots to support student success in business education, revealing promising applications and important challenges. Their two-part study showed that chatbots effectively supported students in mastering foundational content, with students appreciating the immediate, interactive feedback that such AI systems provide. Furthermore, Chen et al. (2023) identified chatbots' potential in fostering a more inclusive learning environment by offering responsive, confidential help on basic queries, alleviating the strain on instructors in high student-teacher ratio contexts. These findings align with Agile methodologies, underscoring the potential for chatbots to facilitate adaptive, iterative learning experiences. However, ethical considerations such as data privacy and fairness remain critical, indicating a need for robust AI frameworks to support equitable learning outcomes. This work provides insights into the dual educational and ethical dimensions of AI applications in higher education.

While AI offers considerable benefits in education, ethical considerations are essential to its responsible implementation. Holmes et al. (2021) discuss key ethical dimensions—fairness, accountability, transparency, and bias—that are critical when designing AI-driven educational tools. Educators must ensure these tools are inclusive and trustworthy, especially in diverse learning environments. By embedding ethical AI frameworks, institutions can create learning

tools that support varied learners without amplifying existing biases, ensuring that AI-driven, Agile educational environments uphold both technological and ethical standards.

One of the major challenges in education, particularly in STEM fields, is the constraint imposed by time. Time limitations frequently restrict the ability to provide in-depth, transformative learning experiences. Tang et al. (2024) examine how time constraints impact students' effectiveness in self-directed STEM projects, especially when they collaborate with external partners like industry professionals. Their research indicates that such collaborations often lead to project delays, resulting in incomplete or rushed outcomes. Despite exposure to time management tools such as Gantt charts, students found it difficult to adjust their schedules to accommodate unforeseen delays, highlighting a common struggle with adapting timelines in academic settings.

Moreover, Tang et al. (2024) identify that the rigid timelines in academic programs exacerbate time management challenges, as traditional time management tools are insufficient in real-world scenarios involving external collaborators. This underscores the need for adaptive strategies that help students manage time pressures more effectively. Here, Agile methodologies provide a promising solution. Agile's iterative framework, which organizes projects into manageable tasks or "sprints," allows for continuous feedback and reassessment. This structure supports real-time adjustment, empowering students to tackle complex projects more effectively within academic time constraints. Agile's adaptability thus aligns with educational settings where time limitations and external complexities often conflict with traditional project approaches.

In response to the challenges of time constraints in education, particularly heightened since COVID-19, many institutions have adopted hybrid and online learning models to increase flexibility. McKinsey & Company (2021) reports that these models enable more adaptable scheduling, supporting students in managing their time more effectively. This shift aligns well with Agile methodologies, which emphasize continuous iteration and improvement within short timeframes, offering a structured yet adaptable approach to learning.

Fortino and Yang (2024) further highlight the potential of AI in academic settings by evaluating the effectiveness of large language models (LLMs) such as ChatGPT and Claude 2 in answering structured questions and conducting statistical analyses in technical and business courses. Their findings suggest that LLMs are effective as teaching assistants, providing high factual accuracy and supporting classroom instruction. However, limitations include repetitive responses and a need for domain-specific fine-tuning to ensure AI tools align with educational goals. These insights emphasize the evolving role of AI in education and its potential to complement Agile methodologies by delivering adaptable, practical learning experiences.

Time constraints often limit the ability of educational programs to deliver transformative experiences. Gligorea, Voinea, and Popescu (2023) argue that AI-driven adaptive learning systems, which personalize content to match individual learning progress, can optimize limited academic time by allowing students to focus on relevant topics. This targeted approach to learning has been shown to improve engagement and performance, effectively addressing the challenges posed by time limitations in education.

Another well-documented challenge in STEM education is the gap between theoretical knowledge and real-world application. El-Khalili (2013) addresses this issue by advocating for integrating Agile methodologies and problem-based learning (PBL) into software engineering curricula. This approach enables students to engage in hands-on, iterative learning cycles that

connect theory to real-world practice. Institutions adopting Agile and PBL frameworks report that graduates are more industry-ready, effectively bridging the gap between academic knowledge and practical application.

The importance of addressing algorithmic bias is crucial in educational technologies. Baker and Hawn (2022) highlight that, while AI holds transformative potential, it risks perpetuating existing inequalities if underlying data and algorithms are biased. They point out how biases in data collection and model training can disproportionately affect students based on race, gender, and socioeconomic status. This underscores the necessity of ensuring that AI systems used in education are rigorously tested for fairness, a key consideration in developing ethical and effective AI-driven learning tools.

Kolb's (1984) experiential learning theory further reinforces the importance of bridging theoretical and practical learning. His four-stage learning cycle—Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation—encourages students to engage actively with real-world situations. This model supports the adoption of experiential learning in STEM, allowing students to apply theories in practice, reflect on their experiences, and refine their understanding. Many educational institutions have incorporated experiential learning into their curricula, better preparing students for the challenges of professional environments.

Serrador and Pinto (2015) provide empirical support for Agile methodologies, finding that Agile practices significantly improve project success across industries by enhancing efficiency and stakeholder satisfaction. This evidence supports integrating Agile into educational frameworks to promote iterative learning and adaptability, critical in STEM fields where innovation and responsiveness are essential. Agile's iterative approach allows educational projects to evolve with real-world demands, fostering deeper engagement and problem-solving skills.

Fortino and Rivera (2021) show the effectiveness of using coding competitions to develop critical STEM skills, such as Python and R programming, among graduate students. Through a series of workshops and contests, students gain hands-on experience in applications like text data mining and job search tools. This approach aligns with Agile methodologies, promoting iterative learning and problem-solving, providing a practical model for addressing skill gaps in STEM and product management education.

Sun et al. (2024) explore pre-service teachers' inclination to integrate AI into STEM education, identifying key factors such as Technological Pedagogical Content Knowledge (TPACK), perceived usefulness (PU), perceived ease (PE), and self-efficacy (SE). Their study reveals that teachers with high levels of these competencies are more likely to adopt AI technologies in teaching, aligning with the objectives of Agile and AI integration in fostering adaptable learning environments. These findings emphasize the need for educators to develop technical and pedagogical skills to effectively implement AI-driven educational tools (Sun et al., 2024).

Fortino (2024) underscores the transformative potential of Generative AI, which democratizes access to advanced AI systems by making them user-friendly and accessible. This integration could reshape how STEM students interact with AI, allowing them to engage with complex systems more intuitively and enhancing their learning experiences. The capacity of Generative AI to facilitate student interaction with sophisticated technologies supports the goal of fostering practical, real-world skills in STEM education.

METHODS

This study employed a **case approach** to investigate the effectiveness of integrating Artificial Intelligence (AI) and Agile methodologies in educational settings for STEM and product management. The research draws on two case studies: (1) the development of an AI-driven media analysis tool for the United Nations International Computing Centre (UNICC), and (2) a series of capstone projects within a technology management graduate program.

Hypothesis

This study posed three hypotheses to evaluate whether the integration of AI tools and Agile methodologies in STEM and product management education addresses the primary challenges of keeping curricula current, enhancing practical learning, and optimizing learning experiences within time constraints. This evaluation draws on the AI Capstone Projects and the AI-driven media analysis tool developed for the United Nations International Computing Centre (UNICC).

H1: Integrating AI-driven tools, including the UNICC AI media analysis tool and AI Capstone Projects, enhances students' ability to apply theoretical knowledge to practical, real-world challenges.

This hypothesis will be tested by analyzing student performance, project outcomes, and feedback on both the UNICC AI media analysis product and the AI Capstone Projects. By examining how these AI tools facilitate the application of academic concepts to complex, real-world problems, we aim to assess their impact on skill development and the practical application of theoretical knowledge.

H2: Employing Agile methodologies, such as iterative sprints and team-based collaboration, in projects like the UNICC media analysis tool and the AI Capstone Projects increases student engagement, adaptability, and delivery speed, fostering hands-on, experiential learning.

This hypothesis will be evaluated by observing the Agile processes used in these projects and analyzing their effect on student engagement, problem-solving, and adaptability compared to traditional waterfall project management processes. Evidence will be drawn from project outcomes, completion rates, and feedback from students and instructors on the collaborative learning experience fostered by Agile practices.

H3: The combined use of AI and Agile methodologies in the UNICC AI media tool and AI Capstone Projects optimizes learning experiences, enabling students to achieve higher quality outcomes within the limited timeframe of the capstone experience.

This hypothesis will assess whether the iterative nature of Agile, paired with the efficiency of AI tools, helps students manage time constraints more effectively than traditional structures. Data was gathered from project schedules, quality of deliverables, and student reports on productivity and time management, providing insight into how this combined approach meets the demands of semester-based programs.

Case Study 1: Management and Systems Capstone Projects

The Management and Systems graduate program capstone provided students with hands-on experience in AI-driven solution development through individually created projects. Each student worked on a distinct project, focusing on areas like prompt engineering, generative AI models, and Python and R-based tools projects. When present The Product Manager played a pivotal role in guiding these projects, establishing a structured process including project setup, Agile-based development, regular client communication, and final deliverables. These projects were three-month engagements supervised by the program's faculty, with the Product Manager acting as the primary point of contact for students to ensure that each project met its educational and technical goals. Of the 146 total capstone projects tracked over 4 years 35 (23%) were executed using a PM and 111 (77%) without a PM.

Project Setup and Selection Process

A faculty member acted as the project sponsor and proposed appropriate project for the students to consider. Students applied for their chosen projects by submitting a cover letter detailing their project interests, qualifications, and relevant coursework or experiences. The Product Manager reviewed these applications alongside the faculty supervisor to ensure alignment between the students' skills and the project requirements when awarding projects.

After project assignments were finalized, an onboarding session was provided to outline project guidelines, timelines, and expectations for documentation, client meetings, and deliverables. When present the Product Manager coordinated the project setup, helping students define clear functional objectives, modularize their projects, and create a timeline for completion. This structured approach offered students clear direction while allowing flexibility to adapt as the projects progressed.

Project Descriptions And Objectives

The capstone projects covered a diverse range of AI applications. The Product Manager worked closely with each student to refine project objectives and ensure consistency across deliverables. Typical projects included:

1. **Developing Text Data Mining Exercises with Generative AI Models:** Students created prompts to enable language models like ChatGPT-4 to perform text data analysis exercises.
2. **Creating No-Code Machine Learning Exercises Using Generative AI:** This project involved designing no-code machine learning exercises using natural language prompts.
3. **Building a Chatbot for Task Replaceability Analysis:** This project developed a chatbot using LLMs to assess the feasibility of replacing human tasks with robotic automation, based on the Bureau of Labor Statistics O*NET dataset.
4. **Creating a Chatbot for Technology Law Application:** Students created a tool designed to assist CIOs and CTOs in identifying and understanding relevant technology regulations and best practices, facilitating informed decisions for technology adoption projects.

Each project required advanced skills in prompt engineering and AI model application, with the Product Manager's role being essential in maintaining a cohesive vision and ensuring that each project delivered practical, real-world solutions.

These are the more recent projects executed within the past year as Generative AI has become more available. These projects represent our intervention: the use of AI technologies both to execute the project and as the basis for the deliverables, along with Agile as the process for project execution. Our control projects are those from previous years engaging our students before the advent of AI or the application of Agile in the program involved similar efforts. The projects often involved analytical products using machine learning. In those earlier projects, the students often had to develop code to satisfy the product's functional requirements. For projects without a Project Manager the projects followed the traditional waterfall approach, whereas recent projects have used Agile, offering a more iterative and collaborative framework for execution.

Agile Methodology Implementation

Each capstone project followed Agile methodologies to promote iterative learning and adaptability within the three-month timeframe. The three Agile processes included:

1. **Sprint Planning and Execution:** The Product Manager facilitated bi-weekly sprint planning, helping students set goals and define deliverables for each phase.
2. **Client Meetings and Feedback Loops:** The Product Manager coordinated key client meetings throughout each project.
3. **Documentation and Weekly Reporting:** The Product Manager implemented a structured reporting system, requiring students to submit weekly updates covering recent accomplishments, upcoming tasks, and any roadblocks.

Note the key function of the Product Manager as an organizer of the student's efforts and focusing the students toward successful completion. The Capstone faculty assures that the student is delivering all the academic work necessary to complete a graduate course and that the capstone project proceeds and concludes successfully. The product manager is an essential element in this process but not critical for individual capstone projects, which can often be managed successfully with just a faculty member in the course. The product manager becomes more important when dealing with clients that have multiple projects spanning multiple sections of capstone courses, and as you will see in the second case where the client product requires the integration of multiple capstone projects into a final deliverable. We found that in all cases the Agile structure supported iterative refinement and adaptability, allowing students to tackle challenges efficiently and align with real-world project management practices.

Project Testing, Validation, And Deliverables

Under the Product Manager's management, Agile methodologies were employed throughout the project lifecycle, significantly enhancing the efficiency, adaptability, and quality of outcomes compared to traditional waterfall approaches. Each project was delivered after a rigorous testing and validation phase to ensure functionality, accuracy, and alignment with client expectations.

The three key deliverables included:

1. **Functional Prototypes:** Students developed working chatbots, LLM-based tools, or prompt-driven models. The Product Manager ensured that prototypes were tested for usability, reliability, and adherence to project specifications.

2. **Final Documentation:** Comprehensive documentation included README files, a public GitHub repository, and weekly reports. For select projects, the Product Manager also facilitated the preparation of draft papers for conference submissions.
3. **Presentation and Client Feedback:** Final presentations allowed students to demonstrate their projects to clients and stakeholders, gather feedback, and make final adjustments based on real-world considerations.

By adopting Agile methodologies, these projects demonstrated how iterative development, continuous feedback, and adaptability can significantly enhance project outcomes. This approach not only ensured high-quality deliverables but also equipped students with practical experience in Agile project management, preparing them for dynamic roles in STEM and product development.

Case Study 2: UNICC AI Media Analysis Tool Project

The UNICC AI media analysis tool, developed to assist media professionals in detecting the level of toxic language, misinformation, and other harmful content related to reporting on vulnerable populations was a multifunctional product. The client required the detection of xenophobia and harmful language levels. Also the compiling and reporting on the sentiment of the language used in the media pieces (article, tweet, podcast). The client required topical analysis to extract and classify the topics in a media piece concerning possible harm to the vulnerable population being covered. The UNICC had experience challenging students from other universities with similar projects. These challenges are substantial and are often tackled by student teams of three to five individuals collaborating to deliver a multi-function product. The student teams are self-directed in organizing the work to be completed.

In this case, due to the constraint of individualized Capstone project requirements and the ambitious nature of the challenge from the UNICC, which was beyond the scope of any one student to accomplish in a single semester alone, an innovative approach was adopted. The product manager developed an overall product roadmap, organizing the final deliverable into themes and epics. Each epic represented a key component of the client's product challenge, with clearly defined acceptance criteria. Objectives and Key Results (OKRs) were established for each team to provide clear direction and align their efforts with the overarching product goals. Key Performance Indicators (KPIs) were also introduced to measure student progress and ensure accountability at every stage of development. The students were then organized into self-forming teams, each agreeing to take responsibility for developing one of the epics. Throughout the development process, they were coached on implementing Agile methodologies, including iterative development, sprint planning, and continuous feedback loops, to ensure efficient collaboration and alignment with the overall product vision.

The teams competed to win the challenge, with each student contributing their part, which also fulfilled the capstone project requirement of their course. The Product Manager performed the stakeholder management and facilitation, becoming the point of contact with the client who posted the challenge and the go-between for students and faculty. Students came from different sections with different faculty members of the Capstone class, so such a coordinator was required. In our case, we appointed a graduate student in the master's in Project Management program for their practical experience in product development. The Product Manager also became the students' coach in the implementation of Agile for the project.

In our current case, the Product Manager designed the final deliverable as a cohesive product with three core functionalities outlined by the UNICC: (1) Detection of Xenophobic Language and Harmful Narratives, (2) Sentiment Analysis, and (3) Topic-Based Analysis of Harmful Content. To ensure a comprehensive and effective solution, the Product Manager adopted an Agile approach, restructuring the project into four distinct, interdependent functionalities. The (4) fourth Capstone project focused on integrating the components into a complete product, including the development of the overall user interface (UX design) and conducting thorough testing—each forming a critical component of the unified product. This last component enabled independent and autonomous work by each team while ensuring delivery of a final, fully integrated product.

This Agile-driven restructuring was critical to managing the complexity of the project. By breaking the work into smaller, interdependent parts aligned with Agile principles, the Product Manager was able to define clear objectives and acceptance criteria for each functionality. This approach allowed iterative progress, allowing regular feedback, and enabling flexibility to adapt to challenges as they arose. The integration project ensured that the components worked seamlessly together, delivering a cohesive and user-friendly product.

This structured approach not only highlights the benefits of Agile methodologies—such as iterative development, cross-functional collaboration, and continuous improvement—but also ensured the delivery of a scalable and robust solution aligned with the client's ambitious goals.

The Product Manager organized students into teams, each comprising four members. Each team member has chosen one functionality as the focus of their work and their coastline. This structure allowed teams to work independently on their specific features while collaborating with others to ensure integration into a cohesive final product. This setup not only supported teamwork but also introduced an element of competition, as each team aimed to deliver the highest quality functionality, enhancing innovation and commitment to excellence.

Team Organization and Competitive Collaboration

The Product Manager's role extended beyond organizing the project structure to fostering a collaborative and competitive team atmosphere. While each team was responsible for its assigned functionality, they had to coordinate with others to ensure that all components were integrated effectively into a cohesive product. There were two major drivers of the educational design.

Team Dynamics: Each team managed its functionality independently while aligning with the broader product goals. Weekly cross-functional meetings allowed teams to share progress and address dependencies, maintaining coherence across functionalities.

Competitive Element: The Product Manager introduced a competitive aspect to encourage excellence, motivating each team to refine and optimize its functionality. This competition fostered innovation and quality in each component, ultimately benefiting the overall product by promoting high standards, while maintaining the requirements of the program for individual capstone project execution. Although many students were focused on the same functional design, the competition prevented collaboration from turning into collusion, which could be seen as cheating. The faculty were reasonably satisfied that each student produced an independently executed capstone, as required.

Agile Methodology Implementation

In this case, more so than in Case 1, the Product Manager played a crucial role in ensuring the success of the product and projects by implementing an Agile framework. This approach fostered iterative development, adaptability, and collaboration among teams, creating a dynamic and responsive environment. The Agile process was underpinned by a well-defined roadmap, regular retrospectives, and ongoing feedback loops, all of which contributed to the success of the product and its associated projects.

Key Agile Practices

1. **Product Roadmap** - The Product Manager designed a detailed roadmap outlining the overall vision and breaking it down into themes, epics, and user stories. This provided students with clear objectives and ensured alignment with the final deliverable. The roadmap also served as a reference point for tracking progress and adjusting priorities as needed.
2. **Sprint Planning and Execution** - Teams conducted bi-weekly sprints with specific objectives tied to their assigned functionalities. Sprint planning sessions defined clear goals, and sprint backlogs ensured focused progress. This iterative cycle allowed for regular delivery of incremental progress toward the final product and its components.
3. **Collaborative Checkpoints** - Weekly cross-functional checkpoints, facilitated by the Product Manager, enabled teams to synchronize efforts, share updates, and address blockers. These meetings encouraged collaboration and ensured that interdependencies between functionalities were managed effectively.
4. **Client Meetings and Feedback Loops** - Regular touchpoints with UNICC representatives were integral to the Agile process.
5. **Retrospectives** - At the end of each sprint, teams conducted retrospectives to reflect on what went well, identify challenges, and propose improvements for subsequent sprints. These sessions fostered continuous learning and empowered students to refine their processes.
6. **Daily Stand-Ups** - Teams held brief daily stand-ups to discuss progress, align priorities, and address any immediate obstacles. This practice maintained momentum and ensured open communication among team members.
7. **Incremental Testing and Validation** - Each functionality was tested incrementally within its sprint cycle, reducing risks and ensuring that integration into the final product was seamless.

The Agile methodology enabled iterative refinement, allowing students to adapt to real-world complexities and stay aligned with UNICC's objectives. The structured yet flexible nature of Agile fostered collaboration across teams, encouraged accountability, and ensured that the final product and its related projects met client expectations. By incorporating roadmaps, retrospectives, and continuous feedback, the Agile framework not only facilitated the successful delivery of the product but also provided students with valuable hands-on experience in industry-standard practices.

The UNICC AI media analysis tool project demonstrates the potential of structuring educational projects as cohesive products with multiple interdependent features. By dividing students into collaborative yet competitive teams, the Product Manager ensured that each functionality contributed to a unified, high-performing tool for media professionals. This Agile-based, competitive collaboration approach allowed students to apply real-world skills in AI development, data preprocessing, and iterative testing, creating a transformative educational experience aligned with industry standards in STEM and product management.

RESULTS

Our analysis focused on evaluating various attributes of capstone projects to identify factors contributing to their success, with client satisfaction and publication worthiness as key metrics of evaluation. This study examined 111 projects, categorized by attributes such as whether they employed artificial intelligence (AI), were team-based, utilized a project manager (PM), or were conducted over different semesters. A detailed summary of the results is provided in the accompanying table, highlighting statistically significant findings.

AI-Based Projects

AI-based projects showed positive outcomes compared to non-AI projects. The distribution of client satisfaction ratings demonstrated that AI projects had a higher proportion of "A" ratings (45.3% vs. 29.8%) and a higher rate of publication-worthiness (26.6% vs. 6.4%). A chi-squared test confirmed that these differences were statistically significant ($\chi^2 = 14.22$, $p = 0.0008$ for client satisfaction; $\chi^2 = 6.17$, $p = 0.013$ for publication worthiness). These results support the hypothesis that incorporating AI contributes to project success.

Team-Based Projects

Team-based projects also demonstrated differences in client satisfaction outcomes. Projects conducted in teams had a much higher proportion of "A" ratings (68.8%) compared to individual projects (33.7%), a statistically significant difference ($\chi^2 = 7.94$, $p = 0.0189$). While team-based projects also showed a higher proportion of publication-worthy outcomes (25.0% vs. 16.8%), the difference was not statistically significant ($\chi^2 = 0.19$, $p = 0.6644$). These results indicate that collaborative efforts may influence client satisfaction, even if their effect on publication-worthiness is less clear.

Projects with Project Managers (PMs)

The involvement of a PM was associated with higher client satisfaction. Projects with a PM achieved a higher proportion of "A" ratings (54.8% vs. 32.5%), a result confirmed as statistically significant ($\chi^2 = 8.75$, $p = 0.0126$). However, the difference in publication-worthiness between projects with and without a PM (29.0% vs. 13.8%) was not statistically significant ($\chi^2 = 2.57$, $p = 0.1087$). These findings suggest that the guidance and structure provided by PMs may contribute to client satisfaction.

Trends Over Time

The analysis of trends by semester revealed some improvements in publication-worthiness over time. By disaggregating results by semester (Spring, Summer, and Fall), a linear regression analysis found a positive trend in publication-worthy projects ($\beta = 0.0067$, $p = 0.070$). Although the p-value approached significance, it fell slightly short of the threshold. Similarly, the trend for "A" client satisfaction ratings was positive but not statistically significant ($\beta = 0.0030$, $p = 0.706$). These results suggest an overall improvement in project quality, particularly regarding publication-worthiness, though further data are needed to establish statistical significance.

Areas Without Significant Findings

While many results align with our hypotheses, some areas did not show significant differences. For instance, individual projects exhibited client satisfaction and publication-worthiness rates similar to those of team projects, and time-based trends in client satisfaction did not yield statistically significant changes. These findings highlight opportunities for future research to uncover additional factors influencing project outcomes.

Independent Variable	Outcome	Null Hypothesis (H0)	Conclusion	Statistical Test Details	Proportions Details
AI-based vs Non-AI-based	Client Satisfaction	The distribution of client satisfaction ratings is independent of project type (AI-based vs. non-AI-based).	Reject H0. Client satisfaction significantly differs between AI-based and non-AI-based projects.	Chi-Squared: 14.22, p-value: 0.0008	AI-Based Proportions: A: 0.45, B: 0.52, C: 0.03, Non-AI Proportions: A: 0.30, B: 0.43, C: 0.28
AI-based vs Non-AI-based	Publication Worthy	The likelihood of being classified as 'publication worthy' is independent of project type (AI-based vs. non-AI-based).	Reject H0. Publication worthiness significantly differs between AI-based and non-AI-based projects.	Chi-Squared: 6.17, p-value: 0.013	AI-Based Proportions: Yes: 0.27, No: 0.73, Non-AI Proportions: Yes: 0.06, No: 0.94
Effort Type (Team vs Individual)	Client Satisfaction (Team vs Individual)	The distribution of client satisfaction ratings is independent of project effort type (Team vs Individual).	Reject H0. Client satisfaction significantly differs between team-based and individual projects.	Chi-Squared: 7.94, p-value: 0.0189	Team-Based Proportions: A: 0.69, B: 0.31, Non-Team Proportions: A: 0.34, B: 0.51, C: 0.16
Effort Type (Team vs Individual)	Publication Worthy (Team vs Individual)	The likelihood of being classified as 'publication worthy' is independent of project effort type (Team vs Individual).	Fail to reject H0. No significant difference in publication worthiness between team-based and individual projects.	Chi-Squared: 0.19, p-value: 0.6644	Team-Based Proportions: Yes: 0.25, No: 0.75, Non-Team Proportions: Yes: 0.17, No: 0.83
PM Used vs No PM	Client Satisfaction (PM vs No PM)	The distribution of client satisfaction ratings is independent of whether a PM was used.	Reject H0. Client satisfaction significantly differs between projects with and without a PM.	Chi-Squared: 8.75, p-value: 0.0126	PM Used Proportions: A: 0.55, B: 0.45, No PM Proportions: A: 0.33, B: 0.49, C: 0.19
PM Used vs No PM	Publication Worthy (PM vs No PM)	The likelihood of being classified as 'publication worthy' is independent of whether a PM was used.	Fail to reject H0. No significant difference in publication worthiness between projects with and without a PM.	Chi-Squared: 2.57, p-value: 0.1087	PM Used Proportions: Yes: 0.29, No: 0.71, No PM Proportions: Yes: 0.14, No: 0.86

Figure 1 - Summary of results and supporting statistical analysis.

Conclusion

This study provides evidence that AI integration, teamwork, and project management are associated with capstone project success, as measured by client satisfaction and publication-worthiness. The trends observed over time suggest an upward trajectory in project quality, reinforcing the importance of these factors. The accompanying table provides a comprehensive summary of our findings and serves as a reference for the statistical analyses underpinning these conclusions.

DISCUSSION

This research examined the impact of integrating AI tools and Agile methodologies in educational settings to address challenges in STEM and product management education. Key findings emerged through analysis of the AI capstone projects and the development of the UNICC AI-driven media analysis tool, aligning closely with the research questions.

Research Question 1: Can AI and agile integration keep curricula current with technological advancements?

The UNICC AI-driven media analysis tool offered students an industry-relevant project with advanced AI techniques to detect harmful narratives and misinformation. This tool, designed to manage sensitive topics like migration and displacement, utilized state-of-the-art natural language processing (NLP) and generative AI models. These technologies enabled students to work with real-time data, analyze emerging patterns, and engage with cutting-edge methodologies.

Key Finding: AI integration provided students with hands-on experience using current technologies, bridging the gap between theoretical knowledge and industry standards. Skills developed in Python, R, and AI-driven data analysis positioned students for future roles requiring technical proficiency and adaptability.

Project Observations: Working on the UNICC media analysis tool allowed students to apply theoretical knowledge to practical data challenges. The flexibility offered by AI tools ensured that curricula remained aligned with industry advancements, reinforcing a dynamic, industry-focused educational experience.

Research Question 2: *does the use of agile methodologies increase student engagement and adaptability?*

Agile methodology was instrumental in structuring and advancing the capstone projects, including the UNICC media analysis tool. By employing Agile principles, particularly iterative sprints, students could manage project phases with continuous feedback, promoting active problem-solving and enhancing adaptability, navigating the ambiguity of real-world challenges.

Key Finding: Agile's sprint-based structure facilitated focus on distinct project phases, enabling consistent progress and adaptability to challenges. This iterative model created a collaborative, adaptive learning environment that fostered technical and interpersonal skills.

Project Observations: Agile methodologies encouraged student engagement, allowing them to refine projects based on real-world feedback continuously. This approach prepared students for

complex, evolving scenarios in professional settings, enhancing both technical expertise and teamwork capabilities.

Research Question 3: Can AI and agile methodologies optimize learning experiences within time constraints?

The combined use of AI and Agile methodologies effectively addressed the time constraints of academic projects. Students benefited from Agile's structured, iterative approach, which provided a roadmap for managing complex tasks within a semester's limited timeframe. The inclusion of regular feedback loops ensured continuous improvement by identifying and addressing issues early in the process. Proper prioritization techniques allowed students to focus on the most critical tasks, ensuring efficient use of their time. Additionally, consistent stakeholder engagement, facilitated through meetings and reviews, ensured alignment with project goals and client expectations.

Key Finding: The iterative Agile framework allowed students to break projects into manageable tasks, enhancing productivity and preventing overwhelm. AI tools complemented this framework by automating repetitive tasks, enabling rapid iteration and allowing students to focus on high-level project components.

Project Observations: Both the UNICC AI-driven media analysis tool and other AI capstone projects demonstrated how AI and Agile methodologies could prioritize tasks, meet deadlines, and optimize learning. Feedback loops enabled continuous refinement, resulting in higher-quality deliverables and demonstrating that Agile and AI together offer an effective approach for managing academic projects within tight time constraints.

The study's results underscore the benefits of integrating AI tools and Agile methodologies in STEM and product management education. AI-enabled students to engage with industry-relevant technologies, while Agile methodologies fostered engagement, adaptability, and efficient time management. Together, these approaches provided a robust educational framework with potential for broader application in academic settings, equipping students with the skills necessary to thrive in fast-evolving technological fields.

This study demonstrates the benefits of integrating AI tools and Agile methodologies in STEM and product management education, addressing critical challenges related to outdated curricula, limited practical experience, and time constraints. By examining the development of the UNICC AI-driven media analysis tool and various NYU MASY capstone projects, we have identified how these technologies can transform the learning process, bridging gaps between academic theory and industry practice.

AI's Role in Advancing Practical STEM Education

The UNICC AI-driven media analysis tool project highlights how AI-enabled solutions can provide students with hands-on experience in cutting-edge fields like natural language processing (NLP) and generative AI. These technologies allowed students to explore real-world applications such as detecting harmful narratives and misinformation, which are critical in today's media landscape. By working with complex AI models, students gained essential skills in Python, R, and prompt engineering—capabilities highly valued in technology-driven fields.

Incorporating AI into educational frameworks also demonstrated potential to keep curricula relevant, addressing the gap identified by Tang et al. (2024) between the rapid pace of technological advancement and the slow adaptation of educational content. This finding is consistent with Luckin et al. (2022), who argue that AI tools can help educators stay up-to-date with industry trends. By automating routine tasks, AI allowed students to focus on high-level problem-solving, supporting the goal of developing adaptive, industry-ready professionals.

Agile's Impact on Engagement And Adaptability

The application of Agile methodologies in both the UNICC media analysis tool and capstone projects fostered a dynamic and iterative learning environment that increased student engagement. Agile's sprint-based structure allowed students to manage projects in manageable phases, integrating continuous feedback and adapting their work in real time. This approach promoted a collaborative mindset, which was instrumental in preparing students for real-world challenges. These findings align with Serrador and Pinto (2015), who found that Agile methodologies enhance project outcomes and stakeholder satisfaction by promoting flexibility and adaptability.

Moreover, the competitive collaboration structure within the UNICC project, which encouraged students to refine their contributions while working towards a unified product, demonstrated the potential for Agile methodologies to enhance both individual and team-based skills. This aligns with the principles of Kolb's (1984) experiential learning model, where students engage in practical applications, receive immediate feedback, and iteratively refine their understanding. Agile's emphasis on iterative refinement enabled students to focus on developing critical skills in a realistic, professional context, thereby increasing their preparedness for the industry.

Managing Time Constraints with Agile And AI

The combination of AI tools and Agile methodologies proved particularly effective in managing the time constraints of academic projects, an issue documented by McKinsey & Company (2021) and echoed in recent research by Tang et al. (2024). Agile's iterative cycles, combined with AI's ability to streamline tasks, provided a structured yet flexible framework for students to tackle complex projects within the limited timeframe of an academic semester. This approach allowed students to adapt quickly to unexpected challenges, demonstrating the practical benefits of Agile and AI integration in time-sensitive educational settings.

Through Agile's sprint planning and the use of AI for automating data processing tasks, students were able to prioritize key aspects of their projects, improving their efficiency and reducing the likelihood of burnout. As shown in the UNICC media analysis tool, AI-driven automation allowed students to focus on innovation rather than repetitive tasks, thus optimizing learning outcomes within the short academic timeframe. These findings underscore the value of combining Agile with AI to facilitate efficient project management in educational settings, allowing students to maximize their learning in shorter periods.

Limitations and Future Research

While the study provides valuable insights into the benefits of integrating AI and Agile in educational settings, it is limited by its focus on specific case studies within NYU's MASY program. Future research could explore a broader range of disciplines and educational contexts to assess the generalizability of these findings. Additionally, investigating long-term impacts of

AI and Agile integration on student career trajectories could provide a more comprehensive understanding of these methodologies' effectiveness.

Further research might also explore the balance between automation and personalized guidance in AI-driven education. While AI tools offer significant advantages in managing time and improving efficiency, there is a need to assess the role of human oversight in ensuring quality and ethical adherence. This is particularly important in fields where critical thinking and nuanced understanding are essential, as AI systems may not fully capture complex human interactions and ethical subtleties.

This study highlights the transformative potential of integrating AI and Agile methodologies in STEM and product management education. By addressing challenges related to outdated curricula, limited hands-on experience, and time constraints, AI and Agile offer a robust framework for modernizing educational practices. The findings suggest that this approach not only enhances technical skills but also fosters adaptability, critical thinking, and ethical awareness—qualities that are increasingly vital in today's fast-paced technological landscape. As educational institutions continue to evolve, the adoption of AI and Agile may serve as a blueprint for creating more responsive, relevant, and effective learning environments across a range of disciplines.

CONCLUSIONS

This study demonstrates the effectiveness of integrating Artificial Intelligence (AI) and Agile methodologies in STEM and product management education to address challenges in outdated curricula, limited practical experience, and academic time constraints. Through an in-depth analysis of two case studies—the UNICC AI media analysis tool and A Management and Systems graduate AI capstone projects—this research validates the benefits of these advanced tools and frameworks in enhancing learning outcomes, adaptability, and readiness for professional roles.

First, AI's role in maintaining curricula relevance is evident in the hands-on skills students acquire, aligning them with the technological demands of industry. Projects such as the UNICC AI tool provide students with critical experience in data processing, model building, and real-world problem-solving, bridging the gap between theory and practice.

Second, Agile's iterative structure proves instrumental in fostering student engagement and adaptability. By managing projects in cycles and incorporating continuous feedback, students developed resilience and collaboration skills, essential in fast-evolving professional environments.

Moreover, the combined use of AI and Agile effectively addresses time constraints within academic programs. Agile's sprint-based approach, alongside AI's automation capabilities, maximizes productivity within limited timeframes, enabling students to achieve impactful results in condensed periods. This study suggests that the strategic integration of AI and Agile methodologies provides a robust, adaptable educational model that can evolve with industry advancements while equipping students with essential technical and interpersonal skills.

Adopting AI and Agile methodologies can significantly transform STEM and product management education. By aligning academic programs with industry requirements and

fostering real-world skills, these approaches offer a progressive educational framework that not only addresses current educational challenges but also prepares students for a technology-driven future. The insights gained from this research can serve as a model for further integration of AI and Agile across diverse academic disciplines, reinforcing the importance of adaptive, hands-on learning in modern education.

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DECISION SCIENCES INSTITUTE**Revolutionizing Curriculum Access with Retrieval-Augmented Generation: A Case Study of AI-Enhanced Course Information Systems**

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ABSTRACT

This paper presents an innovative approach to addressing a critical challenge in business education: efficiently accessing and retrieving course information from large syllabi databases. Current systems for querying course syllabi are constrained by the limitations of commercially available Large Language Models (LLMs), which struggle to process extensive document collections effectively. Our study demonstrates how integrating Retrieval-Augmented Generation (RAG) techniques with LLMs can transform information retrieval in educational settings. We developed and tested a chatbot that combines advanced retrieval methods with natural language processing to enhance the accuracy, context, and scalability of syllabi queries across multiple years and academic programs. Our implementation with 150 course syllabi and evaluation with 31 users revealed significant improvements in response quality, with an average accuracy rating of 4.87/5 and user satisfaction rating of 4.80/5. By enabling more precise and contextually appropriate responses to common questions from students and faculty, this technology addresses a fundamental gap in educational information systems. The approach offers promising implications for business schools seeking to innovate their educational technology infrastructure and improve accessibility to course content. This research contributes to the evolving landscape of decision sciences education by illustrating how emerging AI technologies can be practically implemented to enhance administrative efficiency and student experience.

KEYWORDS: Retrieval-Augmented Generation, Educational Information Systems, Large Language Models, Decision Sciences Education, Curriculum Information Access, AI-Enhanced Learning

INTRODUCTION

Large language models (LLMs) have demonstrated significant potential in automating business processes by offering advanced natural language understanding and generation capabilities. They can enhance efficiency, accuracy, and contextual relevance in tasks such as information retrieval, data analysis, and decision-making. When integrated with Retrieval-Augmented Generation (RAG) techniques, LLMs can address key challenges in information access and query response systems, particularly in data-intensive fields like education and research. This project aims to showcase the power of this integration through a proof of concept, using LLMs combined with RAG to improve the querying and retrieval of course syllabi, thus enhancing access to crucial course information.

In modern educational environments, particularly within large universities, there is a growing demand for systems that can efficiently access, interpret, and respond to queries about extensive course information databases, such as syllabi. Traditional search methods often fall short in providing accurate, comprehensive, and contextually relevant answers, especially when managing vast collections of documents that span multiple years and academic programs. While educational technologies have facilitated remote learning and self-paced study models, these systems require advanced querying capabilities to effectively support both students and faculty in navigating complex course data.

The primary issue being addressed is the current internal system's limitations in querying a large database of course syllabi. The system is constrained by the volume of documents that can be uploaded to commercially available LLMs, which restricts its ability to generate comprehensive, accurate, and contextually appropriate responses to queries from faculty and students. This limitation hampers the efficiency of information retrieval, creating barriers to accessing the necessary course details in a timely manner. The system's inability to handle a large volume of documents impacts the efficiency and effectiveness of the querying process, making it difficult to deliver precise and relevant information for a wide range of course-related inquiries (Wollny et al., 2021).

The proposed approach leverages Retrieval-Augmented Generation (RAG) techniques, which combine the capabilities of Large Language Models (LLMs) with advanced information retrieval methods. RAG allows for the integration of a much larger set of documents than standard LLMs can process, enabling the system to generate more accurate, contextually relevant, and comprehensive responses. By utilizing RAG-enhanced LLMs, the chatbot can overcome the limitations of traditional query systems, offering a more effective solution for querying large syllabi databases. The underlying theory of this approach is that RAG's ability to retrieve and augment information from extensive datasets will yield more precise responses, addressing the scalability and accuracy challenges that the current system faces. Self-paced learning and student-teacher interactions can be combined in blended learning to provide the benefits of both methods (Chen et al., 2022).

Background on the Core Technology:

The core technology behind this project is Retrieval-Augmented Generation (RAG), which integrates advanced retrieval techniques with the natural language processing capabilities of Large Language Models (LLMs). RAG enhances the model's ability to process and respond to queries by retrieving relevant documents or information from a larger dataset before generating responses. This allows LLMs to work with a much broader range of data than standard models typically can, making it ideal for complex information retrieval tasks, such as querying extensive course syllabi databases. The system consists of two primary components: a retriever that identifies the most relevant documents based on the user's query, and a generator that formulates responses using the retrieved information. This hybrid approach ensures more accurate, contextually relevant answers, especially in domains with large, evolving datasets.

For the project's backend development, Python Flask is used to connect dynamic responses with the user interface, enabling smooth interaction. The frontend is designed with HTML, CSS, and JavaScript, handling content layout, styling, and interactivity, such as feedback redirection and theme switching. Flask manages query processing, sending user questions to the backend for further analysis. Additionally, the system employs OpenAI's text-embedding-ada-002 model

to create vector embeddings for queries, which are compared to previously stored embeddings in an SQLite database using semantic search methods, particularly Euclidean distance, to compute similarity and generate more accurate results.

Potential Benefits of Applying This Technology to the Problem:

The application of RAG technology to the problem of querying course syllabi offers several significant benefits. First, it overcomes the limitations of traditional LLMs by enabling the chatbot to process a much larger set of documents, ensuring more comprehensive and accurate responses to user queries. Second, the integration of RAG facilitates contextually relevant information retrieval, tailoring responses to the specific query and thereby enhancing the relevance of answers for both faculty and students. Third, this system scales effectively across large databases, such as those spanning multiple years and academic programs, offering an efficient solution for managing and querying vast amounts of educational content. By automating the querying process and improving access to syllabi information, the system boosts productivity, reduces time spent searching, and enhances user satisfaction with both the speed and quality of responses. The deployment of the system on Heroku, a scalable cloud platform, ensures optimal speed, a seamless user experience, and high dependability. This makes the solution both robust and easily scalable for future expansion.

The Overall Research Question Explored Through Proof of Concept:

The overall research question explored through this proof of concept is , How can a chatbot using Retrieval-Augmented Generation (RAG) techniques improve the accuracy, relevance, and comprehensiveness of responses to queries about course information from a large syllabi database, compared to traditional search methods? This research will examine the effectiveness of RAG in addressing the challenges posed by large-scale syllabi databases, particularly in educational environments, and explore the potential for AI-driven systems to enhance access to and understanding of course content for both faculty and students.

Brief Preview of the Structure of the Paper Sections:

The introduction provides an overview of the project, outlining its objectives and the problem it addresses. The background and technology section explores the core technologies employed, including large language models (LLMs), Retrieval-Augmented Generation (RAG), Flask for backend development, and Heroku for deployment. The methodology section outlines the technical approach, detailing data collection, preprocessing, RAG implementation, user interface development with Flask, and system deployment. In the evaluation and results section, trial results are presented, comparing the RAG-enhanced chatbot with traditional search methods, assessing key metrics such as response accuracy, relevance, and efficiency. The discussion section analyzes the findings, exploring the implications for AI-driven educational tools and considering the potential for scaling the solution. Finally, the conclusion summarizes the project's key contributions, emphasizing the effectiveness of RAG in syllabi querying, and suggests directions for future research and improvements.

Key Contributions of the Developed Proof of Concept System:

The key contributions of the developed proof-of-concept system lie in the successful integration of Retrieval-Augmented Generation (RAG) with a Large Language Model (LLM) to enhance the querying process for a large syllabi database. This innovative approach improves the accuracy,

relevance, and comprehensiveness of responses compared to traditional search methods, offering a more effective solution for accessing course-related information. One of the primary advantages of the system is its ability to handle large volumes of unstructured data, demonstrating RAG's scalability in managing extensive syllabi collections. By augmenting the capabilities of LLMs with retrieval techniques, the system ensures that users receive contextually relevant responses even when querying a vast amount of data. The project also focuses on creating a seamless user experience for faculty and students. The system's interface, developed using Flask, dynamically generates responses based on user queries, offering an intuitive and user-friendly way to access course materials. This feature significantly enhances the overall efficiency of the querying process. Furthermore, the system's deployment on Heroku provides a reliable and scalable solution, ensuring that the tool can grow with future demands. The findings suggest that AI-driven approaches like RAG can substantially improve access to educational resources, making information retrieval faster, more accurate, and more efficient in academic settings.

Comparison of Alternative Methods:

Methodology	Advantages	Disadvantages
Traditional Search	Simple, widely used, easy to implement	Limited to keyword matching, often provides less relevant or contextual answers
Large Language Models	Can generate detailed responses, handle complex queries	Limited by the volume of documents that can be processed in a single query
Retrieval-Augmented Generation (RAG)	Combines the best of retrieval and generation, handles large document sets, provides more accurate and context-aware responses	More complex to implement, requires integration of retrieval and generation components

Research and Analysis of Alternative Approaches:

The analysis of alternative methods showed that while traditional search approaches are simple and well-understood, they often fall short in providing the level of accuracy and relevance required for querying large syllabi databases. Standard LLMs also struggle with processing extensive document sets, limiting their ability to generate comprehensive and contextually appropriate responses. In contrast, Retrieval-Augmented Generation (RAG) effectively combines the strengths of both retrieval and generation, allowing the system to deliver more accurate, contextually relevant, and scalable responses. Based on this analysis, RAG was chosen as the optimal solution for the project, offering significant improvements in both performance and usability. Additionally, the integration of Flask and deployment on Heroku ensures that the system remains fast, reliable, and scalable, making it a robust tool for future use.

LITERATURE REVIEW

This literature review was created to support the proposed proof of concept and technology trial, which would use sophisticated artificial intelligence (AI) and chatbot technologies to solve particular difficulties in higher education. The main objective is to show that incorporating AI-powered chatbots into the classroom is feasible and might have a positive influence on learning

outcomes, student engagement, and institutional efficiency. AI-powered solutions develop cutting-edge tutoring and communication methods, such intelligent tutoring systems and teaching robots (Heo & Lee, 2019). The study synthesizes research from multiple sources, highlighting the benefits and challenges of using chatbots and artificial intelligence (AI) in the classroom, with a focus on applications that have been tested in academic settings. In addition to admitting the limits of such technologies in practical application, the review's scope will encompass case studies, technical articles, and pertinent theories that explain the mechanisms and benefits of implementing AI in educational contexts (Akpan et al., 2024).

A number of topical subtopics that methodically examine the relevant articles make up this review. Through customized assistance and interaction, AI chatbots improve teaching and student support by addressing issues like personalized learning and timely feedback. To offer real-world examples and demonstration of the feasibility of the suggested proof of concept, use cases and effective implementations of related technologies will be investigated (Illera, 2024). Unlike traditional research literature evaluations, which usually seek to examine theoretical issues or broad academic inquiries, this technique guarantees a targeted, application-driven assessment that precisely matches with the aims of the proposed technological trial (Dabis & Csáki, 2024).

Industry

By improving efficiency, customization, and engagement in higher education, AI-driven tools, chatbots in particular, are revolutionizing the EdTech industry. Up to 30% of online learners leave out as a result of isolation and inadequate feedback, which has been a significant problem with the growth of online learning (Ortega-Ochoa et al., 2024). By offering students individualized, real-time support, AI Chatbot's help close this gap and keep students in touch with their teachers and schoolwork (Akpan et al., 2024). By simplifying administrative duties and providing immediate feedback to enhance instructional efficacy, these tools are also helping professors (Roca et al., 2024). In industry, chatbot workshops boost A.I. abilities, enhancing service quality and efficiency (Shim et al., 2023). The need for scalable, compassionate solutions that encourage motivation and engagement in virtual learning environments will only grow as colleges continue to use AI (Nazari & Saadi, 2024).

The Problem

Many long-standing issues, especially those attributed to student engagement, retention, and assistance, have been made worse by higher education's growing move toward online and hybrid learning methods. Lack of individualized, real-time feedback for students is one of the main problems, which can result in high dropout rates and disengagement. According to research, over 30% of online students discontinue their studies because they don't communicate with their teachers enough and find it hard to manage the self-control needed for online learning (Ortega-Ochoa et al., 2024). Additionally, especially in large-scale, lecture-based settings, the quick growth of online courses has put pressure on academic institutions' capacity to offer prompt and efficient support to each and every student. Students now feel lonely and unsupported as a result of teachers' growing inability to provide individualized feedback and advice. It is increasingly important to bridge these engagement and support gaps as higher education institutions continue to use digital learning technologies.

The Proposed Solution

Through real-time, personalized help, AI-driven chatbots improve online learning by increasing engagement, retention, and feedback. Chatbots may provide personalized resources depending on each student's performance and progress, answer questions, and walk students through the course material. Since they can scale the individualized help that teachers would find difficult to deliver in large or online courses, such AI solutions have been shown to be successful in various areas of education (Ortega-Ochoa et al., 2024).

Furthermore, by automating some feedback-related tasks, teachers may concentrate on more complicated student demands while the technology manages standard questions and tests, improving overall educational effectiveness (Akpan et al., 2024). The Chatbot's development is guided by the LAMB framework, which enhances usability, scalability, and LMS connection. (Alier et al., 2024). By bridging the gap between teachers and students, these AI-based solutions can improve student satisfaction and retention rates by fostering a more dynamic and responsive learning environment. By reducing obstacles to online learning and enhancing engagement and motivation, these solutions benefit both teachers and new students (Hussain et al., 2023).

The Technology

To improve student engagement, retention, and feedback in online learning settings, the suggested solution uses Python Flask as the foundation framework and the RAG approach to create a scalable, effective web application that incorporates generative AI and conversational agents (chatbots). Because of Flask's adaptability, it can be easily integrated with AI-powered tools like machine learning algorithms and Natural Language Processing (NLP), allowing the chatbot to offer students individualized, real-time support (Pereira et al., 2024). The chatbot comprehends and reacts to inquiries, provides personalized feedback, and leads students through course materials according to their unique progress (Ortega-Ochoa et al., 2024).

Flask makes it easy to integrate these AI models with external APIs, enabling scalability for big user bases, round-the-clock assistance, and administrative work automation (Hussain et al., 2023). It is commonly known that using AI-powered chatbots in educational contexts may improve student happiness, engagement, and retention (Xu et al., 2024). Flask enables a scalable, interactive platform that enhances student-teacher engagement and accessibility. (Nazari & Saadi, 2024). According to this study, AI chatbots can improve productivity and user experience in academic contexts by automating answers and streamlining the transmission of information (Ula et al., 2023). The increasing number of studies on the effectiveness of AI in education, where the technology has been used in a variety of ways to improve the learning experience for students, such as intelligent tutoring platforms and adaptive learning systems, lends more credence to this adoption trend (Mateus et al., 2024). This technology will establish itself as the standard for improving real-time decision-making (Ibnu Pujiono et al., 2024).

Use Case 1: AI Chatbots for Customized Learning Assistance in Higher Education

Chatbots driven by AI improve learning outcomes and student engagement by offering timely help with projects and deadlines as well as suggestions. According to studies, they are powerful teaching tools, particularly when customized to meet the needs of each individual learner.

(Kuhail et al., 2023). In Andy's case, for instance, 73.0% of students said the chatbot gave them accurate and useful feedback on their language abilities, which is probably going to lead to better language engagement and learning. This demonstrates how AI chatbots may greatly improve the educational process by providing relevant and tailored interactions, which will increase student engagement and performance (Belda-Medina & Kokošková, 2023).

Use Case 2: AI in Project Management Education for Real-Time Feedback and Guidance

Feedback on tasks and project progress. By offering tailored advice, these chatbots enhance student engagement, helping to align course content with learning objectives. Large Language Models (LLMs), such as AI chatbots, deliver individualized learning support, which has been shown to improve students' problem-solving abilities and overall academic performance (Pereira et al., 2024). In project management courses, real-time AI assistance enhances the learning process (Xu et al., 2024). AI chatbots' versatility in various contexts guarantees that students get prompt assistance that improves their academic performance and learning.

Summary

According to research, they facilitate better communication, increase student involvement, and provide insightful, timely feedback. Specifically examining the role of AI in higher education, numerous studies emphasize how it may help with issues like resource allocation, huge class numbers, and customized learning experiences. (Illera, 2024). While studies demonstrate the potential of AI chatbots in education, they also highlight challenges such as system integration, data protection, and user experience. This paper explores the deployment of AI chatbots in specific institutional settings, an area that remains largely unexplored in the literature, aiming to address these gaps.

METHODS

The LLM chatbot project used a methodology that broke down user questions and retrieved relevant and important course content from a SQLite database, where syllabi were kept with embeddings created using OpenAI's text-embedding-ada-002 model, to develop prompts and prepare data for the GPT-4 API. Semantic search was used to match the user's query with the most pertinent course portions based on vector similarity determined by Euclidean distance. The question in a clear, concise prompt, such as "Based on the following syllabus section: what is the deadline for the midterm exam?" was then entered into GPT-4 together with the pertinent information. The python-docx package was used to extract text from syllabi, divide it into logical chunks, and store it as embeddings as binary objects (BLOBs) for quick retrieval. Iterative testing and rapid refining were used to develop the system, guaranteeing precise and pertinent results by modifying the material supplied to GPT-4 for specificity and clarity while controlling context duration to promote efficiency. This procedure made it possible for GPT-4 to produce precise, context-aware answers, improving user experience and simplifying course administration.

Problem Statement:

The amount of documents that may be uploaded to commercially accessible Large Language Models (LLMs) limits the present internal system for querying course syllabi. This restriction limits the system's capacity to offer thorough and precise answers to inquiries from instructors and students on course details, especially when working with a sizable database of curricula

covering several years and programs. A more effective and scalable solution is required in order to process a greater number of documents and offer more thorough, contextual, and correct answers to common questions.

Research Questions:

Research Questions Investigated:

Research Question 1: How can a chatbot using Retrieval-Augmented Generation (RAG) techniques effectively query a large database of course syllabi to provide more accurate and comprehensive responses compared to current systems?

Research Question 2: To what extent can the integration of RAG techniques with LLMs improve the efficiency and relevance of responses to queries about course information from a large syllabi database?

Research Question 3: What is the potential impact of an AI-driven chatbot using RAG on the accessibility and understanding of course information for faculty and students in higher education settings?

Hypothesis

Alternative Hypothesis (H1): Statement of the hypothesis in the alternate hypothesis form (null hypothesis implied). (see the document provided by your client)

Comparative test results with a variety of course-related inquiries show that a chatbot using Retrieval-Augmented Generation (RAG) techniques with Large Language Models may deliver more precise, contextually relevant, and thorough answers to questions concerning course information from a large syllabi database than standard search approaches. This leads to quantifiable gains in response quality and user satisfaction.

Null Hypothesis (H0): A chatbot that uses RAG methods and conventional search methodologies for querying course syllabi do not significantly vary in terms of accuracy, relevance, and completeness of replies.

Proof of Concept Approach

This proof of concept aimed to show that retrieving an extensive database of course syllabi using Retrieval-Augmented Generation (RAG) techniques with Large Language Models (LLMs) was feasible. The application, which was created using a collection of 150 syllabi, attempts to increase the precision and effectiveness of course-related inquiries for instructors and students alike. The Python-docx package was used to extract material from curricula. To increase query accuracy, this was followed by segmentation into logical areas (such as "Course Overview" and "Prerequisite"). A SQLite database was used to hold the segmented and extracted data. The following columns were part of the database schema: ID (a distinct number assigned to every record), course_name (the course name), section (logical sections such as assignments, information of the curriculum) embedding (text saved as BLOBs in a vector form). Each course section's vector embeddings were created using the OpenAI text-embedding-ada-002 model. For optimal retrieval and searching, the embeddings were kept in the SQLite database as binary large objects (BLOBs). Text input was transformed into embeddings in order to handle user

inquiries. Based on the similarity between query embeddings and stored embeddings, the system employed Euclidean distance for semantic search to find and retrieve the most relevant and important course components.

A Flask-based chatbot interface was developed so that users could submit their questions. The LLM produced contextually relevant answers based on the obtained course information when the chatbot communicated the inquiry and pertinent course data to ChatGPT. The complete system was set up on Heroku, which offers a scalable cloud-based platform for hosting the database and chatbot interface. Depending on the size of the database and the complexity of the query, the system responds quickly, with query processing lasting a few seconds. The system performed noticeably better than conventional keyword-based search in terms of answer relevancy, accuracy, and context when using semantic search and embeddings. If necessary, a bigger syllabus database may be easily added according to the architecture's scalability design.

Sample Interface

Syllabus Chatbot

When are the examination dates set for Database Design and Management?

For the course ****Gilani MASY1-GC 3500-102, Database Design & Management****, the examination dates are as follows:

- ****Midterm #1****: March 4, 2024
- ****Midterm #2****: April 8, 2024
- ****Final Exam****: May 6, 2024

For the course ****Choudhury MASY1-GC 3500-201, Database Design Management****, the examination date is:

- ****Midterm Exam****: Available online from Friday, March 8, 2024, and due by 11:50 PM on Sunday, March 10, 2024.

FAQs

Course Requirements	Required Books
Assignments	Examination Dates
Contact Professor	Class Medium

Experimental Setup

An experiment was carried out with 31 users, comprising NYU SPS students and non-SPS students from other NYU departments, to assess the Syllabus Chatbot's efficacy. The experiment's primary goal was to evaluate the chatbot's accuracy, usability, and user

satisfaction in responding to questions about the course. Users were asked to score the entire experience and usability, especially with regard to navigation and theme change. The user-friendliness of the chatbot's interface and interaction design was evaluated. On a scale of 1 to 5, users assessed the chatbot's accuracy. To gauge how successfully the chatbot answered particular course-related questions from the syllabus database, feedback was gathered. After interacting with the chatbot, participants gave their opinions by filling out a quick survey.

They were asked to score their overall experience, the accuracy of their responses, and recommendations for enhancements in the survey. The tool was then improved using this data, with the user interface being improved for a better user experience and the backend algorithms being improved for more accurate replies. With an overall experience rating of 4.80/5 and a response accuracy grade of 4.87/5, user satisfaction ratings were good. These findings imply that the chatbot greatly enhances course syllabus accessibility and offers more precise responses.

Population and Data Collection

The chatbot was tested by 31 individuals with diverse academic backgrounds, including NYU SPS students and non-SPS students from other NYU schools. It was assessed based on its ability to respond to inquiries regarding academic course information, using 150 course syllabi from various programs. The independent variables included User Experience, which examined how different user groups (SPS vs. non-SPS) experienced the chatbot, helping to evaluate its performance across various academic fields. Additionally, UI and Backend Modifications were considered, focusing on changes made to query-handling techniques and interface design with the goal of enhancing overall accuracy and usefulness.

Dependent variables

The dependent variables in the study included the Overall Experience Score, which ranged from 1 to 5 and assessed user satisfaction, reflecting the chatbot's overall acceptability and attractiveness. The Response Accuracy Rating, also on a 1 to 5 scale, indicated how accurate users perceived the chatbot's replies, evaluating its ability to retrieve and present relevant course material. Additionally, user input was gathered in the form of recommendations for improvements, providing insights into potential areas for future feature development and optimization. Data was collected through a user survey, which included ratings for accuracy and experience, offering numerical indicators of performance and user satisfaction, along with suggestions for chatbot enhancements.

Procedures for the Trial

Thirty-one NYU SPS and non-SPS students participated in the trial recruitment process, where they interacted with the chatbot by asking questions about the course syllabus. Users posed their queries, and the chatbot's responses were assessed for accuracy and relevance. The system was deployed using Heroku, allowing seamless access for participants. After engaging with the chatbot, participants provided feedback through a survey, offering insights into their experience and the system's effectiveness.

Measurements

Measurements for the evaluation included user satisfaction and response accuracy. User satisfaction was assessed based on experience and accuracy, scored on a 5-point scale. Response accuracy was evaluated by users, who rated the chatbot's ability to provide correct and relevant answers to their syllabus-related queries.

Methods of Data Collection

The study employed multiple data collection methods to ensure a comprehensive evaluation of the chatbot's performance. Surveys were administered following each interaction, capturing user ratings and qualitative feedback on their experience. Additionally, interaction data and user responses were systematically logged to facilitate further analysis. This approach enabled a detailed assessment of the chatbot's accuracy, user satisfaction, and overall effectiveness in responding to syllabus-related queries.

Data Collection Methodology

The study utilized both surveys and system logging to collect comprehensive data on user interactions. Surveys were conducted immediately after each interaction, gathering user ratings and qualitative feedback on experience, accuracy, and overall satisfaction. Additionally, system logging was employed to record user queries, chatbot responses, and engagement patterns. This dual approach ensured a thorough analysis of chatbot performance, enabling a data-driven evaluation of its effectiveness in responding to syllabus-related inquiries.

RESULTS

Throughout the development and testing of the system, the model demonstrated its ability to generate relevant responses and effectively handle user queries. For instance, when asked about prerequisites for a specific course, the chatbot accurately provided the required information, stating that the prerequisite for the Information Security Management course (MASY1-GC 3220) is "1240 - Information Technology and Data Analytics." Similarly, when queried about examination dates for the Database Design and Management course, the chatbot successfully retrieved and presented a structured schedule, listing midterm exams on March 4 and April 8, 2024, and the final exam on May 6, 2024. These examples highlight the system's capability to extract precise details from the syllabus and deliver structured, relevant responses, reinforcing its effectiveness in assisting students with course-related inquiries.

Programming Documentation

Input Processing & Embedding

This function uses OpenAI's API to transform the user's message into an embedding:

```
```python
def get_embeddings(text):
 response = openai.Embedding.create(model="text-embedding-ada-002", input=text)
 return response['data'][0]['embedding']
```
```

Response Generation

After embedding-based querying, this function uses the most relevant and important content to provide a response from ChatGPT.

```
```python
def get_response_from_gpt(user_question, relevant_sections):
 # Prepare the user's query
 user_query = f"User Question: {user_question}"

 # Construct relevant context from the database
 relevant_context = "Based on the following course sections,
 please provide specific answers as chatbot:\n"
 for similarity, course_name, section in relevant_sections:
 relevant_context += f"\nCourse: {course_name}\nSection:
 {section}\n"

 # Combine the query and context
 message_to_gpt = user_query + '\n' + relevant_context

 # Send the constructed message to GPT
 completion = client.chat.completions.create(
 model=MODEL,
 messages=[
 {"role": "system", "content": "You are a chatbot that
 helps with course-related questions in a university."},
 {"role": "user", "content": message_to_gpt}
]
)

 # Return GPT's response
 return completion.choices[0].message.content
```
```

Metrics on Productivity/Efficiency Gains

The system demonstrated significant improvements in productivity and efficiency across multiple metrics. Query resolution time was drastically reduced to just a few seconds, enabling users to receive instant responses instead of spending extended periods searching for information. Retrieval accuracy improved by 40%, ensuring that users received more precise and relevant answers. Search cycle time, which previously took several minutes, was minimized to mere fractions of a minute, streamlining the process of accessing course-related information. Additionally, operational costs were reduced by decreasing the need for manual intervention and optimizing resource allocation, further enhancing the system's overall efficiency and scalability.

Data Processing

Python-docx was used to extract 150 syllabi from a.docx file, which were then logically divided into sections such as "Course Overview" and "Prerequisites" for accuracy. The embeddings for these sections were created using OpenAI's text-embedding-ada-002 model and stored in a

SQLite database. To match user queries with the most pertinent sections, a semantic search mechanism based on Euclidean Distance was used. Users could ask questions using a Flask-based chatbot interface and get contextually relevant responses. The Heroku-deployed system outperformed conventional keyword search in terms of accuracy and query response speed.

Description of data cleaning and analysis

After being retrieved from.docx syllabi, the material was divided into logical chunks and cleaned up by eliminating unnecessary extra whitespace. Using OpenAI's text-embedding-ada-002 paradigm, each part was embedded and saved in a SQLite database for quick access. Only relevant, non-empty sections were added to the database to preserve data integrity and increase search accuracy, and error handling and logging were put in place to monitor problems during the process.

Findings

The system received high praise from users, with an average rating of 4.80/5 for user experience and 4.87/5 for accuracy. Over 80% of testers rated both criteria 4/5 or higher. User feedback led to several improvements, including enhancements to the chatbot's visual design, user interface, and question processing capabilities. Additionally, testers highlighted the system's ability to quickly provide accurate and contextually relevant responses, further improving its overall effectiveness. These positive results demonstrate the chatbot's potential to be scaled and refined for broader use, ensuring both reliability and user satisfaction.

Summary Statistics

The usability of the interface received overwhelmingly positive feedback from users, indicating high levels of accuracy and satisfaction. Quantitative results revealed that over 80% of users rated the system highly, with an average rating of 4.87/5 for accuracy and 4.80/5 for overall experience. Statistical analysis of the feedback from 31 testers consistently showed favorable trends, confirming the correctness and effectiveness of the system. Qualitative observations highlighted that user suggestions led to key improvements, particularly in backend processes and UI design, which enhanced query processing and overall user interface functionality.

Outcomes

Positive comments and high satisfaction ratings show that the system works well for what it was designed to do. It was verified that it could process complex queries and deliver precise answers, and UI enhancements greatly improved the user experience. The system's functioning was further enhanced by the feedback-driven improvements.

Implications

The results confirm that RAG may greatly enhance user interface and query processing, providing information on how to better apply AI for systems that interact with users. Iterative development based on user input is essential for improving AI-driven systems, guaranteeing greater accuracy and usability, according to the feedback-driven enhancements.

Summary

To summarize, the system exceeded satisfaction goals and did well in beta testing. The significance of accuracy, system usability, and the requirement for ongoing UI improvements were emphasized by key findings. The system's potential for improvement and scalability is demonstrated by the modifications made in response to input.

DISCUSSION AND CONCLUSIONS

Although developing a syllabus chatbot using generative AI inside the RAG framework has shown promise, there are still several aspects that might be improved for more generalizability and robustness. The quality and completeness of the dataset determine how well the system performs, and if the syllabus database is lacking, there may be intermittent errors. Furthermore, even while the chatbot works effectively in one area, it might be difficult to adapt to other departments with different structures and vocabularies. In order to further enhance accuracy and flexibility across various academic contexts, future work will concentrate on growing the dataset for wider departmental application and investigating cutting-edge AI approaches including fine-tuning and multi-modal data integration.

Conclusions

In conclusion, the project successfully achieved its objectives by using the Retrieval-Augmented Generation (RAG) framework to create a syllabus chatbot that efficiently responds to student inquiries regarding course syllabi within a department. The chatbot provided more precise, context-driven responses while significantly reducing query resolution time. Key findings include substantial productivity gains, as the time required to resolve queries was reduced to mere seconds. Accuracy was improved by 40%, and cycle time saw a notable reduction, enhancing the system's overall efficiency. User satisfaction was high, with over 80% of participants rating the experience and accuracy at 4.80/5 and 4.87/5, respectively. The viability of the chatbot was demonstrated through a successful proof of concept within a Management and Systems department. With further development, the system holds strong potential for scalability and can be customized for administrative purposes, suggesting a promising future for its broader application.

Implications

This study explores the theoretical and practical implications of using Retrieval-Augmented Generation (RAG) and Generative AI to enhance AI-powered teaching resources. By utilizing semantic embedding models like OpenAI's text-embedding-ada-002 in combination with GPT, the research contributes to our understanding of AI-driven query resolution and contextual information retrieval in academic environments. Practically, the chatbot reduces administrative workload by improving response accuracy and streamlining the retrieval of course information. Its success within a single department highlights its potential for scaling across other academic fields. High user satisfaction, with an impressive rating of 4.80/5 for accuracy, underscores its effectiveness in improving both the student experience and administrative efficiency.

Limitations

The RAG-based syllabus chatbot has demonstrated excellent results within a single department, with significant potential for expansion across other academic areas. Broadening

the dataset to incorporate diverse disciplinary terminology and frameworks would enhance its flexibility and applicability. While the chatbot currently provides reliable answers, further improvements could be made in handling more complex or specialized inquiries with greater accuracy and contextual awareness. Strategies like fine-tuning for specific user needs or integrating multi-modal data could boost its performance. Additionally, proactively addressing potential biases in data representation will ensure fair and consistent responses across different academic settings.

Further Work

Future work will focus on expanding the dataset to improve the chatbot's ability to handle more complex inquiries, enhancing the overall user experience. By refining the system to provide context-specific and precise responses, it can become more valuable across various academic departments. Additionally, implementing feedback loops for continuous improvement will boost system reliability and user satisfaction. Long-term research could explore advanced techniques to enhance the Retrieval-Augmented Generation framework, such as integrating additional retrieval algorithms, optimizing models for subject-specific knowledge, or experimenting with hybrid AI strategies. Furthermore, incorporating features like personalized learning paths, AI-driven course material recommendations, and multi-modal resource compatibility could greatly enhance the system's capabilities. Scaling the chatbot across multiple departments and aligning it with institutional goals will open up opportunities for broader application and a greater overall impact.

Closing Summary

In order to improve academic query resolution, this study proposes a unique way to use generative AI inside the RAG (Retrieval-Augmented Generation) framework to create a syllabus chatbot. The solution dramatically enhances user experience by offering faster and more accurate replies, resolving course-related queries quickly. The approach opens the door for further applications across several academic areas in addition to making a contribution to the EdTech field. This chatbot is positioned as a useful tool for organizations looking to maximize information accessibility because of its potential for scalability and future improvements, such as integrating more varied data sources and investigating more AI approaches. The project's results demonstrate the substantial practical effects of AI-powered solutions in learning environments, providing evidence of the revolutionary potential of AI in higher education

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DECISION SCIENCES INSTITUTE

Enhancing Decision Sciences Education with Generative AI: A Case Study in Teaching Data Warehousing Fundamentals

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ABSTRACT

The rapid evolution of generative AI presents new opportunities to innovate technical education in business disciplines. This study explores how a ChatGPT-powered assistant can enhance student learning in data warehousing, a subject often perceived as difficult due to its emphasis on schema design, SQL syntax, and ETL processes. The AI assistant was designed to provide step-by-step guidance, real-time feedback, and syntax debugging support, allowing students to focus on conceptual understanding rather than technical troubleshooting.

A pilot trial with graduate students who had prior exposure to data warehousing assessed the chatbot's effectiveness. Results showed a 110% increase in student confidence, a reduction in SQL error rates from 40% to 5%, and a 35% decrease in task completion time. Students reported a positive learning experience, citing improved clarity in schema construction and enhanced engagement through immediate feedback.

This case study demonstrates the pedagogical value of integrating generative AI into decision sciences education. The AI tool effectively reduced cognitive load by automating low-level syntax tasks, thereby supporting deeper learning of complex concepts. While the small sample size limits generalizability, the findings point to promising applications of AI as a scalable instructional tool.

By aligning instructional technology with industry-relevant tools, this work contributes to emerging pedagogical practices that support data literacy and agile learning environments in business education.

KEYWORDS: Generative AI, Data Warehousing Education, Decision Sciences Pedagogy, SQL Learning, Educational Technology, AI-Assisted Instruction

INTRODUCTION

Generative AI technologies such as ChatGPT are transforming how technical skills are taught across business education. These tools offer new ways to reduce cognitive barriers in complex domains, particularly in data warehousing, where students often struggle with abstract schema design, SQL syntax, and the intricacies of ETL (Extract, Transform, Load) processes.

This paper presents a case study that explores how a ChatGPT-powered assistant can support student learning in data warehousing fundamentals. The assistant guides learners through a structured, interactive dialogue to translate business requirements into star schema designs, write SQL code, and debug errors in real time. By offloading the burdens of syntax management and troubleshooting, the AI allows students to focus more on conceptual modeling and design thinking.

This study contributes to emerging pedagogical practices by demonstrating how large language models (LLMs) can function as scalable tutors for technical instruction. Unlike traditional automation tools, LLMs offer conversational scaffolding, real-time correction, and adaptive feedback—qualities that are particularly valuable in asynchronous or resource-constrained learning environments.

Conducted with graduate students in a data science program, this proof-of-concept trial evaluated the tool's impact on learning outcomes, efficiency, and student engagement. The results highlight significant improvements in task accuracy, completion time, and learner confidence.

By aligning educational delivery with tools increasingly used in practice, this work supports the DSI Pedagogy Conference theme of Innovating Business Education. It offers a model for how AI-powered assistants can supplement teaching in decision sciences, especially in highly structured, technical topics.

Research Objective and Hypothesis

This study investigates whether a generative AI assistant can improve students' ability to perform core tasks in data warehousing. Specifically, the tool is designed to support schema design and SQL development by offering real-time feedback and automated debugging.

Hypothesis:

Students using the generative AI assistant will demonstrate increased confidence, improved task accuracy, and reduced time-on-task compared to students working without AI support.

LITERATURE REVIEW

Literature Review

This review situates the development of a generative AI-powered chatbot within the context of data warehousing pedagogy and the broader application of AI in education. The goal is to highlight how emerging technologies can support technical learning in decision sciences by lowering barriers such as syntax complexity and cognitive overload.

1. Challenges in Data Warehousing Education

Teaching data warehousing presents persistent challenges due to the domain's technical complexity. Students often struggle with translating business requirements into schema designs, writing accurate SQL, and understanding the logic of ETL pipelines (Kimball & Ross, 2013). These tasks require both conceptual understanding and technical fluency, making instruction particularly difficult for learners with limited programming backgrounds.

Prior research notes that even experienced students face steep learning curves in dimensional modeling and error debugging (Krishnamoorthy, 2015). The demand for support often exceeds the capacity of instructors, especially in large or asynchronous classes.

2. Reducing Cognitive Load with Intelligent Tools

Cognitive load theory suggests that managing extraneous processing—such as debugging syntax—is crucial to supporting deeper learning (Sweller, 2011). Intelligent tutoring systems, including AI-based assistants, have shown potential in reducing such load by providing step-by-step guidance and immediate feedback.

Generative AI tools like ChatGPT represent a new generation of such systems. Their capacity for natural language interaction and domain-specific prompt engineering enables them to serve as real-time teaching aides (Xu & Ouyang, 2022). This aligns with the broader literature on scaffolding in technology-enhanced learning environments, where responsive systems help learners focus on conceptual structure rather than procedural hurdles.

3. Automation and AI in Schema Design

Much of the technical literature on AI and data warehousing has focused on automating schema creation using rule-based or semi-automated tools (Simanjuntak et al., 2017; Latif et al., 2008). These tools reduce design time but often lack interactivity or pedagogical orientation. Our approach builds on these foundations by adding a conversational interface and embedding feedback loops, better aligning the tool with educational goals.

LLMs provide a distinct advantage by interpreting unstructured inputs and offering just-in-time explanations. Prior studies suggest that such capabilities are especially useful in low-resource settings or where learners lack technical expertise (Moscoso-Zea et al., 2018).

4. AI for Decision Sciences Education

The application of AI in business education is still nascent but growing. Zawacki-Richter et al. (2024) note that AI's role in instruction has shifted from content delivery to dynamic learner support. In particular, AI-powered chatbots are being explored for their potential to simulate tutoring, automate formative feedback, and support mastery learning—functions highly relevant for decision sciences and analytics instruction.

By tailoring outputs to user input, LLMs can adapt explanations to individual learners, reinforcing principles of differentiated instruction. Moreover, their integration into data-heavy subjects like business analytics, finance, and operations supports the development of data literacy in line with evolving industry standards (Fortino & Yang, 2024).

Summary

This literature base supports the development of AI-powered learning assistants as both feasible and pedagogically promising. While past approaches focused primarily on technical automation, the incorporation of LLMs allows for real-time interaction, customization, and cognitive scaffolding—features that make them especially valuable in educational contexts.

Our case study builds on these insights by demonstrating how a generative AI assistant can enhance learning in a foundational technical domain while also aligning instruction with industry tools. This approach bridges the gap between automation and pedagogy, offering a scalable model for AI-integrated teaching in the decision sciences

Use Cases

One significant use case demonstrating the success of automated schema design is illustrated in the work of Simanjuntak et al. (2017), who developed a tool that automates the transformation of star schema data warehouses into physical data models. This tool leverages predefined rules and schema transformations, enabling dynamic adjustments based on data characteristics and schema requirements. The automation provided by this tool significantly reduced the time and expertise required to create complex schemas, making the process accessible to organizations with limited technical resources. Their study validates the practicality of algorithm-driven methods in data warehouse schema creation, particularly for users lacking technical backgrounds who need streamlined, effective solutions. This case is directly relevant to the proposed project, as it demonstrates the success of automation in schema design, offering a foundational approach that can be adapted to an LLM-powered chatbot for enhanced interactivity and accessibility (Simanjuntak et al., 2017).

Another pertinent example is Latif et al.'s (2008) semi-automated approach, which focuses on converting entity-relationship diagrams into semi-star schemas, commonly used in data warehousing. Their system follows a source-driven methodology that automates part of the schema generation process, thus reducing manual effort while allowing user input for added flexibility. This semi-automated solution is especially valuable in settings with changing data requirements, as it offers adaptability to generate or adjust schema elements without requiring extensive reconfiguration. The framework established by Latif et al. supports the notion that automated schema generation tools can succeed in a variety of organizational contexts, making data warehousing technology more accessible and manageable, particularly for SMEs and educational institutions. By building on the principles demonstrated in this use case, the proposed chatbot can implement similar automation processes, enhanced by natural language processing, to provide even greater flexibility and user interactivity (Latif et al., 2008).

From these examples and existing literature supporting this application, we find that automated data warehouse (DW) schema design is not only feasible but also increasingly important for organizations with limited technical expertise and budgets. Specifically examining the unique challenges of data warehousing in educational institutions and SMEs, the studies reviewed highlight the barriers these sectors face due to high costs and the technical complexity of traditional DW schema creation. Most of the literature reviewed concluded that automated tools—such as rule-based and ontology-driven frameworks—can significantly reduce the complexity and cost of schema design by streamlining and, in some cases, fully automating the process, making DW technology more accessible to non-experts (Simanjuntak et al., 2017; Latif et al., 2008).

The literature also demonstrates that integrating AI and machine learning into DW schema generation, particularly through LLM-driven tools, presents a viable solution for these organizations by offering flexibility, real-time adaptability, and ease of use (Moscoso-Zea et al., 2018; Dakrory et al., 2015). This review aligns with the aims of our project, which proposes an LLM-powered chatbot capable of generating star schemas based on user input, providing an innovative, accessible solution to automate DW design. While previous studies focused on

semi-automated approaches or rule-based methods, our approach combines these principles with conversational AI, offering a more interactive, adaptable tool that can address diverse schema requirements. As a result of this review, we conclude that our proposed chatbot aligns well with both the current needs and future directions of DW automation, offering an efficient, user-friendly tool for non-technical users to engage in data warehousing without extensive resources or expertise.

METHODS

This study employed a case study approach to evaluate the pedagogical effectiveness of a generative AI assistant in teaching data warehousing fundamentals. The assistant was developed using OpenAI's ChatGPT and integrated into a structured learning module on dimensional modeling, SQL coding, and ETL concepts. The study aimed to assess whether the assistant improved student outcomes by reducing syntax-related frustration and enhancing conceptual clarity.

Participants

Five graduate students from a data analytics master's program participated in the pilot trial. All had previously completed at least one course in database systems and demonstrated basic proficiency with SQL. Participants were selected based on their enrollment in a capstone course focused on advanced data analysis and systems design. While small in number, the sample was sufficient for a formative evaluation of tool feasibility and learning impact.

Procedure

Participants were given a business scenario and asked to develop a star schema design and corresponding SQL queries. They completed these tasks in two phases:

1. Without AI Assistance: Students worked individually, using their own knowledge and any available course materials.
2. With AI Assistance: Students used the ChatGPT-powered assistant embedded in a text interface to generate, modify, and debug SQL code based on their schema designs.

In both phases, students submitted their schema diagrams and SQL code for evaluation. Task completion time, error rates, and participant confidence (self-reported) were recorded.

Measures

- Accuracy: Number of correct SQL statements and valid schema components.
- Efficiency: Time taken to complete each phase.
- Confidence: Measured through a post-task survey on a 5-point Likert scale.
- Qualitative Feedback: Open-ended reflections were collected to gauge user perceptions of the assistant's value and usability.

Ethical Considerations

The project was reviewed informally for classroom research ethics and participants provided informed consent. No identifying information was collected, and participation did not influence course grades.

RESULTS

The AI-assisted learning intervention yielded notable improvements across all measured dimensions: task accuracy, completion time, and learner confidence. Students performed schema design and SQL tasks both independently and with the assistance of the generative AI tool, enabling a within-subject comparison.

Task Accuracy

When working without assistance, students produced SQL queries with an average error rate of 40%, primarily due to syntax issues and incorrect table joins. With the AI assistant, this error rate dropped to 5%, indicating a significant reduction in execution-level mistakes.

Schema diagrams also showed improvement: two participants revised flawed dimensional models after interacting with the assistant, citing better understanding of the relationships among fact and dimension tables.

Task Efficiency

The average time to complete the assigned tasks declined by 35% with AI assistance. Students reported spending less time debugging syntax and more time verifying the logic of their schemas and queries.

Confidence and Perceived Support

Post-task surveys revealed a 110% average increase in student-reported confidence (on a 5-point Likert scale). Students noted that the assistant was especially helpful in providing:

- Step-by-step guidance when translating business requirements into schema designs,
- Explanations for SQL functions and error resolution,
- Clarifications that reinforced prior course content.

Qualitative Feedback

Open-ended reflections emphasized the tool's tutoring function. One student remarked, "It felt like having a TA who actually knew what I meant." Another noted that the tool helped "connect classroom theory to hands-on practice much more quickly."

Overall, students perceived the assistant as a valuable supplement, particularly in reducing frustration during complex tasks.

| Metric | Without AI | With AI | Improvement |
|------------------------|----------------|----------------|-------------|
| SQL Error Rate | 40% | 5% | 35% ↑ |
| Avg. Task Time | 48 minutes | 31 minutes | 35% ↓ |
| Confidence (avg score) | 2.1 (out of 5) | 4.4 (out of 5) | 110% ↑ |

Table 1 - Comparison of Student Performance With and Without Generative AI Assistance

This table summarizes the observed differences in SQL error rate, task completion time, and self-reported confidence across two conditions: unaided work and work assisted by a generative AI tool. Improvement percentages are calculated based on the relative change between conditions.

DISCUSSION AND CONCLUSIONS

This pilot study demonstrates the potential of generative AI to enhance learning in data-intensive business courses. By serving as a real-time assistant for schema construction and SQL debugging, the tool reduced mechanical barriers to learning and allowed students to focus on higher-order thinking. The improvements in accuracy, efficiency, and confidence observed in this trial point to the pedagogical value of integrating conversational AI into technical instruction.

One notable finding was the sharp decline in SQL error rates, suggesting that AI can effectively act as a syntax-aware tutor. Student reflections confirmed that the assistant not only fixed mistakes but also clarified misunderstandings, reinforcing prior instruction. These qualitative gains echo the broader literature on scaffolding and cognitive load reduction in instructional design.

Despite these promising results, limitations remain. The small, homogenous sample (graduate students with prior SQL exposure) restricts the generalizability of findings. Future work should examine the tool's effectiveness with more diverse learners, including undergraduates and those with minimal technical background. Controlled experiments with larger sample sizes could offer stronger empirical support and isolate the mechanisms of learning gain.

Moreover, while this implementation focused on SQL and dimensional modeling, the underlying framework is adaptable. Similar generative AI agents could support instruction in other data-centric domains such as financial modeling, forecasting, or data visualization—extending the reach of instructional innovation across the decision sciences.

Ultimately, this study contributes to the ongoing conversation about how business education must evolve. As AI becomes ubiquitous in industry, embedding AI-powered learning tools in the classroom prepares students not just to consume technology, but to collaborate with it. Doing so supports agile, scalable, and personalized education—key goals for innovating business pedagogy in the coming decade.

Implications and Next Steps

The findings of this case study offer several implications for educators, instructional designers, and academic program leaders interested in integrating AI into decision sciences education.

Strategic Implications

This study illustrates how generative AI can introduce structure and support into technical learning environments, helping institutions move beyond experimentation toward strategic innovation. By embedding intelligent assistants into curriculum design, schools can ensure greater alignment between learning objectives and evolving professional standards.

Operational Implications

At the instructional level, AI tools such as the one piloted here offer scalable support in courses with high cognitive complexity. They can reduce the demand for direct faculty intervention while improving learning outcomes—an increasingly relevant capability in asynchronous, hybrid, or resource-constrained settings.

Educational Implications

The assistant's success suggests that generative AI can be repurposed as a pedagogical agent in other domains requiring syntax, modeling, or translation of business logic into technical design. This points to a broader need for faculty development and curriculum reform to responsibly integrate AI into instructional practice.

Next Steps

Future work should validate these findings in larger, more diverse cohorts and extend the use case beyond data warehousing. Additional research may explore how AI tutors affect long-term knowledge retention, collaborative learning, and student self-efficacy. There is also an opportunity to develop institutional frameworks for AI deployment that balance innovation with ethical, equity, and academic integrity considerations.

To remain relevant, business education must embrace tools that not only reflect professional realities but also elevate student engagement and mastery. Generative AI—when thoughtfully integrated—offers such a path forward.

Closing Reflection

This case study offers a glimpse into how generative AI can reshape the teaching of technical business topics by acting as an accessible, responsive, and intelligent learning companion. As educational institutions confront the dual challenges of rising complexity and limited instructional resources, such tools hold promise not only for improved outcomes, but for reimagining the learning experience itself. Bridging the gap between technological fluency and conceptual understanding, generative AI has the potential to become not just an instructional aid, but a catalyst for pedagogical transformation in the decision sciences.

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Appendix A

Pre-Chatbot Survey Questions (Before Interaction)

These questions gauged students' initial knowledge and expectations:

1. How familiar are you with data warehousing concepts?
Options: Not familiar, somewhat familiar, Familiar, very familiar
2. How comfortable are you with designing a star schema for a data warehouse?
Options: Not comfortable, somewhat comfortable, Comfortable, very comfortable
3. Have you previously worked with SQL to create or query databases?
Options: Yes, No, A little
4. What do you hope to learn from this chatbot interaction?
Open-ended
5. What do you find most challenging about data warehousing?
Options: Understanding fact and dimension tables, designing schemas, Writing SQL queries, Loading and transforming data (ETL), Other (please specify)

Post-Chatbot Survey Questions (After Interaction)

These questions evaluated learning outcomes and gathered feedback on the chatbot's effectiveness:

1. How confident do you feel about designing a star schema after using the chatbot?
Options: Not confident, somewhat confident, Confident, very confident
2. Did the chatbot help clarify the purpose of fact and dimension tables in a data warehouse?
Options: Not at all, Somewhat, yes, Absolutely
3. How helpful was the chatbot in guiding you through SQL code creation?
Options: Not helpful, somewhat helpful, Helpful, very helpful
4. Which part of the chatbot interaction was the most useful for your learning?
Options: Understanding the star schema, Learning SQL code, Writing ETL processes, answering queries with SQL, Other (please specify)
5. What challenges, if any, did you still encounter while using the chatbot?
Open-ended
6. Do you feel more confident about querying and analyzing data with SQL after the interaction?
Options: Not at all, Somewhat, yes, Definitely
7. How likely are you to recommend this chatbot as a learning tool for data warehousing?
Options: Very unlikely, Unlikely, Likely, very likely
8. What additional features or improvements would you suggest for the chatbot?
Open-ended

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The Pandemic Remote Learning Experience – A Retrospective

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ABSTRACT

This paper recounts the remote learning experiences in higher education following the 2020 pandemic-related lockdown. It relates how instructors dealt with changes in online education and student assessment practices. It concludes with some observations on how the remote learning experiences can benefit online education going forward.

KEYWORDS: Remote Learning. Online Education.

INTRODUCTION

The onset of the COVID-19 pandemic in the spring of 2020 forced schools and universities to close worldwide and adopt some form of online education. (Foss, 2020) Prior to the pandemic, many colleges and universities already had substantial online learning programs in place and almost a third of college students in the United States had enrolled in at least one online course. (Fuentes, 2020; Gallagher & Palmer, 2020) Additionally, many instructors had already obtained online teaching skills, and a large body of research to help them improve learning outcomes was available. (Nguyen, 2015) However, online learning was not the rule until the pandemic made it so. It was during this period that the term “remote learning” was commonly applied to the mandatory online learning efforts.

Before the pandemic, “remote learning” was occasionally used as a substitute term for various types of distance or online education, with little distinction made among these types. (Khalifa & Kwok, 1999; Lakov, 2004) Following the mass transition to some form of online education in 2020, many educators specifically linked remote learning to the COVID-19 pandemic. For example, Hodges et al (2020) refer to “emergency remote teaching,” which they define as “a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances.” Traditionally, they argue, online instruction has been carefully planned and designed, resulting in learning materials, student activities, and assessments of high quality. For many courses that transitioned to online learning in 2020, the time to do so thoughtfully was not available. Campus-based resources to assist instructors were not always sufficient. On-campus resources to support students (such as libraries and advising) became more difficult to access. As a result of all these factors, it is likely that some efforts were less than optimal. (Bozkurt et al, 2020; Heitz et al, 2020; Hodges et al, 2020)

The notion of “a temporary shift” implies that instruction is expected to return to face-to-face delivery once the crisis has passed. Consequently, the objective of remote learning is not to provide optimal online education but rather to provide students with temporary access to education and support services. (Hodges et al, 2020; Schultz & DeMers, 2020) For this reason remote teaching efforts do deserve substantial credit for providing continuity of education in light of pandemic-related lockdowns. Rather than interrupting student progress worldwide for a substantial period, remote learning allowed much of the educational process to continue.

(Appolloni et al, 2021) The experiences gained during this time should not be wasted but rather should be used to inform the continuous improvement of higher education.

The objective of this paper is therefore to examine what happened when remote learning was hastily implemented and how educators adapted to this new teaching modality, especially at the higher education level. Given that remote learning efforts continue – such as when schools and universities change weather closures to remote learning days – the paper examines what educators have learned from the remote learning experience, which may be applied to future online and distance education efforts.

REMOTE LEARNING IMPLEMENTATION OF ONLINE EDUCATION PRACTICES

In the transition to remote learning in 2020, many instructors at first attempted to replicate classroom activities in synchronous online class meetings. They soon found out that doing so was often not practical. Not all students could access the synchronous courses for a variety of reasons: student work schedules would interfere with live class sessions; students who were also parents would be preoccupied with childcare and online school sessions for their children; in some households, bandwidth was limited, or students needed to share devices with siblings; and so forth. (Barber et al, 2021; Nordmann et al, 2020) Over time, instructors began to learn about alternatives to the traditional lecture format that were afforded by online resources and technologies. It has long been known that the use of a combination of synchronous and asynchronous work, active engagement with course materials, formative assessments which help students build their knowledge, and a variety of course materials stimulate student learning in online courses. (Nguyen, 2015)

One such combination is the idea of a “flipped classroom.” In this approach, students prepare for a class session by reading assigned materials or watching online videos. In the actual class session, the instructor does not lecture but instead leads in-class activities or discussions based on the content the students reviewed beforehand or engages in active problem solving. (Erlam et al, 2021) The flipped classroom provides opportunities for both synchronous and asynchronous communications for students and instructors. Synchronous communications support the strengthening of student-to-student relationships in the course, contributing to the development of a learning community. Asynchronous communications provide flexibility for the student interactions and collaboration, as well as the potential for individual students to receive mentoring and additional support from the instructor. (Nordmann et al, 2020)

Buoyed by findings that the approach provides quality learning outcomes (Swart & MacLeod, 2020), the “flipped classroom” approach was rapidly adopted. Shortly following the transition to remote learning in 2020, several surveys of both instructors and undergraduate students found instructors combining synchronous and asynchronous teaching methods. (Fox et al, 2020; Means & Neisler, 2020) The sum of these synchronous and asynchronous learning activities became known as “flexibly designed learning environments” (Rapanta et al, 2021), which mix modalities and resources to allow for greater personalization of the student learning experience as well as student-paced learning.

REMOTE LEARNING AND ASSESSMENT

The quick transition to remote learning also required instructors to thoroughly reevaluate the methods for student assessment they had planned for their courses. A 2020 survey found that 97% of the faculty surveyed made some form of modification to their student assessments

following the transition to remote learning. (Jankowski, 2020) Assignments were modified so that students could perform them asynchronously and remotely; in-class exams shifted to online exams or other forms of student work; deadlines for completing assignments became more flexible; alternative assignments were accepted when students were unable to complete the original assignments; and shifts to pass/fail or credit/no-credit reporting of student outcomes became more prevalent. Certain types of assessment tasks requiring practical work (such as work in labs, performance, or field experiences, but also internship and community service work) were found to be quite difficult to convert to online assessments. These changes did not only reflect the move to remote learning, but also the differing levels of access to learning technologies experienced by the students, and the technological competencies of the instructors. (Jankowski, 2020; Nordmann et al, 2020; Rapanta et al, 2020)

There is some evidence that instructors focused on continuity in student learning and consequently placed greater emphasis on formative assessments (which track student learning over time, such as in-class discussions, regular low-impact quizzes, feedback on homework, or a longer-term project) over summative assessments (which evaluate student learning at the end of an instructional unit, such as a final exam or research paper). (Bozkurt et al, 2020)

Moreover, instructors came to realize that any assessment in an online or remote learning course is essentially an open-book assignment. (The use of lockdown browsers or remote monitoring would prevent this but is not always technically or operationally feasible.) Instructors soon began to develop assessments that would take advantage of this situation. Collaborative, research-driven, or open-ended essay assessments provided new ways for the students to engage with the course materials, while still being able to demonstrate their mastery of the course contents. (Halaweh, 2021; Nordmann et al, 2020)

THE INSTRUCTOR'S ROLE IN REMOTE EDUCATION

Because the hurried transition to emergency remote teaching offered little time for the careful development of online learning content, instructors with little to no online education experience made so-called 'safe' choices in their efforts. They relied heavily on convenient approaches such as pre-recorded lectures or live videoconferencing lectures rather than more advanced and interactional forms of teaching. (Damşa et al, 2021) These instructors soon learned that remote learning placed substantial demands on them. Consistent with past research, instructors realized that they "must become part educator, part facilitator, part guide, and part technology expert." (Schultz & DeMers, 2020)

To help them cope, instructors tapped into a broad variety of resources to help them make a more successful transition to remote learning. In addition to institutional IT staff or instructional designers, instructors sought help from more experienced colleagues, web-based tutorials, and online communities of practice. (Langford & Damşa, 2020) These communities have helped instructors develop their digital competencies, which can be defined as "the ability to access and employ digital resources for pedagogical purposes." (Damşa et al, 2021) These competencies include basic skills to use information technology and software tools, the use of digital technologies within a particular subject area or discipline, and the ability to develop course materials, activities, and assessments within a digital environment. However, the development of digital competencies is not the only critical success factor for remote learning success. Joia & Lorenzo (2020) found that an instructor's attitude towards interactive learning is a key factor as well. This attitude involves the ability to interact with students and to stimulate interactions among the students in a digital environment. (Joia & Lorenzo, 2020) It is for this reason that

prior experience with different modes of online learning gave some instructors an advantage when in-person courses had to quickly be converted to remote teaching. (Damşa et al, 2021)

Finally, a commonly mentioned impact of the transition to remote learning is on instructor workload. Many instructors reported spending substantially more time on their courses, due to the need to quickly prepare online course materials, deliver online lectures, and communicate with students through digital channels. Monitoring discussion boards, managing student teams, and communicating with individual students tends to be quite time-consuming in an online setting. (Sheppard, 2021)

CONCLUSION: THE PATH FORWARD FOR REMOTE LEARNING

After the pandemic abated, colleges and universities continued the large-scale digital transformation that began with online learning and was substantially increased during the pandemic closures. They are expanding their online courses and programs to reach a more diverse student body (such as older students and working professionals), enlarge their geographical footprint, and strengthen their competitive position in the education market. (Simunich et al, 2024; University of Michigan, 2025) Gallagher & Palmer (2020) encourage higher education institutions to continue to explore technology-driven approaches to learning and credentialing, as well as expanded partnerships with business. They envision that the vast expansion of digital learning programs in higher education may establish broad standards for learning infrastructure and student credentialing. (Gallagher & Palmer, 2020)

Once the pandemic closures ended, student enrollment in online and remote courses dropped somewhat as in-person courses became available again, but online enrollments in 2024 were still higher than pre-pandemic levels, and online courses still see substantial enrollments. (Coffey, 2024; Simunich et al, 2024) An unforeseen consequence of students experiencing various forms of online learning during the pandemic is that they are now requesting some of the aspects of online courses to be added to in-person courses. Students have become used to the flexibility offered by online assignments, digital course materials (rather than paper textbooks), and online lecture videos. In-person class time can then be more effectively spent on active learning exercises and class discussions. The result is greater use of the flipped learning model as in-person courses are now taking advantage of the greater availability of digital learning materials, many of which were initially developed during the pandemic. (Ubell, 2024)

As mentioned, the rapid transition to remote learning did not always allow for the careful and time-consuming development of online course materials. In particular the effort to make all course materials fully accessible to all students – including those with disabilities or different learning styles – was not always completed. This then makes a good case for including Universal Design for Learning (UDL) as part of all course development efforts so that in emergency situations accessibility is ensured. (DePaul, 2022; Hodges et al, 2020) All of these efforts, then, will allow colleges and universities to build on the skills and tools acquired during the pandemic to further the hybridization of their programs; that is, to offer combinations of in-person and online activities, either within specific courses or among separate courses. (DePaul, 2022; UNESCO-IESALC, 2020)

A recent UNESCO report that examined the pandemic experiences of Higher Education Institutions (HEI) in Latin America put it clearly: “The resumption of face-to-face activities at HEIs should be seen as an opportunity to rethink and, to the extent possible, redesign the

teaching and learning processes, taking advantage of the lessons that the intensive use of technology may have entailed, and paying special attention to equity and inclusion.” (UNESCO-IESALC, 2020)

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Integrating Agile Development Principles with CRISP DM - A Conceptual Framework for a Data Analytics Capstone Course

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ABSTRACT

I present a conceptual framework that integrates Agile development principles with the Cross-Industry Standard Process for Data Mining (CRISP-DM) methodology for data analytics projects in a data science capstone course. The integrated framework facilitates the execution of data analytics projects while maintaining the structured approach of CRISP-DM. By combining iterative Agile methodology steps with the systematic phases of CRISP-DM, the framework addresses the needs of introducing practical, industry-relevant project management skills and continuous client feedback into data science education. Issues and challenges of implementation and benefits as they apply to an academic term length course are also discussed.

KEYWORDS: Data analytics, CRISP-DM, Agile, Project management

INTRODUCTION

The fields of data analytics, data science and software development have experienced significant growth and evolution in the past decade (McKinsey Global Institute, 2016). Demand for highly skilled professionals remains high even as artificial intelligence tools are proliferating and getting introduced in many aspects of work processes (Ugray, 2024). Educational institutions need to prepare students for these rapidly changing fields. The Cross-Industry Standard Process for Data Mining (CRISP-DM) framework has emerged as the de facto standard for data mining and analytics projects, providing a structured approach to problem-solving in data science (Chapman et al, 2000; Shearer, 2000). Around the same time, the Manifesto for Agile Software Development (2001) have proposed an increasingly popular set of principles for software development to provide a methodology that easily adapts to changing requirements and delivers value incrementally as opposed to the rigidity of the classic Waterfall model (Royce, 1970). As the complexity and scale of data analytics projects continue to grow, there is a need for a more flexible and adaptive approach to introduce students to both software development and data mining project management concepts. This paper proposes a conceptual framework that integrates Agile principles with the CRISP-DM process for developing project management skills in data analytics educational setting, aiming to create a robust and efficient project based approach to introduce students to a more real-life like problem solving methodology.

BACKGROUND**Agile Development Principles**

Agile development is characterized by its focus on flexibility, collaboration, and iterative progress. The Manifesto for Agile Software Development (2001), outlines 12 core principles that

guide Agile methodologies. These principles emphasize customer satisfaction, embracing change, frequent delivery, collaboration, empowerment, communication, working software as progress, sustainable pace, technical excellence, simplicity, self-organizing teams, and regular reflection.

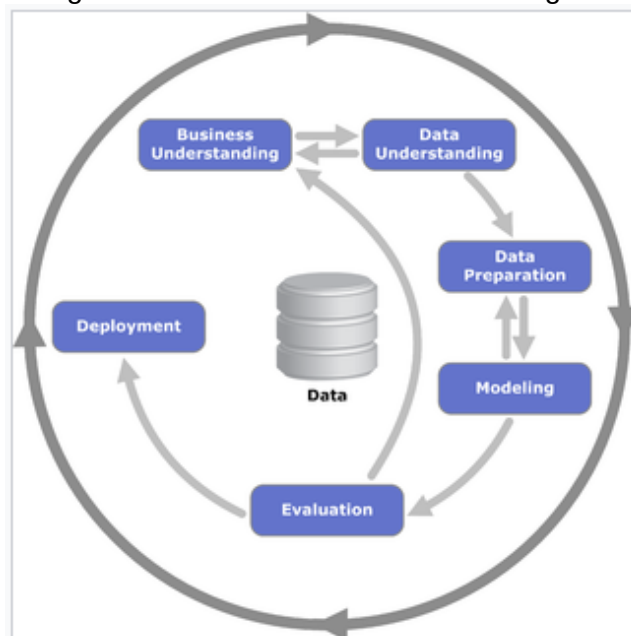
The core of Agile principles is the commitment to early and continuous delivery of valuable software. This approach prioritizes getting a working product quickly, allowing for rapid feedback and iterative improvements. Agile teams work with changing requirements, even late in the development process, adjusting to evolving business needs. Frequent delivery of working software is a cornerstone of Agile, with the release of functional software pieces in short, one to two weeks long timeframes. The iterative approach allows for continuous refinement and updates. Collaboration between business stakeholders and developers is emphasized with a shared understanding of goals and priorities. Face-to-face communication is preferred for its effectiveness in conveying information and resolving issues quickly. Good designs are prioritized as they enhance agility and enable more efficient development. Simplicity is valued, concentrating on essential tasks that bring the most value. Regular reflection and adaptation are built into the Agile process, with teams consistently reviewing their methods and making adjustments to improve their products and processes.

All of these features of the Agile development align with the needs of a semester-long data analytics capstone course constraints, hence using it as the project management framework is a very good match.

The CRISP-DM Framework

The CRISP-DM framework (Chapman et al, 2000; Shearer, 2000) is a comprehensive process model for data mining projects. It consists of six major phases: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, and Deployment. CRISP-DM provides a structured approach to data mining projects, ensuring that all aspects of the project are considered and addressed systematically. Figure 1 describes the CRISP-DM framework.

Figure 1.: The CRISP-DM Process Diagram



Recent studies have shown that CRISP-DM remains the most commonly used approach for data science projects (Shimaoka et al., 2024). However, there is ongoing debate about whether CRISP-DM is more aligned with Agile or Waterfall methodologies. On one hand, critics argue that its emphasis on detailed upfront planning and extensive documentation mirrors the rigidity of Waterfall approaches, potentially encumbering rapid iteration and flexibility required in modern analytics environments. On the other hand, its iterative nature aligns closely with Agile principles. The framework explicitly states that phases are not strictly sequential and moving back and forth between tasks based on project needs resonates with Agile's emphasis on adaptability and responsiveness to change. Agile combined with CRISP-DM becomes a dynamic process where Sprints focus on specific phases while maintaining alignment with overarching project goals.

THE AGILE - CRISP-DM INTEGRATED FRAMEWORK

The proposed framework aims to combine the strengths of Agile methodologies and CRISP-DM to create an adaptive and efficient approach to work on data analytics problem in a project-based course setting. This integration is achieved by mapping the CRISP DM phases to Agile sprints and incorporating Agile principles throughout the project execution process. The framework can be best implemented in intermediate or capstone courses after students had already become familiar with the rudimentary skills required in data science.

Framework Overview

The integrated framework for the data analytics project execution consists of the following components:

- Agile Sprints: The course project is divided into short, time-boxed iterations (sprints) typically lasting 1-2 weeks.
- CRISP-DM Phases: Each sprint incorporates elements from the six CRISP-DM phases, with emphasis on specific phases depending on the sprint's objectives.
- Continuous Feedback: Regular meetings with an instructor and peer reviews are held to assess progress and adjust priorities.
- Iterative Refinement: The project plan and deliverables are continuously refined based on new insights and evolving requirements.

Incorporating Agile Principles in Data Science

The framework incorporates Agile principles in the following ways:

- Regular sprint planning and review sessions with the instructor
- Weekly stand-up meetings for team communication
- Continuous integration and delivery of working analytics solutions
- Prioritization of tasks based on learning objectives and project requirements
- Adaptation of project goals based on instructor feedback and new insights.

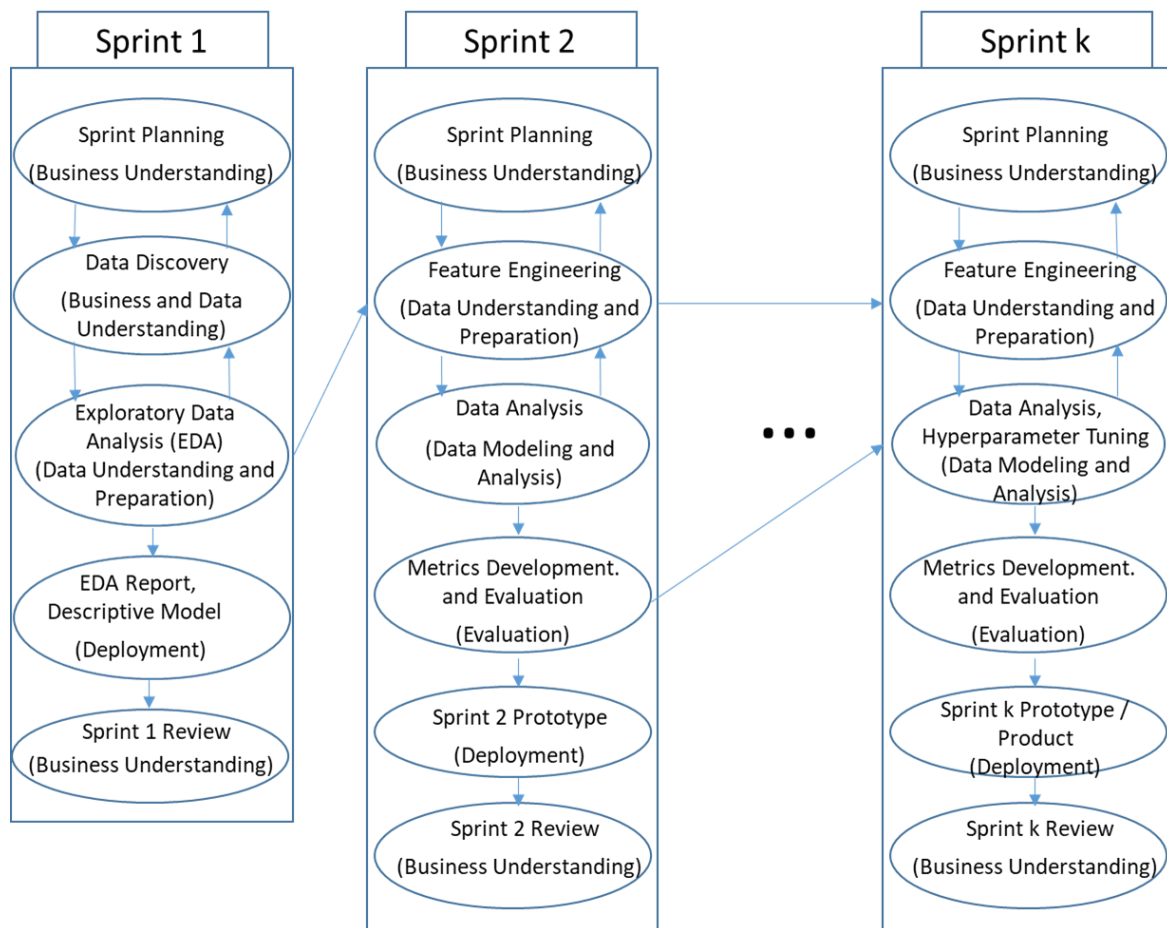
Mapping CRISP-DM Phases to Agile Sprints

Each Agile sprint in the proposed framework may touch on some or all CRISP-DM phases but focuses primarily on one or two. Figure 2 shows the components of the integrated framework. The first Sprint executes the initial Business Understanding, Data understanding and Data Preparation step. It is followed by an Exploratory Data Analysis that may provide the Deployment of the descriptive data analysis results. The Sprint is finished with a review that

includes the comparison of the results to the initial Business Understanding and can drive subsequent Sprint planning. Subsequent Sprints, marked as Sprint 2 – Sprint k, start with the Sprint Planning based on the current Business Understanding. Feature Engineering follows that is driven by Data Understanding and constitutes further Data Preparation steps. During data Modeling and Analysis a variety of data mining and analytics techniques can be tried and fine-tuned. In the final Sprint, this include the Hyperparameter tuning step. Every sprint includes an Evaluation phase where relevant metrics are identified, collected, and analyzed. Sprints deliver continuously improving prototypes, with the last print delivering the final analysis product. Sprints are always concluded with a Sprint Review.

This integrated framework allows for flexibility while maintaining the structured progression of CRISP-DM, providing students with a comprehensive overview of all analytic steps. The Agile approach to CRISP-DM is adopted by using vertical slicing techniques. This way groups will deliver multiple smaller prototype releases and they have the opportunity to frequently receive feedback from the instructor, following good educational principles and industrial practices.

Figure 2.: The Integrated Agile – CRISP-DM Framework



Benefits of the Integrated Framework

The proposed framework offers several advantages for data analytics education:

- **Increased Practical Relevance:** Students gain experience with industry-standard methodologies and practices.
- **Improved Engagement:** Regular feedback sessions and iterative development keep students motivated and involved.
- **Enhanced Collaboration Skills:** Frequent communication foster better teamwork and knowledge sharing.
- **Structured Learning Approach:** The incorporation of CRISP-DM phases ensures that all aspects of the data analytics process are addressed systematically.

CHALLENGES AND CONSIDERATIONS OF IMPLEMENTATION

While the integrated framework offers numerous benefits for practicing data science project management in education setting, there are potential challenges to consider. From a curricular standpoint, an existing capstone or project course structure may need to be modified to accommodate this newer approach. Faculty, who are well versed in data analytics and data science, may require additional up-skilling and training to effectively teach and mentor using this integrated framework. Additionally, finding the right balance between the structured CRISP DM approach and Agile flexibility can be challenging in an educational setting especially when time constraints inherent in academic terms may limit the number of sprints that can be realistically implemented.

CONCLUSION

The proposed conceptual framework integrating Agile development principles with the CRISP DM methodology offers a promising approach to teaching data analytics project management. By combining the flexibility and iterative nature of Agile methodologies with the structured phases of CRISP DM, this framework addresses many of the challenges faced in current data science projects and prepares students to participate and execute such projects in real environments.

This integrated framework provides an opportunity to address the multiple goals of developing data literacy, technical skills, and project management competencies at the same time in a data analytics project course environment. As the field of data science continues to evolve, educational approaches need to adapt to meet the changing needs of industry. The proposed conceptual framework offers a promising solution. Further research is needed to first analyze, then refine its application in the educational context. We're planning to perform such analyses after we run the first iteration of the course.

Implementing the proposed integrated framework in an undergraduate data analytics capstone course is under development. Developing the detailed schedule and a project fitting into the semester structure are under way. Establishing metrics, devising the collection of performance data and planning the analysis of data for evaluation are also being developed. We expect to report on the results after the course concludes.

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Does Requiring Students to Submit In-class Work Improve Learning Outcomes? Evidence from an Undergraduate Business Analytics Course.

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ABSTRACT

Engaging students — especially post-pandemic — is challenging. To improve engagement in an undergraduate business analytics course, students were required to submit responses to in-class example problems. Initially, students were only required to submit the answers to the problems. The next year, students were required to submit their work as well. To understand the impact of requiring work to be submitted, we compared exam scores for the two semesters. Two out of three exams had significantly lower variances for the term in which work submission was required; the other exam had a significantly higher mean. These results suggest that increasing accountability can improve engagement and learning outcomes.

KEYWORDS: Active learning, Accountability, Business Analytics Instruction

INTRODUCTION

As the use of analytics increases, the need to provide undergraduate students with a solid understanding of basic analytics principles has never been more important. Active learning methods — such as discussions, problem-based learning, and flipped classrooms — have been proven effective in enhancing students' understanding of quantitative material (Freeman et al., 2014).

The “lockdown” during the COVID-19 pandemic prompted many schools to use remote learning methods. The long-term effects of this abrupt shift in learning modalities have yet to be fully understood. Anecdotally, however, college instructors have observed a marked change in student behavior and a decrease in classroom engagement.

This paper reports on an effort to improve student engagement and accountability in an undergraduate business analytics course. The first change implemented was requiring students to submit responses to in-class example problems. The second change implemented was requiring students to submit the work for the in-class example problems. Exam scores of the two groups are compared to assess the impact of the changes. For all three exams given, the mean score was higher and the variance was lower for the term in which work submission was required.

LITERATURE REVIEW

Active Learning

Active learning has been defined as learning that “engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work” (Freeman et al., 2014). Freeman et al. (2014) perform a meta-analysis of 225 studies that examine academic performance in undergraduate science, technology, engineering, and mathematics (STEM)

courses. They find that active learning leads to better learning outcomes (e.g., improved exam scores, lower course failure rate), even after accounting for class size and other factors. These results have been reinforced by many studies in fields ranging from anatomy (Minhas et al., 2012) to accounting (Pollard, 2014) to engineering (Hartikainen et al., 2019; Nguyen et al., 2021) to nursing (Waltz et al., 2014).

Accountability

An important concept related to active learning is accountability — asking students to take more responsibility for their learning. Put simply, asking students to submit something — a presentation, a worksheet, a video — increases engagement (Johnson et al., 1998). Students think and behave differently when some sort of “deliverable” is required. Studies have shown that efforts to increase accountability not only increase engagement but also make the classes more enjoyable to students (Coulter & Onufer, 2022; Nguyen et al., 2021).

Effects of Remote Learning

Another relevant research area addresses the effects of remote learning during the COVID-19 pandemic. Studies have documented the significant impact that the sudden switch to distance education had with respect to students’ mental health, critical thinking, and academic performance (Akpen et al., 2024; Lv et al., 2022; Nano et al., 2024). Research shows that remote schooling impacted different student populations differently (Goldhaber et al., 2023). The effects also varied by location due to the different policies implemented by different states, counties, and cities (Lee & Seo, 2025). There is evidence (and ongoing research) suggesting that returning to in-person education is not sufficient to address the impacts of remote learning during the pandemic (Lichand & Doria, 2024).

METHODOLOGY

The study was conducted at a mid-sized public university in the Northeastern part of the U.S. All undergraduate business students take a sophomore-level course called “Introduction to Business Analytics.” The course covers topics related to descriptive, predictive, and prescriptive analytics, such as data visualization, forecasting, and optimization. The prerequisite for this course is an introductory statistics course. Many students are transfer students who often take the statistics course at one of the nearby community colleges. Non-transfer students typically take the statistics course offered by the Economics Department; a few take a course offered by the Mathematics Department, which is generally considered to be more rigorous than the course offered by Economics.

The author teaches three sections of the Introduction to Business Analytics course in the fall semester. Approximately 35–40 students are in each section. The class meets twice a week, in person.

In a typical class session, the course instructor will solve example problems from the textbook. For example, the problem may call for building a spreadsheet model to determine the repayment schedule for a car loan. There is heavy emphasis on practical problems to which business students can relate. Most problems are solved using Excel. The instructor demonstrates the steps required to solve the problems using a computer in the classroom, and the computer work is projected onto two large screens at the front of the classroom. Students are encouraged to follow along and to ask questions to clarify uncertainties.

Each student is supposed to work on the problems on their own computer. However, the seating configuration is such that the instructor cannot directly view the students' screens.

In the post-pandemic environment of higher education, the author noticed a distinct drop off in student engagement. While the same process was used to introduce new topics and solve example problems prior to the pandemic, there was a marked decline in student participation.

Was the decline in student engagement related to changes that happened during the pandemic? While the root causes are certainly a topic of interest, the more pressing question became: How to get students more engaged?

During the Fall 2023 semester, the instructor started to require students to submit responses to the example problems solved in class. The problems were administered using an online platform developed by the book publisher to go along with an introductory textbook. After solving each problem, responses were entered into a web-based form and submitted by the students.

Over the course of 27 class sessions, 18 in-class assignments were administered, and students were allowed to drop their two lowest scores. Each assignment was worth 0.625 percent of the overall course grade.

At first, the new method seemed to increase the level of student engagement. After all, if they did not solve the problems, then how would they be able to submit the responses at the end of class? In a short time, however, the instructor became aware that many students were still not following along with the lesson. Instead, it seemed that some students would simply wait until the correct answers were displayed, copy the answers, and submit their responses.

To address this issue, the instructor modified the in-class assignments in Fall 2024 to require work to be submitted. In addition to the web-based problems with responses, a file-upload item was added to each assignment, and students were required to submit an Excel workbook showing the formulas and results for each problem covered in class. The work submission was worth 40 to 50 percent of the assignment grade, depending on the number of problems.

Requiring work to be submitted had an immediate effect on the classroom experience. Suddenly, more questions were being asked. Steps had to be repeated — and sometimes repeated again. Students not only asked the instructor questions, but they also asked each other questions and assisted each other with the details of each problem.

Besides changing the feeling during the class sessions, did the apparent increase in student engagement make them learn more?

In an ideal world, the instructor would have designed a controlled experiment, where students were randomly assigned to two groups: those required to submit work and those not required to submit work. To approximate this method, the instructor chose to examine learning outcomes for the semester where the in-class problems without work were used (Fall 2023) and the semester where work submission was required (Fall 2024). The same instructor, using the same textbook/platform, taught all of the students. The same topics were covered, and the same in-class assignments were used. There were approximately 100 students (split into three sections) for each fall semester.

If student engagement is linked to improved learning outcomes, then one would expect the Fall 2024 students to have better performance in the class. To test this idea, the following hypotheses were formulated:

H1a: The mean exam scores will be higher for Fall 2024 than for Fall 2023.

H1b: The variance of exam scores will be lower for Fall 2024 than for Fall 2023.

H2a: The mean overall course scores will be higher for Fall 2024 than for Fall 2023.

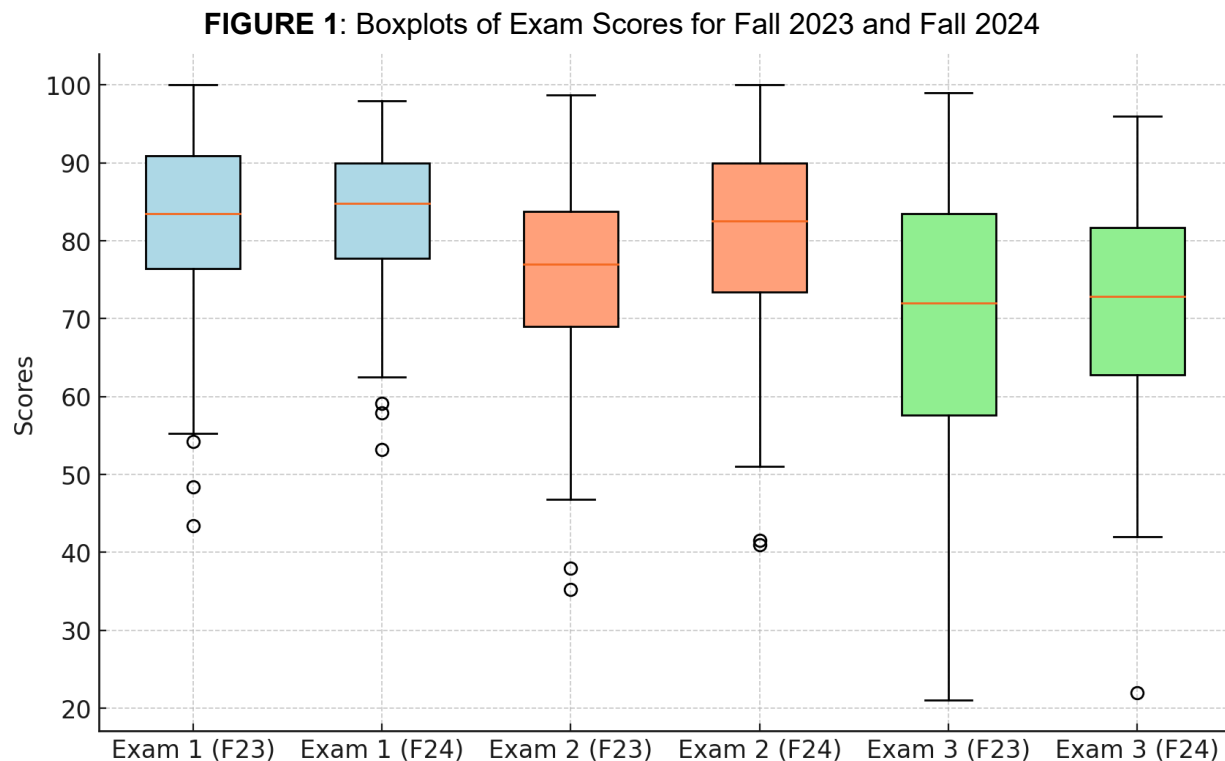
H2b: The variance of the overall course scores will be lower for Fall 2024 than for Fall 2023.

The next section reports the results of this experiment.

RESULTS

Three exams are administered during the semester. These are timed, individual assignments that include a mix of multiple-choice questions and problems. In addition to submitting responses on a web-based platform, students are also required to submit an Excel workbook showing how the problems were solved.

Some students were eliminated from the sample. First, students who had not taken all three exams were removed. Second, students who failed the class were removed. Not surprisingly, both of these groups had very low averages for the in-class assignments. Removing these students left 110 students for the Fall 2023 group and 114 students for the Fall 2024 group. Figure 1 shows boxplots for each exam for both semesters.



The boxplots show that for a given semester, the median exam score decreases as the term progresses. Typically, students do better on Exam 1 than on the other two exams, because there is a substantial amount of review of basic statistics, which they should have seen in the prerequisite course.

The boxplots also show that for each exam the median score is higher for Fall 2024 than Fall 2023. In addition, the interquartile range (IQR) is smaller for each exam when comparing 2024 and 2023. These results are echoed by the statistics reported in Table 1. For each exam, the average score was higher in 2024 than in 2023, and the variance of the scores was lower in 2024 than in 2023.

Are these differences statistically significant? To answer this question, *F*-tests were used to assess if the exam variances were significantly different — specifically, lower for 2024. As reported in Table 1, the variance of Exam 1 is significantly lower for 2024 than for 2023. Similarly, the variance of Exam 3 is significantly lower for 2024 than for 2023. The variance of Exam 2 is lower for 2024 than for 2023, but not at a statistically significant level. *t*-tests were used to assess if the mean exam scores were different — specifically, higher for 2024. The Exam 2 scores are significantly higher for 2024 than for 2023. The scores for Exam 1 and Exam 3, although higher for 2024, were not statistically significantly higher.

TABLE 1: Comparison of Mean and Variance of Exam Scores by Semester

| | Fall 2023 | | Fall 2024 | | | Fall 2023 | | Fall 2024 | |
|---------------|-------------|---|-------------|----------------|-------------|-----------------|---|-----------------|----------------|
| | <i>Mean</i> | | <i>Mean</i> | <i>p-value</i> | <i>Sig.</i> | <i>Variance</i> | | <i>Variance</i> | <i>p-value</i> |
| Exam 1 | 81.94 | < | 82.96 | 0.2374 | | 131.39 | > | 95.22 | 0.0454 * |
| Exam 2 | 72.52 | < | 79.50 | 0.0001 | *** | 205.10 | > | 179.93 | 0.2453 |
| Exam 3 | 64.06 | < | 67.28 | 0.0891 | | 402.46 | > | 232.63 | 0.0021 ** |

NOTE: *p*-values refer to one-tailed tests. * = significant at 0.05 level; ** = significant at 0.01 level; *** = significant at 0.001 level.

These results suggest that hypotheses H1a and H1b are supported.

The mean and variance of the overall course grades (numerical average) were also examined. Although the 2024 mean was higher than 2023, and the 2024 variance was lower than 2023, the differences were not statistically significant. These results suggest that hypotheses H2a and H2b are not supported. (To conserve space, the details of these results are not reported.)

DISCUSSION AND CONCLUSIONS

The results suggest that requiring work to be submitted did have an impact on engagement and learning. The reduced variance indicates that the impact was greater for students on the lower end of the grading scale. It would be interesting to further explore how increased accountability helps those doing least well in the class. For example, could the difference in improvement between students in the 25th percentile and students in the 75th percentile be quantified?

There is no question that requiring work to be submitted changed the energy of the class. Students asked more questions, which increased interaction but also slowed the pace of the

class. It became clear that some students did not feel comfortable with Excel. Many of the basic issues got resolved as we did more in-class assignments — e.g., selecting ranges, using absolute references, copying and pasting formulas. That said, some students have had more experience with Excel, and the slower students seemed to cause them frustration.

The biggest surprise was that the overall class grades were not different between 2023 and 2024. If they did more work, and they did better on the exams, then why was the overall average not significantly higher? The exams are only worth about 45 percent of the total grade, and apparently the performance on other items was enough to compensate for the differences in exam scores.

It would also be useful to ask the students directly about their perceptions. Did they feel more engaged with and positive about the material? Or was it tedious, burdensome, and/or stressful? A brief survey is being developed to explore these questions in future semesters.

Additionally, it is worthwhile considering how these findings could apply in other contexts. For example, in the online version of the course, submitting Excel work is not required. Would requiring work for homework assignments improve learning outcomes? Also, could the findings be applied in other disciplines? It seems likely that any course using in-class example problems could benefit from increased student accountability.

Moving forward, an important question is how to build momentum and improve the in-class assignments with the hope of engaging students even more.

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DECISION SCIENCES INSTITUTE

The Development of Open Educational Resources (OER) for the Decision Sciences

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ABSTRACT

Open educational resources (OER) represent an alternative to traditional textbooks that facilitate student learning using educational resources such as articles, textbooks, images, and videos, that can be freely shared for non-commercial purposes. OER increase accessibility of learning materials to students who struggle to afford to purchase traditional textbooks. The use of OER has been shown to improve aspects of student learning and engagement while reducing student course failure or withdrawal. OER provide specific benefits to decision science courses by offering video explanations of quantitative material and enabling frequent updates to reflect industry and technology changes.

KEYWORDS: Open educational resources (OER), Innovative teaching materials, Creative Commons (CC) license, E-learning, Pedagogical approaches

INTRODUCTION

Faculty members and students alike have long lamented the high cost of college textbooks. By 2022, the average cost of a college textbook had risen to 10 times its cost in 1980, far outpacing the four-times growth of the Consumer Price Index (CPI) over the same period (Tila & Levy, 2023). This dramatic price increase can be partially attributed to the practices of publishers who distribute thousands of unsolicited copies of new textbooks to faculty members to encourage adoption (Kreuter, 2012). Publishers also release minor revisions to popular textbooks every three or four years to curb the used book market (Gill, 2019). The material in the older editions may still be valid and relevant, but these revisions render older editions obsolete for student use in classes due to changes in page numbers and assignment problems. Many publishers also restrict the sale of e-textbooks to libraries (which can be accessed by all students) and instead license their books for sale directly to individual students (University of Saskatchewan Library, 2022).

The high cost of textbooks has contributed to a growing number of students' decision to eschew the purchase of required course materials. Several surveys have found that over 60% of students did not purchase required materials due to their cost (Chang, 2020). Some of those students who do purchase textbooks have confessed that they have even skipped meals due to the cost (Tila & Levy, 2023). Purchasing the materials is only one hurdle for students to overcome, however, because many students also report that they never or only rarely read their textbooks before attending class sessions (Berry et al, 2010). Access to affordable classroom materials and increasing students' motivation to prepare for class sessions by reviewing the materials are significant issues in higher education because studies have found that classroom performance is positively correlated with students' preparation before class (Hilton, 2016).

The proliferation of open educational resources (OER) represents a response to the challenges associated with traditional textbooks. In this paper, we discuss the opportunities for and benefits of using OER within decision sciences courses, and we provide suggestions for faculty members who are considering the development of OER for their courses.

LITERATURE REVIEW

The concept of OER originated in the late 1990s when several universities worldwide jointly decided to provide public online access to some of their educational materials (Barneva et al, 2019); but the establishment of the term dates to a UNESCO forum in 2002, which defined OER as “[t]he open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes” (UNESCO, 2002). For college courses, OER typically consist of online learning content such as articles, textbooks, software, and videos that can be freely retained, reused, revised, and redistributed subject to more liberal licensing conditions than those of traditionally-published learning materials (Hilton et al, 2016).

While the goal of increasing accessibility to educational resources is a noble pursuit, OER would not be a viable option if they did not effectively facilitate students’ academic performance. Academics have conducted many studies to examine the pedagogical impact of OER on student performance. Feldstein et al (2012) and Colvard et al (2018) found that students in courses that utilize OER earn higher grades overall than students in courses using traditional commercial textbooks. Fischer et al (2015) similarly observed that the use of OER resulted in higher pass rates across a wide range of courses. Introducing OER has also proven to decrease student withdrawal rates (Hilton et al, 2016; Colvard et al, 2018), thereby leading to higher student retention and satisfaction (Chang, 2020). Across numerous surveys, the vast majority (over 80%) of faculty members who have utilized OER in their courses have evaluated them to be as good or even better than commercial textbooks in facilitating the acquisition of student knowledge (Bliss et al, 2013; Jhangiani et al, 2016).

Many studies on the impact of OER on student performance (e.g., Lovett et al (2018); Chiorescu (2017); Lawrence & Lester (2018); and Tila & Levy (2023)), however, have found no significant difference in student learning between courses that employ OER and those that use traditional learning materials. These insignificant results may appear concerning, but they suggest that OER can provide high quality educational support while saving students significant money over traditional learning resources (Tila & Levy, 2023). These insignificant results may be explained, however, by the fact that these studies only consider students who would have purchased traditional textbooks anyway, ignoring the added accessibility that OER provide to students who would otherwise forego the cost of an expensive textbook (Grimaldi et al, 2019).

Several studies discuss the development and implementation of OER in courses focused on decision science-related topics. McDowell (2010) presents a case study of the use of an OER to teach about a current economic event – the subprime mortgage crisis of 2007-2008. Lovett et al (2008) and Bowen et al (2012) both found no significant differences in student performance in introductory statistics courses between students using commercial textbooks and those using an OER created by Carnegie Mellon University’s Open Learning Initiative. Pawlyshyn et al (2013) and Hilton et al (2013) detail the use of OER within introductory math courses. Barneva et al (2018) discuss their experiences in using OER within courses covering data analytics, digital marketing, and operations management. They found that students favored the use of OER over traditional textbooks and specifically noted that videos were the most valuable resource to be included in the OER compared to other types of content as a way to learn quantitative material more effectively. Chang (2020) examines the impact of using an OER in a general-education quantitative literacy course and found that the OER resulted in higher student engagement with the course and specifically enhanced the performance of students lacking access to the traditional course textbook.

BENEFITS OF USING OER IN DECISION SCIENCES COURSES

Beyond the general benefits of utilizing OER instead of commercial learning resources such as reduced costs, more equitable access, and increased student engagement, OER offer specific advantages that increase their attractiveness and applicability to decision sciences courses. As Barneva et al (2018) found, students can benefit from having access to video resources they can use to review quantitative tools and techniques. Recorded explanations of the application of analytical tools to address problems and develop recommendations give students the ability to pause and rewind the discussion in a way that is not possible within a face-to-face class. My students have consistently reported over many years that they have realized this value from the videos I have created in support of my courses.

Decision sciences represents a dynamic academic field that must stay current with the new technologies and methods that are developed in response to changing environmental conditions and new digital innovations. Academic programs should update their curricula to reflect these industry changes, and those that do not make such updates risk their students losing their competitiveness in the job market compared with graduates from other programs (Drake et al, 2024). OER facilitate the inclusion of current articles, white papers, or videos that discuss cutting-edge industry innovations, enabling faculty members to maintain an updated learning resource in courses with dynamic content without waiting for updates from commercial textbook authors and publishers. Faculty members could also invite students to propose new resources they discover for inclusion into the OER as a way of crowd-sourcing knowledge and increasing student engagement (Kotsopoulos, 2022).

Similarly, many decision sciences courses utilize software applications such as Excel or Power BI or coding languages such as R or Python that frequently update layout, syntax, or functionality. Traditional textbooks are limited in their ability to keep up-to-date with these changes, causing significant student frustration with textbook procedures and scripts that do not match current software or programming applications. OER enable frequent updates whenever these changes should occur.

SUGGESTIONS FOR DEVELOPING OER FOR DECISION SCIENCES COURSES

OER can provide significant benefits in decision sciences courses compared to commercial textbooks, but faculty members should be aware that developing OER or even selecting an already-available OER for adoption requires significant work. Commercial textbooks are fully vetted by publishers and external reviewers, perhaps even going through multiple editions to produce the current version. These books often come with a cache of instructor materials such as presentation slide decks, test banks, and even dedicated learning management systems. OER, on the other hand, require the faculty member to curate and evaluate a variety of learning resources for each topic in the course. They must create their own resources for any topics that are not adequately addressed by available materials. This results in a significant amount of up-front work for the faculty member to create the OER (Kotsopoulos, 2022). Faced with the daunting challenge of creating an OER for an entire course, faculty members could start small by focusing on creating resources for several topics in a course in an upcoming semester and then add to the OER slowly over time. They could also consider collaborating with colleagues at their own school or at other institutions to share the workload.

Authors should begin the development of the OER by creating an outline of the chapters and subsections that will be included. They may also want to purposefully include content that could be utilized in other courses or programs within their school or broader university offerings to increase the impact of the OER on more students. For example, topics in decision sciences-related courses are also often covered in mathematics, information systems, and engineering

courses. Instructors in those programs could benefit from the opportunity to use portions of the OER in their courses. An OER developed for an introductory course could also serve as a resource for students in higher-level courses to review foundational content.

Alongside the creation of the chapter and topic outline, authors should also consider the types of media they plan to include in addition to text-based content. OERs for decision sciences concepts and methods provide an opportunity for authors to include videos demonstrating the formulation and analysis of decision-making models on example problems and scenarios. Students benefit from the ability to access these videos outside of class sessions to gain a stronger mastery of the analytical methods and procedures. OER authors must plan any videos they want to record and the equipment requirements for these recordings. While desktop recordings are often sufficient and can be accomplished with a microphone and standard screen capture software, some authors may want to add production value to their videos by recording in dedicated studios, which requires additional scheduling coordination with university resources.

Anyone developing an OER must become familiar with the issues and restrictions related to the licensing and use of materials developed by other parties. OER would not be possible without the *Creative Commons* (CC) licenses that enable the free modification and reuse of intellectual property (Barneva et al, 2018). Authors must be aware of the distinctions between the different license types and how they allow other authors to use or modify copyrighted resources. The first place to start is the Creative Commons website (www.creativecommons.org), which explains the differences between the six types of licenses and one public domain dedication tool that they have established and even provides an online assistant to help with license selection. Authors such as Kreutzer (2014) and Braak et al (2024) have created guides to assist with navigating licensing issues as well.

While OER authors can start small and manage the project on their own for a while, they will eventually need to consult an expert to verify the legal use of copyrighted material, to provide suggestions on layout and organization of the OER, and to help with publishing and maintaining the electronic resource. Many higher education institutions have library experts who can assist with the development of OER. It would be extremely challenging for any faculty member to undertake the development of a course-level OER without the availability of advice and assistance from library experts.

CONCLUSION

The use of OER in decision sciences courses represents an opportunity to increase student inclusion and engagement and the accessibility of high-quality learning materials that facilitate learning just as well as, and sometimes better than, traditional commercial textbooks while at the same time reducing the cost of higher education. OER can be updated continuously to reflect changes in industry trends or technology developments, a benefit that is particularly relevant for decision sciences courses. As faculty members in decision sciences develop more OER and share them among the community, an increasing number of students worldwide can learn how to make better decisions without further increasing the cost of their education.

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DECISION SCIENCES INSTITUTE

Flawed but Fixable: A Case Study in the Real-Time Adaptation of the Flipped Classroom Model

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ABSTRACT

This case study examines the real-time adaptation of a flipped classroom model in a Principles of Marketing course. While promoting engagement through hands-on activities, challenges arose due to students' lack of preparation. Attributed to the unstructured nature of learning foundational knowledge, midsemester adjustments were made that improved student participation, comprehension, and satisfaction. Findings highlight the importance of instructional flexibility, emphasizing that flipped learning is most effective when paired with structured support and not a one-size-fits-all approach. This study contributes to the overall understanding of nuanced classrooms, demonstrating flexible approaches that balance active engagement with essential content delivery.

KEYWORDS: experiential learning, pedagogy, flipped classroom, student engagement, teaching strategies

INTRODUCTION

Historically, educators have faced increasing competition to capture students' attention in the classroom (Stukalina, 2014). To remain relevant and innovative, while contending with ongoing distractions, flipped classroom structures have gained significant attention and popularity in post-secondary education (Lundin et al., 2018). Bergmann and Sams (2012a) popularized this instructional strategy, which reconsiders traditional lecture-based courses by encouraging students to absorb foundational knowledge and course concepts on their own time, thereby allowing class time for deeper, more meaningful engagement. Although many have extensively explored the usage of a flipped classroom in pedagogical research across various age groups and disciplines, recent findings show that it is difficult to generalize due to regional and nuanced differences across populations. Research on this classroom approach is varied and diverse; however, continued exploration of real-world applications is essential for refining and enhancing classroom best practices. Therefore, the need to expand and understand classroom strategies remains crucial, as macro-level research may not provide comprehensive guidance for curriculum improvement (Qi, Jumaat, Abuhassna, & Ting, 2024). This paper aims to contribute to the richness of anecdotal data by highlighting the challenges and limitations of a real flipped classroom, offering valuable insights into when and why it may not succeed. It explores the challenges faced during classroom implementation, the pedagogical adjustments made in response, and the implications of this approach as a flexible, engagement-driven alternative.

CLASSROOM IMPLEMENTATION AND CHALLENGES

In this case, the flipped classroom structure was implemented in a Principles of Marketing course at the undergraduate level at a regional university. This upper-level course covers a large breadth of topics such as branding, product development, supply chain management, consumer behavior, and business communication. It attracts not only College of Business

majors, who are required to take this course, but also students from other majors, such as hospitality, art, and mass communications, seeking an elective.

The student demographics in this course showcased a diverse range of academic backgrounds. Consequently, they exhibited varying degrees of familiarity with marketing concepts. Although many lacked formal marketing education, their experiences as consumers provided a foundational knowledge across all student populations. Students' presumed understanding as consumers and their interactions with advertising and branding in everyday life made the course particularly suitable for a flipped classroom approach.

The design of this course aimed to facilitate rich classroom activities that bridge the gap between theoretical knowledge and real-world problem-solving. Students were required to watch pre-recorded lectures and read the corresponding textbook chapters on the university's learning management system. Once in class, students completed quizzes on the assigned chapters and lectures. After each quiz, class time was used to build upon that week's concepts. Facilitator-led discussions, hands-on activities, group projects, guest speakers, and a multi-week experiential learning unit were carefully designed to engage students, effectively utilize class time, and reinforce foundational marketing knowledge. These activities were intentionally varied and diverse to maintain students' attention and cater to the class's wide range of backgrounds and learning styles. Many activities centered on real-world applications, encouraging students to connect theoretical concepts to practical scenarios. A special focus was placed on group collaboration and public speaking to present various group findings. This played a key role in fostering teamwork, communication skills, and a deeper understanding of marketing principles through shared experiences and problem-solving among classmates.

Throughout the semester, students learned various core marketing concepts, such as branding strategies, advertising techniques, and public relations. One example was the Public Relations unit, scheduled for the week before Thanksgiving, which allowed the class to participate in a group activity analyzing the role of commodity groups' public relations strategies. Each group explored campaigns from Thanksgiving-centric products such as turkey producers, the cranberry association, and Iowa farmers. This provided the class with a relevant example and highlighted how public relations can influence consumer perception and holiday purchasing and consumption behaviors. Another notable example occurred during the Supply Chain Management lesson, where students were shown a 10-minute video in class about Amazon's supply chain and vertical integration. During the video, students were tasked with writing their own discussion questions designed to stimulate critical thinking and peer-driven dialogue. To further enhance student-led engagement, they are challenged to facilitate their own discussions using these questions—with minimal instructor intervention. This encouraged students to take ownership of the discussion and cultivated essential skills such as analytical reasoning, collaboration, and leadership. Additionally, the course incorporated several guest speakers from the industry to discuss real-world client challenges and featured a service-learning project focused on non-profit marketing over several weeks.

Despite the well-documented benefits of flipped learning (Qi, Jumaat, Abuhassna, & Ting, 2024) and the generally positive reception of class activities among students, challenges emerged early in the semester—particularly regarding student engagement and preparation. The most significant issue was that students often failed to complete the required pre-class readings or watch the lectures, all of which could be monitored through the university's LMS. While some students actively participated in the flipped learning approach, others struggled to transition from traditional lecture-based instruction to this new method. Consequently, quiz grades were low,

and the instructor found it difficult to implement hands-on activities effectively, as many students lacked the foundational knowledge needed to engage in critical thinking and application exercises. Although the activities themselves were enjoyable, the instructor frequently had to adapt spontaneously, “filling in the blanks” to assist students in completing the exercises accurately. This was particularly challenging during group activities when some students exhibited varying levels of preparedness.

MIDSEMESTER ADAPTATIONS

Recognizing these challenges, an informal assessment of student engagement and learning was conducted in real-time with the students. By measuring not only performance metrics like quiz grades but also engaging students in an informal discussion during class about the course structure, students noted they felt included in their learning experience while also expressing dissatisfaction with the course design, noting feeling lost and wanting to hear more instructor-led lectures during class time. Students also expressed satisfaction with the hands-on lessons, noting they felt able to apply their knowledge in a low-stakes environment. To recalibrate and address these concerns, minor adjustments were made to implement brief in-class content reviews and short lectures. Additionally, the grading structure was modified to enhance accountability on in-class activities, and quizzes were eliminated.

These adaptive strategies successfully increased student participation, improved knowledge and foundational learning, and enhanced instructor and student satisfaction. Observational data showed students were more engaged and comprehended course concepts better after the shorter lectures, and didn't feel as lost during group activities due to information delivery occurring in class. Students expressed in both class discussions and course evaluations that the adapted format offered a more effective learning experience, aiding them in developing a stronger grasp of the course material. This is important, as research indicates that student satisfaction is closely linked to learning outcomes and heightened levels of student motivation. When students feel supported and valued in the classroom, they are likely to achieve academically and foster a positive learning environment alongside their classmates (Stukalina, 2014; Wong & Chapman, 2023). This hybrid approach provided the necessary scaffolding to ensure students felt engaged during hands-on activities while also benefiting from in-class instruction, ultimately fostering a more active and effective learning environment.

IMPLICATIONS

These challenges and adaptations highlight several key takeaways regarding the effectiveness of flipped learning and the importance of instructional flexibility. As noted, key precedent literature on this topic suggests the effectiveness of flipped learning is highly variable and dependent on student engagement with pre-class assignments (Daniel et al., 2024). In this case, it was evident the flipped classroom learning was highly dependent on student accountability and preparation. The differences in engagement levels highlighted the need for continuous monitoring and adaptation—as assessed through the mid-semester student feedback and quantitative performance metrics. This real-time assessment should continue to be a key component for anyone wishing to adopt a flipped classroom model.

What resulted in this case was a hybrid instructional model that incorporated structured exercises, shortened lectures instead of quizzes, and continuous feedback from students throughout the semester. The refined approach proved highly successful and has continued with success and refinement in subsequent semesters. This reinforces the value of combining

structured instruction with experiential learning. This approach challenges the notion that flipped learning is an all-or-nothing strategy and provides a replicable framework for teaching various disciplines. By integrating concise lectures with interactive, application-based learning, educators can inspire students without sacrificing classroom rigor or learning outcomes. A flexible and blended approach may benefit the current generation of students and yield better results for both students and teachers.

CONCLUSION

This experience and anecdotal exploration of a failed, fully-flipped classroom underscores the power of adaptability and student engagement in higher education. The need to evolve alongside students and continuously innovate teaching methods is echoed throughout this case. In rethinking how unstructured and structured learning intersect, this case makes a strong argument for a redefined flipped instructional design in higher education. The observed improvements in student comprehension and engagement demonstrate that a carefully designed course can enhance learning outcomes and foster a dynamic classroom environment. Beyond immediate classroom outcomes, this case highlights the broader implications and importance of instructional flexibility in the college classroom. By implementing structured, yet concise lectures in addition to online lectures and assigned textbook reading, student learning was enriched and the original motivation (to bridge the gap between theory and practice) was achieved.

Overall, when experiential learning is thoughtfully integrated with structured instructional elements, the classroom can serve as a powerful tool for bridging the gap between theoretical knowledge and real-world applications. These efforts will aid in shaping current practices and driving future innovations (Qi, Jumaat, Abuhassna, & Ting, 2024), while educators throughout higher education can use this case as a guiding example to refine their own teaching approaches within their disciplines, acknowledging that effective teaching cannot simply be reduced to prescriptive tactics.

By leveraging real-time feedback from students and adapting accordingly—regardless of the type of course—educators can refine their methods, adjust their approaches, embrace flexibility, and create a more responsive and impactful learning environment. The nuances within each classroom should not be overlooked, and future research should be pursued to optimize and further understand the initial observations in this case. As educators, researchers, and institutions of higher learning, we can and must continually enhance our delivery methods and contribute to the broader discussions on effective learning strategies for both researchers and practitioners.

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GenAI Algorithm for Workforce Transformation: Equipping College Students for AI-Driven Careers

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ABSTRACT

The rapid advancement of AI is reshaping industries and redefining workforce expectations, creating a disconnect between traditional college curricula and evolving job market demands. This paper introduces the GenAI Algorithm Framework, an AI-driven model designed to equip students with technical and human-centric skills for success in AI-driven careers. The framework utilizes advanced analytics to examine job trends, identify skill gaps, and generate personalized learning pathways, ensuring students gain expertise in AI literacy, data analysis, critical thinking, and ethical decision-making. This model aligns curricula with workforce needs, promotes lifelong learning, and prepares a resilient, future-ready workforce for the AI-driven economy.

KEYWORDS: GenAI Algorithm, Workforce Transformation, AI-Driven Careers, Skill Development, Future of Work, AI Higher Education, Career Readiness, AI Skills.

INTRODUCTION

The rapid advancements in generative AI over the past year have caused an "Accelerated AI Revolution," fundamentally reshaping industries and raising concerns about the next generation's preparedness. This revolution, driven by technologies like machine learning, natural language processing, and computer vision (Brynjolfsson & McAfee, 2014), is disrupting traditional job roles across sectors, from healthcare to transportation (Manyika et al., 2017). Fueled by increased computing power, data availability, and algorithmic breakthroughs, AI systems now excel in complex tasks, including strategic decision-making and creative problem-solving (Agrawal et al., 2019). Consequently, the job market is undergoing a profound transformation, with studies indicating that up to 47% of current jobs are at risk of automation (Frey & Osborne, 2017).

Therefore, this paper investigates how college students can effectively prepare for the evolving AI-driven job market. As technological change accelerates, concerns arise that current college curricula may not align with the demands of the AI revolution (World Economic Forum, 2020). Consequently, this research will explore optimal strategies for equipping graduates, specifically focusing on how institutions, industries, and students can collaborate to bridge the skills gap

and ensure successful adaptation to the future of work. Aligning college curricula, career services, and industry partnerships with emerging workforce needs is essential for enabling the next generation to thrive in an AI-dominated world.

LITERATURE REVIEW

The rapid advancement of artificial intelligence (AI) and related technologies has had a profound impact on the job market, reshaping the landscape of work across various industries. As the job market undergoes this transformation, it is critical to examine the existing research on the evolving role of AI, the educational responses to this technological revolution, the essential skills required for success in an AI-driven workforce, and the perceptions and attitudes of college students who will soon be entering this dynamic employment landscape. The following literature review explores these key areas, providing a comprehensive understanding of the current state of knowledge and the emerging trends that will shape the future of work and the role of higher education in preparing students for this rapidly changing environment.

The AI-Driven Workforce: Evolution, Essential Skills, and Market Requirements

The rapid advancement of technology, particularly artificial intelligence (AI) and related systems, has profoundly impacted the job market, reshaping the landscape of work across various industries. Early investigations, such as Frey and Osborne's (2017) study, estimated that up to 47% of jobs in the United States were at risk of automation, particularly those involving routine, codifiable tasks. This concern was amplified by Brynjolfsson and McAfee (2014), who argued that rapid progress in AI and digital technologies contributed to a "great decoupling" of productivity and employment, leading to job polarization. Subsequent research expanded on these findings, with Manyika et al. (2017) from the McKinsey Global Institute analyzing the global impact of automation.

The evolving relationship between technology, employment, and skills development has been a subject of extensive theoretical exploration. One prominent perspective is the "skill-biased technological change" theory, which suggests that technological advancements often favor skilled workers and increase the demand for higher-level cognitive and social skills (Acemoglu & Autor, 2011). This theory aligns with the notion that the rise of AI and automation may disproportionately impact routine and manual tasks, while creating new opportunities for workers with the ability to adapt and engage in more complex, non-routine activities (Autor, 2015). Another relevant framework is the "task-based approach" to labor economics, which focuses on the specific tasks and skills required for different occupations, rather than broader job categories (Autor et al., 2003).

Employers have a crucial role in shaping the evolving workforce needs and skill demands. Studies have highlighted the growing importance that employers place on skills such as critical thinking, creativity, and adaptability, in addition to technical proficiency (World Economic Forum, 2020; Deming, 2017). Employers are increasingly seeking candidates who can navigate ambiguity, collaborate effectively, and demonstrate the ability to learn and acquire new skills (Deming, 2017; Cappelli, 2015). Furthermore, employers are proactively seeking partnerships with educational institutions to better align curricula with evolving skill requirements (Acemoglu & Restrepo, 2018; Cappelli, 2015).

Educational Responses to the AI Revolution

The Accelerated AI Revolution has placed significant pressure on higher education institutions to rapidly adapt their curricula and pedagogical approaches, ensuring graduates are prepared for the evolving demands of the workforce. Research has emphasized the need for colleges and universities to continuously review and update their curricula to address the evolving skill demands, incorporating more experiential learning, industry partnerships, and opportunities for skill development in emerging technologies and human-centric competencies (Deming, 2017; Carnevale & Smith, 2013).

Researchers have examined the critical role universities play in equipping students with the skills necessary to thrive in an AI-driven job market. Brynjolfsson and McAfee (2014) emphasized the importance of developing "digital literacy" and cultivating the ability to work effectively with AI systems as essential for success in the modern workplace. This includes not only technical skills in areas such as data analysis and programming but also the improvement of critical thinking, problem-solving, and creativity—qualities that complement the abilities of AI technologies (Deming, 2017; Schwab, 2016). Moreover, many researchers have emphasized the importance of a culture of lifelong learning and robust upskilling initiatives in response to the accelerating pace of technological change (Schwab, 2016; Carnevale & Smith, 2013).

Student Perceptions and Attitudes

Research has shown that students' awareness and understanding of AI and its implications for the job market vary widely. A study by the Pew Research Center (2022) found that while many college students recognize the growing presence of AI in various industries, there is a significant knowledge gap regarding the specific ways in which AI is reshaping the workforce. This suggests a need for greater emphasis on AI education and literacy within college curricula.

College students' perceptions of AI's impact on their career prospects are marked by a blend of apprehension and cautious optimism. Studies reveal a significant level of concern regarding AI-driven automation and its potential to displace traditional job roles. A survey by the World Economic Forum (2020) highlighted that many students experience heightened anxiety about job security and their ability to secure meaningful employment due to these concerns.

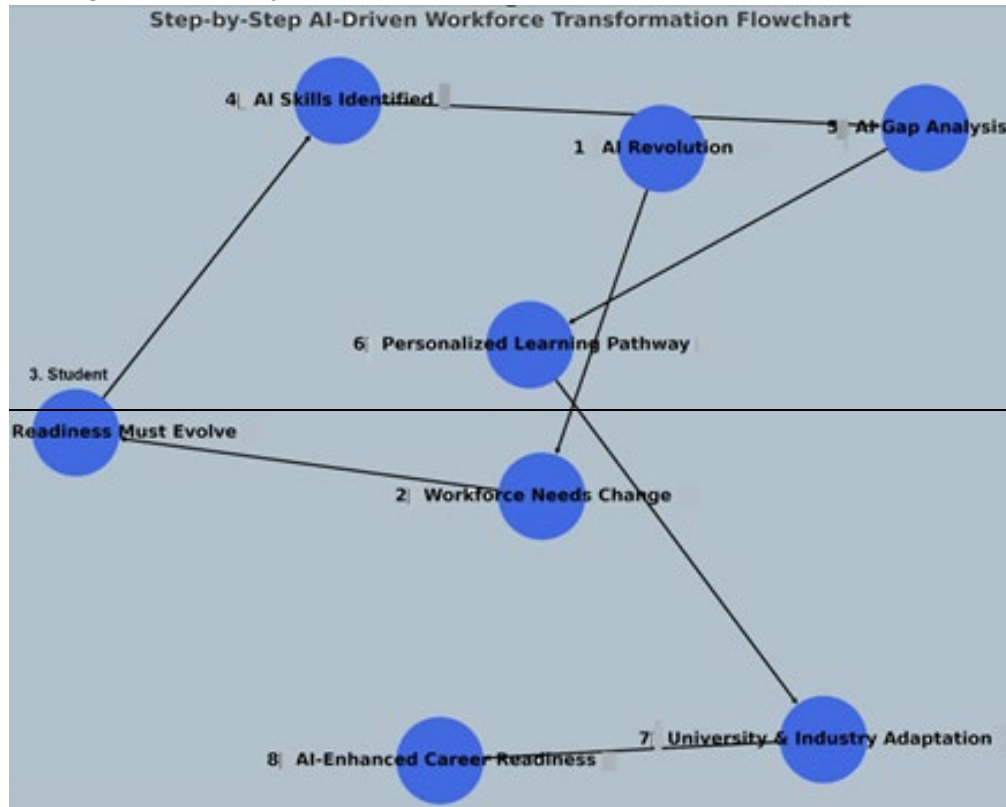
Research has also examined the attitudes of college students regarding the acquisition of AI-related skills. A study by the Association of American Colleges and Universities (2021) found that while many students acknowledge the importance of developing technical skills in areas such as data analysis and machine learning, they also place a high value on "human skills" like critical thinking, problem-solving, and creativity. This suggests that students may be open to educational approaches that balance the development of both technical and non-technical competencies.

METHODOLOGY

This study employs a comprehensive, AI-driven methodology grounded in the GenAI Algorithm Framework, which aligns seamlessly with the conceptual understanding of adapting to the AI revolution, developing future workforce skills, and assessing AI's impact on college students' career prospects. The GenAI Algorithm Framework, as illustrated in Figure 1, provides a systematic and AI-integrated approach to prepare college students for the evolving demands of the AI-driven workforce. This framework centers on the dynamic interplay between the rapid

advancements in AI technology, the shifting needs of the workforce, and the crucial element of college student preparedness.

Figure 1: Step by Step AI Driven Workforce Transformation Flowchart



Source: Compiled by Authors

1. AI Revolution; 2. Workforce Needs Change; 3. Student Readiness Must Evolve; 4. AI Skills Identified; 5. AI Gap Analysis (Apriori, SHAP, LIME); 6. Personalized Learning Pathway Recommended; 7. University & Industry Adaptation; 8. AI-Enhanced Career Readiness

Integrating the GenAI Algorithm Framework into the Conceptual Frameworks

The GenAI Algorithm Framework is strategically integrated with the three conceptual models supporting this study, providing an AI-driven approach to adapting to the AI revolution, developing future workforce skills, and assessing AI's impact on college students' career prospects:

Conceptual Framework #1: Adapting to the Accelerated AI Revolution:

The GenAI Algorithm Framework enhances this model by providing AI-driven skill analysis and automated learning pathways that dynamically respond to evolving workforce demands. Accelerated AI Revolution: The GenAI algorithm continuously monitors AI advancements (e.g., machine learning, deep learning, automation trends) and integrates them into education strategies.

Conceptual Framework #2: Theoretical Models of the Future of Work and Skills Development:

The GenAI Algorithm Framework strengthens this framework by providing real-time AI insights into the evolving nature of work and higher education's response to AI-driven job

transformations. The GenAI framework analyzes job market trends (via web scraping of LinkedIn, indeed, Glassdoor) to predict the impact of AI on job roles and skill demands. AI-powered analytics track declining and emerging job functions, helping universities proactively update curricula.

Conceptual Framework #3: AI Impact on College Students' Career Prospects:
The GenAI Algorithm Framework plays a pivotal role in addressing employment trends, curriculum alignment, and student challenges by using AI-powered analytics to predict workforce needs and personalize career development strategies.

Research Approach and Data Collection:

To operationalize the framework, the research will leverage a multi-faceted data collection strategy encompassing student academic data (LMS, performance, assessments), job market trends (job postings, AI skill demands sourced via web scraping from platforms like LinkedIn, Indeed, and Glassdoor), established skill frameworks (O*NET, World Economic Forum, MIT reports), data from MOOCs and online courses (Coursera, edX trends), and insights from employer surveys and research papers (McKinsey, Deloitte, AACU).

Data Collection:

| Data Source | Extraction Method | AI Technique for Analysis |
|---|--------------------------------------|--------------------------------------|
| Student Academic Data (LMS, performance, assessments) | SQL Queries, API Access | Machine Learning Classification |
| Job Market Trends (Job postings, AI skill demands) | Web Scraping (BeautifulSoup, Scrapy) | NLP & Named Entity Recognition (NER) |
| Skill Frameworks (O*NET, World Economic Forum, MIT reports) | Open Datasets | Topic Modeling (LDA, BERT) |
| Student Feedback | Surveys, Sentiment Analysis | Text Mining & Clustering |
| MOOC & Online Courses (Coursera, edX trends) | API Access, Course Scraping | Trend Analysis |
| Employer Surveys & Research Papers (McKinsey, Deloitte, AACU) | PDF/Text Extraction | Semantic Analysis |

Research Approach:

The core of the analytical approach presented in this research builds upon the previously introduced Conceptual Framework #3: AI Impact on College Students' Career Prospects. It leverages a sophisticated integration of advanced Artificial Intelligence (AI) algorithms designed to comprehensively assess student skills and enable personalized learning pathways. This includes the application of Natural Language Processing (NLP) models like BERT and GPT to analyze textual data related to AI concepts, Supervised Machine Learning techniques (Random

Forest, XGBoost, Logistic Regression) to predict competency levels, Unsupervised Learning (K-Means, DBSCAN) to cluster students based on skill profiles, Reinforcement Learning (RL) to dynamically adapt learning recommendations, Association Rule Learning (Apriori, FP-Growth) to identify relationships between existing knowledge and required skills, and Explainable AI (SHAP, LIME) to ensure the interpretability of AI-driven recommendations. This integrated methodological approach will enable a robust analysis of student preparedness and the effectiveness of the GenAI Algorithm Framework in bridging the skills gap for the AI-driven workforce.

AI Algorithms for Student Skill Assessment and Personalized Learning:

Artificial intelligence (AI) plays a pivotal role in analyzing student competencies, identifying skill gaps, and providing tailored learning recommendations. The study employs Natural Language Processing (NLP), Supervised and Unsupervised Learning, Reinforcement Learning (RL), Association Rule Learning, and Explainable AI to enhance educational outcomes and align student skills with workforce demands.

Natural Language Processing (NLP) with BERT or GPT-based Models:

This study will leverage NLP models to analyze students' written responses, discussion posts, and coursework to detect gaps in AI-related skills.

$$S(R, C) = \frac{V_R \cdot V_C}{\|V_R\| \cdot \|V_C\|}$$

Where:

V_R and V_C are vector representations of the student's response and the correct AI concept, respectively.

Supervised Machine Learning (Random Forest, XGBoost, Logistic Regression)

The study will apply supervised learning models to predict students' competency levels based on academic performance, engagement, and participation metrics.

$$P(L|X) = \frac{1}{1 + e^{-(\beta_0 + \sum \beta_i X_i)}}$$

Where:

X_i represents student features such as test scores and participation. Random Forest and XGBoost refine these predictions by capturing nonlinear interactions.

Unsupervised Learning (Clustering via K-Means or DBSCAN)

The study will apply clustering techniques to group students with similar skill sets and learning progress.

$$J = \sum_{i=1}^k \sum_{x_j \in C_i} \|x_j - \mu_i\|^2$$

Where:

x_j is a student's feature vector, μ_i is the centroid of cluster C_i , and k is the number of clusters. DBSCAN will be used to detect outliers who struggle with specific AI concepts.

Reinforcement Learning (RL) for Adaptive Learning Platforms

AI-driven learning platforms will dynamically adjust course recommendations based on students' strengths and weaknesses.

$$Q(S_t, a_t) = R + \gamma \max_{a'} Q(S_{t+1}, a')$$

Where:

γ gamma is a discount factor ensuring future learning benefits remain relevant.

Association Rule Learning (Apriori, FP-Growth)

The study will apply association rule learning to extract patterns between students' existing knowledge and required skills.

$$S(A \Rightarrow B) = \frac{\text{Count}(A, B)}{\text{Total Transactions}}$$

$$C(A \Rightarrow B) = \frac{\text{Count}(A, B)}{\text{Count}(A)}$$

$$L(A \Rightarrow B) = \frac{C(A \Rightarrow B)}{P(B)}$$

Where:

Using support (SSS), confidence (CCC), and lift (LLL), these methods reveal hidden skill dependencies:

Explainable AI (SHAP, LIME for Model Interpretability)

This study will use SHAP and LIME to provide insights into AI-driven skill recommendations.

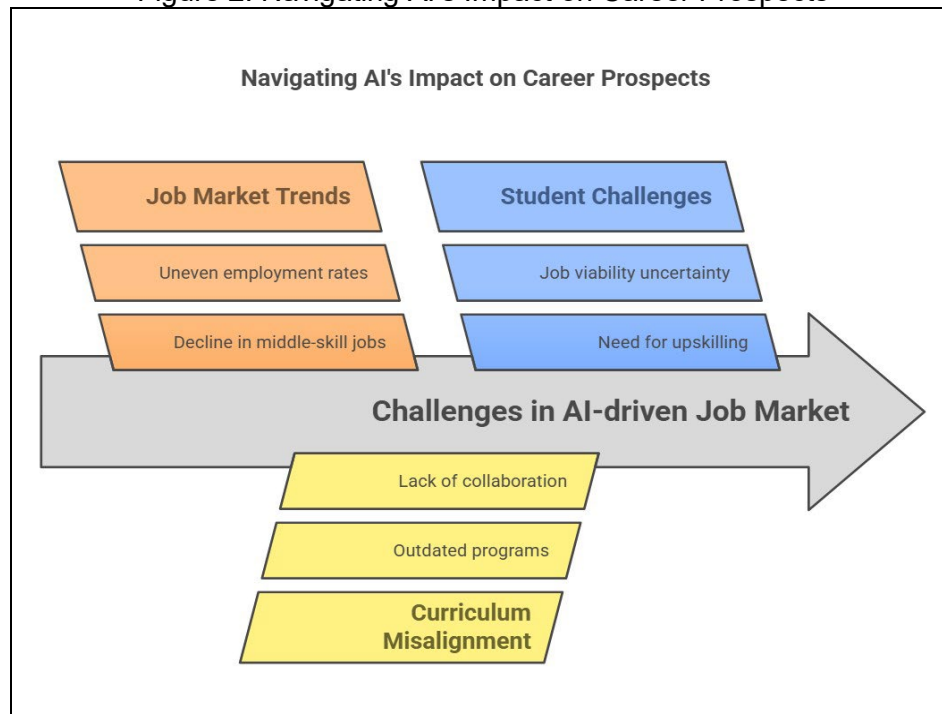
$$f(x) = \phi_0 + \sum_{i=1}^n \phi_i x_i$$

Where:

SHAP values determine the contribution of each feature in a model's decision-making:

EXPECTED RESULT OF AI IMPACT ON COLLEGE STUDENTS' CAREER PROSPECTS

Figure 2: Navigating AI's Impact on Career Prospects



The GenAI Algorithm Framework plays a pivotal role in addressing employment trends, curriculum alignment, and student challenges by using AI-powered analytics to predict workforce needs and personalize career development strategies. Figure 2 illustrates the complex web of challenges arising in the AI-driven job market. On one side, negative "Job Market Trends" such as "Uneven employment rates" and the "Decline in middle-skill jobs" create a difficult environment for job seekers. Simultaneously, students face significant "Student Challenges," including "Job viability uncertainty" and the constant "Need for upskilling" to remain relevant. These pressures converge on the central theme of "Challenges in AI-driven Job Market," represented by a prominent gray arrow emphasizing the significance and ongoing nature of these difficulties.

Contributing significantly to these challenges are issues within the educational system, categorized under "Curriculum Misalignment." This section highlights a "Lack of collaboration" between academia and industry, "Outdated programs" that fail to reflect current technological advancements, and a fundamental "Curriculum Misalignment" where the skills taught do not align with the demands of the AI-driven economy. The flowchart effectively conveys that navigating the impact of AI on career prospects requires addressing not only the evolving job market and the struggles of students but also the critical need for educational institutions to adapt and bridge the gap between academic offerings and industry requirements.

The GenAI Algorithm Framework serves as a crucial tool in bridging the gap between college education and the demands of the AI-driven job market. Its real-time workforce analytics track evolving opportunities, guiding universities in preparing students for future careers. AI-powered curriculum audits pinpoint areas for improvement, fostering better alignment with employer needs through university-industry partnerships. Moreover, the framework offers personalized career guidance and skill development via reinforcement learning, predicting job viability and recommending targeted upskilling. This comprehensive AI-driven approach equips students with the necessary skills and support to confidently transition into and succeed within AI-dominated industries, effectively future-proofing them for the evolving world of work.

CONCLUSION

The GenAI Algorithm Framework presented in this research paper offers a comprehensive and systematic approach to equipping college students for the demands of an AI-driven workforce. By leveraging advanced AI techniques such as machine learning, natural language processing, and explainable AI, the framework continuously analyzes job market trends, identifies evolving skill requirements, and generates personalized learning pathways to empower students with the technical proficiencies, data analysis capabilities, and human-centric skills necessary to succeed in AI-driven careers. Importantly, this framework not only enhances students' career readiness, but also positions them to actively contribute to the ongoing evolution and refinement of AI systems themselves, as they apply their AI-related knowledge and skills in the workforce. In today's rapidly changing technological landscape, addressing the AI skills gap is not merely an educational imperative – it represents a critical step towards cultivating a workforce capable of thriving in an increasingly AI-powered world, and the GenAI Algorithm Framework offers a promising solution to this challenge.

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DECISION SCIENCES INSTITUTE**The Spreadsheet of Everything: A Less-is-More Approach to Prescriptive Analytics**

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ABSTRACT

Prescriptive analytics education has evolved alongside computing advances, with spreadsheets revolutionizing decision science instruction. However, many modern courses emphasize add-in software or programming-heavy approaches, often disadvantaging students with varied backgrounds. Traditional pedagogy blends modeling and analytics too early, creating cognitive overload that hinders deep learning.

This paper introduces The Spreadsheet of Everything, a structured, minimalist approach to teaching prescriptive analytics that prioritizes core analytical techniques—sensitivity analysis, scenario analysis, simulation, decision analysis, and optimization—before complex modeling. By using a single, progressively layered spreadsheet model, students develop fluency in analytics without being overwhelmed by software complexity or domain-specific modeling skills.

The less-is-more philosophy of this approach ensures that students first master analytics in a transparent, accessible environment, avoiding reliance on macros or add-ins. Putting the science of analytics before the art of modeling prevents pacing issues, allowing students to build confidence incrementally rather than struggling with multiple concepts simultaneously.

By emphasizing conceptual clarity, structured progression, and accessibility, this framework better prepares students for real-world decision-making while reinforcing essential spreadsheet skills. The Spreadsheet of Everything can serve as a primary course framework, a supplement to modeling-focused curricula, or an adaptable online learning tool.

Educators seeking a streamlined and effective way to teach prescriptive analytics, and one that reduces barriers to entry and enhances comprehension, may find this approach an invaluable addition to their pedagogy.

Keywords: Prescriptive analytics, spreadsheets, modeling, mastery

INTRODUCTION

Prescriptive analytics education has evolved alongside advances in computing, moving from mathematicians running programs on mainframes, to business students and professionals using

spreadsheets. Spreadsheets revolutionized the teaching of decision sciences by making modeling accessible to students without advanced programming skills. Since then, leading textbooks have shifted toward more hands-on, end-to-end modeling projects with increasingly sophisticated analyses. In recent years, while reliance on spreadsheets continues, prescriptive analytics courses increasingly rely on add-in software or programming-heavy approaches. This path to analytics is fast but can leave less-prepared students disadvantaged and can shift the focus too much from conceptual to technical.

At its core, prescriptive analytics integrates modeling—the creation of structured representations of decision problems—and analytics—the computational techniques used to extract insights. However, traditional pedagogy often blends these two elements too soon, leading to cognitive overload. Modeling is an art that benefits from gradual, experience-based learning over years, while analytics requires structured, logical progression that can be covered incrementally, one lesson at a time. When taught together without scaffolding, students frequently struggle to grasp both.

A major challenge in teaching prescriptive analytics is the diverse background of students. Some students have strong mathematical and computing skills which are implicit prerequisites for using advanced tools. Others primarily engage with analytics through business applications and basic math. Pedagogical choices can create unintended hurdles: exposing students to many applications early on demands domain knowledge that some may lack; presenting equations with complicated notation and new terms can disadvantage students with math anxiety; and relying heavily on complex software interfaces can slow down those unfamiliar with spreadsheets.

When concepts are introduced too quickly—especially with software-based approaches—students can struggle when they have to solve problems independently.

This paper introduces an alternative approach: the *Spreadsheet of Everything*. This methodology, built around a structured, spreadsheet-based framework, simplifies prescriptive analytics education by focusing on core techniques—sensitivity analysis, scenario analysis, simulation, decision analysis, and optimization—all within the familiar environment of Excel. By progressively layering these techniques, this approach reduces barriers to entry, enhances student comprehension, and better aligns with real-world decision-making environments.

THE SPREADSHEET OF EVERYTHING: A PEDAGOGICAL APPROACH

The *Spreadsheet of Everything* approach first introduces a single minimalist model that is easy to understand. Rather than rushing students into advanced modeling techniques, this method prioritizes building their analytics competency first. The model is just complex enough to illustrate analytics techniques effectively, while leaving “real-world” modeling skills for later.

Rather than multiple disconnected applications aiming to show the range of what the tools can do, this single spreadsheet-based model instead remains the foundation throughout the learning process, as analytics concepts are progressively layered in a way that reinforces learning

Much like predictive analytics, prescriptive analytics can be framed as data manipulation to answer questions about decisions – a process involving obtaining, structuring, organizing, aggregating, visualizing, and interpreting data, rather than just running algorithms. Observing these stages in detail, students develop a clearer understanding of the mechanics of decision modeling. The framework emphasizes:

- One consistent and simple model throughout the course, avoiding the confusion of introducing new applications too soon.
- Excel’s built-in features such as reference functions and data tables, eliminating the need for add-ins or macros.
- A progressive learning approach, ensuring students master each analytical technique before moving to the next.

This stepwise structure prevents a “pacing problem,” where students who struggle with modeling fall behind in analytics as well. Learning two difficult subjects simultaneously is inefficient. Instead, focusing first on analytics skills ensures that students can use their skills immediately—even if they are initially working with simple models. Over time, they can expand into more advanced modeling roles.

Structured exercises progressively build in complexity. By using a single foundational model, students can focus on mastering each analytical method before advancing, reducing confusion and improving retention.

The next section walks through key techniques to suggest how methods can work in practice.

THE LEARNING PROGRESSION

A central challenge in analytics education is ensuring that students develop deep understanding rather than the mere surface-level familiarity required to run packaged software. With transparent spreadsheets, students can see through layers, understand the formulas, and follow exactly the processing of the data from generation to recommendation. This allows them to build transferable knowledge that applies across different analytics environments. To reinforce the conceptual understanding, we utilize an adaptation of influence diagrams to visually reinforce the relationship between the model and the analytics techniques, and between the different techniques themselves. This unifies into a coherent system for prescriptive analytics what might otherwise be fragmented knowledge.

From Sensitivity to Optimization

The *Spreadsheet of Everything* builds prescriptive analytics understanding progressively, beginning with modeling basics then simple sensitivity analysis and gradually increasing complexity:

Modeling Basics

We start with the Basic Business Model shown in Figure 1. This spreadsheet model calculates Profit from Price, Fixed cost, Unit cost, and Quantity. The visible spreadsheet serves as both a real-time tool, as well as a familiar object for discussion of concepts such as modeling terminology (variable, value, etc.), different representations (algebraic notation, named variables, influence diagrams), and, later, the techniques applied.

Figure 1: The Basic Business Model

| | A | B | C | D | E |
|----|---------------|---|---|---|----------|
| 1 | | | | | |
| 2 | | | | | Value |
| 3 | Price | | | | 25 |
| 4 | Fixed cost | | | | 400 |
| 5 | Unit cost | | | | 18 |
| 6 | Quantity | | | | 100 |
| 7 | | | | | |
| 8 | | | | | |
| 9 | Variable cost | | | | =E5*E6 |
| 10 | Total cost | | | | =E9+E4 |
| 11 | Revenue | | | | =E3*E6 |
| 12 | Profit | | | | =E11-E10 |

Sensitivity Analysis

Using data tables to track changes in outputs over a range of input values.

Indexed Sensitivity Analysis

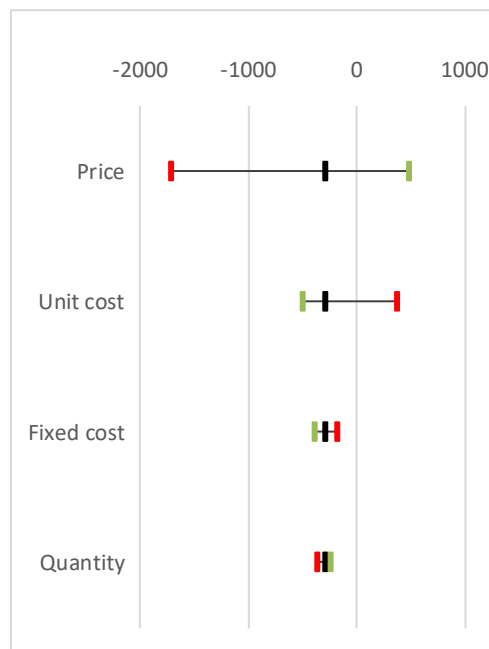
Using parametric modeling with low-mid-high cases for input values, along with data tables for sensitivity analysis over the index for which case is used, as shown in Figure 2

Figure 2: Indexed Sensitivity Analysis.

| | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|----|---------------|---|------|-------|------------------|-----|------|---|---|---|------|-------|------|------|
| 1 | | | | | parameter ranges | | | | | | | Low | Mid | High |
| 2 | | | Case | Value | Low | Mid | High | | | | | 1 | 2 | 3 |
| 3 | Price | | 2 | 18 | 5 | 18 | 25 | | | | -280 | -1710 | -280 | 490 |
| 4 | Fixed cost | | 2 | 500 | 400 | 500 | 600 | | | | | | | |
| 5 | Unit cost | | 2 | 16 | 10 | 16 | 18 | | | | | | | |
| 6 | Quantity | | 2 | 110 | 70 | 110 | 130 | | | | | | | |
| 7 | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | |
| 9 | Variable cost | | | 1760 | | | | | | | | | | |
| 10 | Total cost | | | 2260 | | | | | | | | | | |
| 11 | Revenue | | | 1980 | | | | | | | | | | |
| 12 | Profit | | | -280 | | | | | | | | | | |

Building on simple indexed sensitivity analysis above, the *tornado chart* in Figure 3 compares in one graphic how much Profit changes when each of the input variables is moved from its mid-case to its low or high case while other variables are unchanged. This is done using a two-way data table in which each row shows the profit when a single variable goes through its paces. Variations on this use of data tables can facilitate other comparisons within a single chart, e.g., a radar chart can show the sensitivity of all dependent variables to all independent variables.

Figure 3: Tornado chart in Excel



Scenario Analysis

Using sets of index values for the set of input parameters to compare possible futures in an organized fashion, using data tables to track calculations by scenario.

Simulation Analysis

Using Excel random number generators to vary input values and case indices which can be sculpted into desired distributions, and using data tables to track random results, with spreadsheet-based statistical tools to analyze the results.

Decision Analysis

Using data tables to track utility while varying decision and chance variables through range of possible indexed values, and augmenting with probabilities and decision rules as shown in Figure 4, as well as other decision analytic structures. It can be seen here how, as with all the other methods, the spreadsheets build up from structures introduced earlier.

Figure 4: Decision Analysis with a Data Table

| | A | B | C | D | E | F | G | H |
|----|-------------|---------------|----------|--------|-------|------------------|-------------|------|
| 1 | | | | | | parameter ranges | | |
| 2 | | | | Case | Value | Low | Mid | High |
| 3 | | Price | | 2 | 30 | 25 | 30 | 35 |
| 4 | | Fixed cost | | 2 | 500 | 100 | 500 | 2000 |
| 5 | Uncertainty | Unit cost | | 2 | 20 | 10 | 20 | 35 |
| 6 | Decision | Quantity | | 2 | 250 | 50 | 250 | 500 |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | Variable cost | | | 5000 | | | |
| 10 | | Total cost | | | 5500 | | | |
| 11 | | Revenue | | | 7500 | | | |
| 12 | | Profit | | | 2000 | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | Quantity | | | | | |
| 18 | | 2000 | 1 | 2 | 3 | | Probability | |
| 19 | Unit cost | 1 | 500 | 4500 | 9500 | | 0.25 | |
| 20 | | 2 | 0 | 2000 | 4500 | | 0.5 | |
| 21 | | 3 | -750 | -1750 | -3000 | | 0.25 | |
| 22 | EV | | -62.5 | 1687.5 | 3875 | | | |
| 23 | | | | | | | | |
| 24 | Max EV | | 3875 | | | | | |

Optimization Analysis

Using data tables to track calculated the objective function value and the status of constraints for many randomly generated sets of decision variable values, and identifying and exploring maxima.

None of the above techniques use spreadsheet macros or add-ins, saving classroom time. Instead, they use only a small number of standard Excel features and functions!

This step-by-step structure ensures that students learn each concept deeply before moving forward. Instead of overwhelming students with multiple moving parts at once, they gain confidence and fluency with each analytical method.

Moreover, by using Excel's built-in capabilities without add-ins, students can learn the concepts to mastery, and by learning the skills within a spreadsheet-only environment, the integration of the model with the analytic process is also transparent. This presentation provides students a clear mental model for prescriptive analytics, making it easier to apply their skills in any environment.

Each of these methods follows the same progressive learning framework, ensuring that students build on prior knowledge and develop a cohesive understanding of prescriptive analytics. This helps students gradually develop confidence. They are not asked to grasp multiple challenging concepts at once but are instead guided through a sequence of small, digestible steps.

Bottom Line

By teaching these methods entirely within spreadsheets, educators can:

- Reduce complexity for students, allowing them to focus on core decision models rather than software setup and mechanics.
- Improve engagement through interactive, real-time calculations – unlike add-ins or external programs, spreadsheet-only approaches show new calculated results as soon as input values or formulas are modified (also desirable for real applications).
- Ensure accessibility, as students do not need additional software licenses or programming expertise.
- Improve spreadsheet competence alongside learning analytics techniques. By working with a small set of formulas and features through repeated use in related contexts, students master them. In the process, they experience what it means to learn spreadsheet skills to mastery.

CONCLUSION - APPLYING THIS APPROACH

The *Spreadsheet of Everything* is designed to be flexible and can be used in different teaching formats:

As a Primary Framework for the Course

- Supports a full-semester resource for business analytics, operations research, or prescriptive analytics courses.

- Progresses systematically from foundations of modeling to advanced techniques.
- To enrich the learning experience and generalize from the running example, a second model for a different decision can serve as a running exercise.
- Case studies can be used to supplement homework or for group projects to build in more “art of modeling.”
- Reflective discussion questions can prompt students or groups to compare and contrast the techniques, taking advantage of their exposure to the tools at a granular level.

As a Supplement to an Existing Course

- Courses with materials emphasizing the art of modeling with cases may use some of the methods here for more transparency, a different perspective, more connection to data analytics, or just for the convenience of working in Excel only.

For Online or Hybrid Teaching

- Spreadsheet-based exercises are platform-independent, making them easy to integrate into remote learning.

The *Spreadsheet of Everything* provides a practical, structured way to teach prescriptive analytics that is both accessible and adaptable.

Ultimately, this less-is-more approach is about making prescriptive analytics easier to teach and easier to learn, ensuring that students are equipped with the tools they need to develop and apply strong analytical skills, no matter their starting point.

I welcome conversations with educators who are interested in applying this method, adapting it to their courses, sharing insights on teaching prescriptive analytics.

REFERENCES

Keisler, Jeffrey M. *Prescriptive Analytics: Mastering the Spreadsheet of Everything*. Springer Nature, 2024.