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## **A Case Study on Using AI to Optimize Instructional Quality and Administrative Efficiency: A Practical Approach for Regional Campuses**

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*This study explores the innovative use of AI language models, specifically ChatGPT, to enhance both teaching and administrative efficiency in General Chemistry courses at a regional campus. By integrating AI tools, faculty can streamline course preparation, support personalized student learning, and significantly reduce the time spent on routine administrative tasks. The study highlights practical applications of ChatGPT, including the development of scaffolded worksheets that break down complex chemistry topics, the creation of multi-version assessments to support Specifications Grading (Specs Grading), and the inclusion of real-life chemistry examples to increase student engagement. While this study focuses on ChatGPT, the findings have broader implications for the adoption of various AI models in similar educational and administrative contexts.*

Data collected from three semesters demonstrates a notable increase in student quiz scores, with an average improvement of 3.5 points after the implementation of AI-generated learning materials. Student feedback collected through Likert-scale surveys showed high satisfaction, with scores averaging 4.5 out of 5 for the clarity and usefulness of AI-generated worksheets. Additionally, ChatGPT assisted in administrative tasks, such as drafting detailed letters of recommendation and summarizing departmental meetings, contributing to about 30% reduction in time spent on these tasks.

These findings suggest that ChatGPT not only enhances student comprehension of challenging topics but also helps faculty manage their workload more efficiently. This study provides actionable insights and a model for other regional campus faculty to leverage AI in ways that improve both teaching quality and operational efficiency, making it a valuable resource for educators seeking practical solutions to common challenges in higher education.

### **Introduction**

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The integration of artificial intelligence (AI) in educational settings has shown promise in addressing these challenges by enhancing both instructional and administrative efficiency. Research indicates that AI tools can support educators by automating routine tasks, such as grading, creating personalized assessments, and organizing data, allowing faculty to devote more time to direct student interaction (Guan et al., 2020; Woolf, 2010). In particular, AI-driven tools like intelligent tutoring systems have been found to reduce the time required for feedback and assessment while providing personalized learning experiences tailored to students' individual needs (Murtaza et al., 2022; Nye, 2015). AI's potential to streamline administrative duties, such as drafting recommendation letters or summarizing meeting notes, further contributes to time savings and workload management for faculty, especially in settings where instructors balance high teaching loads with service responsibilities (Holmes et al., 2019; Bates & Sangrà, 2011). As West (2018) notes, the ability of AI to automate repetitive tasks has transformative implications for higher education, potentially reshaping how faculty allocate time and resources.

Faculty at regional campuses often face the unique challenge of balancing high teaching loads with diverse administrative responsibilities, making efficient time management essential. In addition to classroom instruction, these faculty members are responsible for tasks such as creating detailed lesson plans, managing grading systems, writing recommendation letters, and participating in committee work. These demands can limit the time available for developing innovative teaching strategies or providing individualized feedback to students. Although recent studies have highlighted AI's potential in educational settings, there is limited research focusing specifically on regional campuses, where faculty navigate a distinctive blend of instructional and administrative duties. These campuses also attract diverse student populations, including recent high school graduates, mature students, returning students, and individuals changing careers, each with varied learning styles and levels of academic preparedness. This diversity makes personalized and adaptive learning materials crucial for effective instruction. Balancing high teaching loads with administrative responsibilities leaves limited time to meet these diverse learning needs effectively. Addressing this gap, this study investigates how AI, specifically ChatGPT, can support regional campus faculty by improving time efficiency, enhancing instructional quality, and reducing administrative workload.

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One instructional tool that has proven effective in promoting student understanding is the scaffolded worksheet. Scaffolded worksheets, which guide students through progressively challenging concepts, have been shown to enhance comprehension and build foundational knowledge in various subjects, including chemistry (Clark & Mayer, 2016; Reiser & Tabak, 2014). Research indicates that scaffolded learning materials can help students achieve deeper understanding by breaking down complex concepts into manageable steps, making it easier for students to develop the skills needed to tackle advanced topics (Wood et al., 1976). However, creating personalized and adaptive scaffolded worksheets for individual students or different learning groups can be time-consuming. Here, AI offers a significant advantage by efficiently generating multiple versions of scaffolded worksheets tailored to students' unique needs, enabling more personalized learning experiences and repeated practice (Jadhav, 2024). With AI tools like ChatGPT, instructors can create scaffolded worksheets that break down challenging concepts, enabling students to grasp foundational knowledge before moving on to more complex applications. Additionally, using AI to create multiple versions of assessments, as outlined in the Specs Grading approach, supports mastery learning by allowing students repeated attempts on varied questions that reinforce key concepts (Author, in press).

This study builds upon previously published findings by further examining AI-generated scaffolded worksheets, with a particular focus on their impact on faculty workload and administrative efficiency (Author, 2024). While the original study primarily investigated student quiz score improvements, the present research expands the discussion to explore AI integration in higher education from an instructor's perspective. The dataset used in this analysis has been repurposed with permission to extend the scope of inquiry beyond student outcomes.

Using a mixed-methods approach, this study combines quantitative analysis of student performance with qualitative feedback to assess the effectiveness of ChatGPT in achieving instructional and administrative efficiency. Specifically, the study aims to explore the following research questions: (1) How does ChatGPT improve time efficiency in creating personalized study materials and assessments? (2) What impact does ChatGPT have on student engagement and learning outcomes? (3) How effective is ChatGPT in reducing faculty workload through streamlined administrative support?

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This paper presents a case study on the integration of ChatGPT in a General Chemistry course at a regional campus, focusing on four primary areas: study materials for students, course preparation, Specs Grading, and administrative support. By sharing specific prompts and examples, this study illustrates the practical benefits of ChatGPT in creating tailored study materials, automating multi-version quizzes to meet Specs Grading requirements, and assisting with administrative tasks like drafting recommendation letters and summarizing meetings. These applications of ChatGPT not only aim to enhance student engagement and mastery of complex topics, as demonstrated by increased quiz scores and positive feedback ratings, but also offer faculty a valuable resource for managing instructional and administrative workloads efficiently.

While this study demonstrates a measurable improvement in student quiz scores, it is important to recognize that multiple factors contribute to student success. Because all students in the AI-integrated semesters used these worksheets in-class under instructor supervision, self-selection bias was minimized. However, further research using controlled experimental conditions is needed to fully isolate the impact of AI-generated materials on learning outcomes.

## **Method**

### **1. Study Design**

This study was conducted over three consecutive semesters in a General Chemistry I course at a regional campus. The course was taught by the same instructor each semester, using an identical syllabus, grading structure, and assessment design to maintain consistency in instructional delivery. Course topics, lecture slides, and laboratory activities remained unchanged across all semesters to minimize variations in instructional content. The student population included both traditional and non-traditional learners, with an average class size of approximately 40 students per semester. All students enrolled in the course were required to have completed the same chemistry and math prerequisites. While there was no direct control over students' individual academic backgrounds beyond prerequisite coursework, overall student demographics, including age, prior chemistry exposure, and GPA distribution, remained relatively stable across the three semesters.

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To investigate how ChatGPT improves time efficiency in creating personalized study materials and assessments, faculty time spent on course preparation was measured before and after implementing AI-generated resources. The study tracked the time required to develop scaffolded worksheets, multi-version assessments, and study guides using ChatGPT, compared to manually developed versions from previous semesters. Time savings were documented through instructor-reported logs and measured in minutes per task, allowing for a quantitative comparison of AI-assisted versus traditional preparation methods.

The impact of ChatGPT on student engagement and learning outcomes was assessed using two primary data sources. First, Likert-scale surveys were administered at the end of each semester to evaluate student perceptions of AI-generated materials in terms of content clarity, engagement, usefulness, and overall satisfaction. The survey was conducted during a scheduled class session to ensure broad participation from enrolled students. While participation was voluntary, all students present on the survey day were encouraged to respond, resulting in a response rate of approximately 95%. No incentives were provided, and responses were collected anonymously to minimize bias. Since students completed the survey in class, the results reflect a broad representation of those enrolled rather than self-selected participants. However, students who were absent on the survey day did not participate, introducing a potential source of nonresponse bias.

Additionally, changes in student performance were analyzed by comparing quiz scores across semesters. A paired t-test was conducted to determine whether the differences in student quiz scores were statistically significant, providing a quantitative measure of learning gains. Since quizzes directly assessed AI-generated worksheet content, they were selected as the primary metric for evaluating learning gains. Final grades were not used as a performance measure because they incorporate multiple factors beyond quizzes, such as homework, attendance, and participation, which could introduce uncontrolled variability.

The effectiveness of ChatGPT in reducing faculty workload through streamlined administrative support was examined by analyzing faculty self-reported time logs. This included tracking reductions in time spent on routine administrative tasks such as drafting recommendation letters, summarizing departmental meetings, and creating study materials. Time savings from these tasks were compared to previous semesters, and

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qualitative faculty feedback was collected to assess perceptions of AI's role in improving administrative efficiency.

To ensure fairness in performance comparisons, all assessments, including quizzes, exams, and laboratory work, remained identical each semester. Additionally, all quizzes and exams were conducted in person, preventing students from using external AI assistance during assessments. While structured classroom use of AI-generated worksheets minimized self-selection bias, students were not pre-selected based on academic ability, prior performance, or interest in AI. All students in AI-integrated semesters were required to use the worksheets under instructor supervision, ensuring uniform exposure. However, variations in individual study habits, external tutoring, and previous chemistry experience may have influenced learning outcomes.

## 2. Effectiveness of AI in Classroom Instruction

To investigate ChatGPT's effectiveness in classroom instruction, AI-generated scaffolded worksheets and study guides were used to support student learning. These resources were designed to improve student comprehension of complex chemistry topics by gradually building knowledge from foundational to advanced concepts. ChatGPT assists in creating these scaffolded materials by breaking down topics into manageable steps, a method shown to enhance student learning through gradual mastery (Wood et al., 1976; Kinchin, 2006). This approach aligns with Student Learning Objectives (SLOs) and facilitates incremental learning, especially in subjects requiring foundational knowledge like chemistry.

### *Sample Prompts for Scaffolded Worksheets:*

- "Create a scaffolded worksheet on stoichiometry, beginning with basic mole calculations and progressing to limiting reactants."
- "Generate a step-by-step guide on balancing redox reactions, with explanatory notes at each step."

Using these prompts, ChatGPT generates worksheets that guide students from basic to more advanced concepts. This method encourages gradual mastery and supports independent learning. Prior research indicates that AI-driven tools can effectively personalize instruction,

enhancing student engagement and learning (Murtaza et al., 2022; Holmes et al., 2019).

To measure student engagement and perceptions of AI-generated materials, a post-semester Likert-scale survey was administered. The survey contained ten questions evaluating content clarity, engagement, usefulness, and overall satisfaction, with responses ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Additionally, student quiz scores were compared across semesters to assess learning improvements. A paired t-test was conducted to determine whether the differences in quiz scores were statistically significant, allowing for an objective evaluation of the impact of AI-generated resources on student learning outcomes. Table 1 provides an example of the scaffolded structure for a stoichiometry worksheet generated by ChatGPT. For full examples, see Appendix A and B.

Table 1: Stepwise Approach in ChatGPT-Generated Stoichiometry Worksheet

Step	Topic	Example Question/Activity
1	Mole Concept Basics	Calculate moles of NaCl given 5 grams.
2	Stoichiometric Ratios	Given a balanced equation, identify the limiting reactant.
3	Applied Problem on Limiting Reactants	Calculate the yield in grams based on the limiting reactant.

### *Real-Life Chemistry Examples*

In addition to scaffolded worksheets and study guides, ChatGPT was employed to create real-life examples of chemistry concepts, allowing students to see the relevance of these topics beyond the classroom. These examples were designed to make abstract concepts more relatable by connecting them to familiar, everyday phenomena, such as the chemistry of batteries, cleaning agents, and combustion. Context-based learning has been shown to enhance student engagement and comprehension in STEM fields (Clark & Mayer, 2016; Nye, 2015).

Sample Prompts for Real-Life Chemistry Examples: (For full examples, see Appendix C)

- "Provide examples of oxidation-reduction reactions in everyday life, with explanations of how and where they occur."

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- "Generate real-life scenarios where acid-base reactions are essential, such as in cleaning products or food chemistry."
  - "Explain the chemistry behind combustion in engines and how it converts fuel into energy."

These examples were designed to make chemistry more relatable by connecting theoretical concepts to real-world applications, supporting student engagement and retention.

### 3. Impact of AI-Generated Feedback on Student Learning

To evaluate ChatGPT's role in providing feedback and enhancing student learning, the AI tool was used to generate multiple versions of Quests (a combination of quiz and test) aligned with the Specifications Grading (Specs Grading) approach. Specs Grading requires students to demonstrate mastery of specific learning outcomes. By providing multiple opportunities of the unique assessment versions, ChatGPT supports iterative practice, reinforcing students' understanding and retention of key concepts. Adaptive assessments have been shown to support mastery learning by allowing students to repeatedly engage with varied but conceptually aligned content (Clark & Mayer, 2016; Nye, 2015). ChatGPT aids this process by creating multiple versions of assessments that address similar learning outcomes but vary in their content, thus promoting mastery without redundancy.

#### *Prompts for Creating Multi-Version Quests:*

- "Create three versions of a quest question on molar mass calculation, each with different compounds and masses."
- "Generate unique assessment versions on limiting reactants for students retaking the quest."

Table 2 provides examples of multi-version Quest questions created by ChatGPT, demonstrating how different versions assess the same skillset while offering diverse problem sets. This flexibility supports students' engagement and aligns with the mastery-focused approach of Specs Grading.

Table 2: Examples of Multi-Version Quest Questions for Specs Grading using ChatGPT

Version	Question Example
1	Calculate the theoretical yield of $H_2$ when 10g of Zn reacts with HCl.
2	Determine the yield of $O_2$ produced from 12g of $KClO_3$ .
3	Find the grams of $CO_2$ produced from 8g of C reacting with $O_2$ .

By using ChatGPT to automate the creation of these varied assessments, the average preparation time was reduced by approximately 25%, from 40 minutes per assessment to about 30 minutes. Further details on time savings are presented in the Results section.

#### 4. Impact of AI on Instructor Efficiency and Workload

The third research question examines how ChatGPT affects instructor efficiency by reducing the time spent on both course preparation and routine administrative tasks. Faculty members at regional campuses often balance teaching responsibilities with administrative duties, making time management essential. ChatGPT assists by automating repetitive tasks, allowing faculty to reallocate time to direct student engagement and course development (West, 2018; Guan et al., 2020).

In addition to instructional support, ChatGPT helps streamline routine tasks such as drafting letters of recommendation, summarizing meeting notes, and organizing student performance data.

##### *Sample Prompt for Administrative Tasks:*

- “Draft a one-page letter of recommendation for a student who was in the top 5% in my chemistry course and demonstrated excellent lab skills.”

To evaluate time savings, the duration of each task was measured before and after using ChatGPT. Faculty workload reductions were quantified by tracking the time spent on three key tasks before and after ChatGPT integration: developing study materials, grading and assessment preparation, and administrative tasks such as writing recommendation letters and summarizing meeting notes. Time logs were maintained over three semesters, and an average time reduction percentage was calculated. Additionally, qualitative insights on perceived efficiency improvements were gathered through informal reflections on teaching and administrative workload.

## Results and Discussion

This study evaluated the impact of ChatGPT on enhancing instructional quality and administrative efficiency in a General Chemistry course. The findings are organized according to the three primary research areas: the effectiveness of AI-generated materials in classroom instruction, the impact of AI on student learning and engagement, and the role of AI in improving instructor workload efficiency. The integration of ChatGPT in classroom instruction aimed to improve students' understanding of complex chemistry topics through AI-generated scaffolded worksheets and personalized study guides. These AI-generated materials align with scaffolded learning theories, which emphasize gradual mastery of complex topics by breaking them down into manageable steps (Wood et al., 1976; Kinchin, 2006).

### Effect of AI-Generated Worksheets on Student Performance

Results indicate a statistically significant improvement in student performance following the integration of AI-generated scaffolded worksheets. A paired t-test was conducted to compare quiz scores across semesters. The analysis showed a significant increase in quiz scores from Fall 2022 ( $M = 70.3$ ,  $SD = 5.4$ ) to Fall 2023 ( $M = 75.8$ ,  $SD = 6.1$ ), with  $t(39) = 4.75$ ,  $p < 0.001$ . The observed 3.5-point increase corresponds to an improvement of approximately 5% in quiz performance, which is statistically significant and practically meaningful in the context of student learning. As shown in Table 3, the progression of quiz scores across semesters reflects the impact of AI-generated worksheets on student comprehension. Given that quizzes are a direct measure of conceptual understanding, this increase suggests that students using AI-generated materials demonstrated improved mastery of the covered topics.

Table 3: Average Quiz Scores Across Semesters

Semester	Average Quiz Score
Fall 2022 (Baseline, no AI)	70.3
Spring 2023 (Pilot, AI materials)	73.5
Fall 2023 (Full AI integration)	75.8

A paired t-test confirmed that the observed increase in quiz scores was statistically significant ( $p < 0.001$ ), indicating that the improvement was

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unlikely due to random variation. However, while these results strongly suggest that AI-generated scaffolded worksheets contributed to increased comprehension, other factors such as individual student motivation, external study habits, and prior knowledge could also play a role. Since all students in the AI-integrated semesters used these worksheets in a structured classroom setting, the likelihood of self-selection bias was minimized. Future research using controlled experimental conditions or randomized student groups may further isolate the direct causal impact of AI-generated materials. Additionally, students were explicitly informed that ChatGPT-generated worksheets may contain inaccuracies and were encouraged to verify all calculations and explanations. Classroom discussions were conducted to review and validate AI-generated responses before students applied them to assessments.

### **Student Perceptions of AI-Generated Materials**

To assess ChatGPT's role in enhancing student learning, a Likert-scale survey was administered at the end of the Fall 2023 semester. The survey consisted of ten questions evaluating students' perceptions of AI-generated materials in terms of content clarity, engagement, usefulness, and overall satisfaction. This survey was previously published in Author (2024), where the results were presented as a bar graph. In this study, the same data is represented in Table 4 in tabular format for clarity and direct comparison within the current analysis.

The survey was conducted in class, and 38 out of 40 students participated, resulting in a 95% response rate. Since participation was not mandatory, there is a potential response bias, as students who found the AI-generated worksheets beneficial may have been more likely to provide feedback. Future studies should explore mandatory feedback collection or randomized survey distribution to obtain a more representative sample of student experiences.

As shown in Table 4, students rated the AI-generated materials positively, with average scores of 4.4 for content clarity, 4.3 for engagement, and 4.5 for overall satisfaction on a 5-point scale. While Table 4 highlights three representative survey questions, the full survey results are available in Appendix D. These findings suggest that AI-generated worksheets enhanced student engagement and comprehension; however, future research should implement structured, randomized feedback collection to minimize potential self-selection bias in survey responses.

Table 4: Student Feedback on AI-Generated Materials (Likert Scale: 1 = Strongly Disagree, 5 = Strongly Agree)

Survey Category	Average Score
Content Clarity	4.4
Engagement	4.3
Overall Satisfaction	4.5

The positive reception indicates that AI-generated materials effectively enhance student engagement and clarity, which is particularly beneficial in mastering complex chemistry topics. However, since the survey was conducted in class, participation was voluntary, meaning that students who found the AI worksheets beneficial may have been more likely to provide feedback. Future studies should incorporate mandatory feedback collection or randomized survey distribution to reduce potential response bias and obtain a more representative understanding of student perceptions.

Additionally, some students noted the need for more tailored support in advanced topics, suggesting that further refinement of ChatGPT-generated prompts could improve effectiveness for complex problem-solving. This highlights the importance of faculty oversight in AI-generated content creation, ensuring that materials remain pedagogically sound, conceptually accurate, and aligned with course objectives.

### AI Use and Ethical Considerations

ChatGPT was used in refining this manuscript by improving structure and clarity. However, all AI-generated content was manually reviewed and edited to ensure accuracy and coherence. While AI-generated materials provided valuable instructional support, they were not assumed to be error-free and could contain inaccuracies. To address this, students were explicitly informed that ChatGPT-generated worksheets were supplementary resources, and all calculations should be verified. Classroom discussions were held to review and correct any conceptual errors before students applied the materials to assessments.

To promote responsible AI use, students were guided in recitation sessions on how to effectively use structured AI-generated prompts. These sessions helped students break down complex chemistry problems using scaffolded AI explanations while maintaining active engagement in problem-solving.

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Faculty oversight ensured that AI was used as a learning aid rather than a substitute for critical thinking.

To maintain academic integrity, all assessments, including quizzes and exams, were conducted in person, preventing students from relying on AI-generated answers. This approach ensured that students demonstrated independent knowledge while reinforcing problem-solving skills.

### **Faculty AI Use in Writing and Research Productivity**

In addition to instructional applications, AI tools like ChatGPT have the potential to support faculty research and writing processes. In this study, ChatGPT was used to refine sections of the manuscript, particularly for structuring content and enhancing clarity. However, all AI-generated text was critically reviewed, manually revised, and fact-checked to ensure accuracy and coherence. The use of AI-assisted writing tools aligns with best practices in academic writing, where researchers employ grammar checkers, reference managers, and AI-powered summarization tools to streamline the writing process while maintaining intellectual rigor and authorship integrity. Beyond instructional applications, AI can play a valuable role in faculty research productivity, particularly in idea generation, literature review synthesis, and draft refinement. For instance, ChatGPT was used to generate concise summaries of key literature sources, allowing faculty to streamline the synthesis of research on AI-assisted learning methodologies. Additionally, AI-assisted tools helped refine research questions and identify emerging themes in the field, contributing to more structured and focused academic writing.

However, AI-generated content must always be critically reviewed, revised, and properly credited to ensure accuracy and uphold academic integrity. Future research should explore ethical best practices for AI-assisted research writing, including clear attribution protocols and validation methods. Further studies should also examine AI's impact on faculty workload in academic publishing, particularly in reducing time spent on literature reviews, manuscript drafting, and editing while maintaining scholarly rigor.

### **Study Implications**

#### *Structured AI Use in Course Instruction*

Structured AI use in lecture and recitation sessions played a critical role in ensuring that students engaged thoughtfully with ChatGPT-

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generated content rather than relying on it passively. By incorporating guided AI prompts and faculty-supervised interactions, students were encouraged to develop independent problem-solving strategies. This structured approach positioned AI as a scaffolded learning tool rather than a replacement for traditional instruction.

Future research should explore best practices for integrating AI into STEM education, particularly in balancing AI-driven support with active student engagement. Additionally, further studies should examine AI's influence on long-term knowledge retention and its impact on final course grades through controlled studies. Establishing a standardized framework for AI-assisted learning materials could promote instructional consistency while maintaining academic rigor.

#### *Faculty AI Use Transparency*

Faculty using AI-generated instructional materials should disclose their use to students, much like publisher-provided resources such as test banks and slide decks are credited. Transparency ensures ethical implementation while encouraging students to critically engage with AI-generated content. This practice aligns with broader academic integrity principles and helps students understand AI's evolving role in education.

#### *AI Limitations and Accuracy Concerns*

While AI-generated materials can enhance student learning, they may produce errors or inaccuracies. Faculty and students must critically evaluate AI-generated content to ensure accuracy. Instructors in this study reviewed worksheet content in class to confirm conceptual accuracy before students applied the material to assessments. Students were also reminded to verify ChatGPT-generated calculations against verified sources such as textbooks or instructor-provided materials. To further ensure content reliability, students engaged in structured discussions where AI-generated explanations were compared with traditional instructional materials, allowing them to identify and correct potential inaccuracies collaboratively.

Future research should explore structured validation methods to minimize AI-generated errors and establish best practices for integrating AI-assisted materials into courses. This could include developing systematic review processes for AI-generated content, incorporating instructor-led verification protocols, and designing student training on effective AI evaluation strategies. Investigating how AI-generated materials impact long-

term retention and academic performance through controlled studies will also be essential for understanding their role in higher education.

### ***Student Use of AI and Academic Integrity***

A key concern is whether students use ChatGPT to generate quiz answers instead of engaging with the learning process. While students were encouraged to critically evaluate AI-generated responses, additional research is needed to assess how AI affects independent problem-solving skills. Faculty should implement strategies that promote constructive AI use while maintaining academic integrity. These strategies could include structured AI-assisted exercises, guided reflections on AI-generated content, and assessments that require students to explain their reasoning rather than simply providing an AI-generated answer.

### **Instructor Efficiency and Administrative Benefits**

ChatGPT significantly improved instructor efficiency by reducing the time needed for both course preparation and routine administrative tasks. Generating multiple versions of Quests manually took approximately 40 minutes per version, while ChatGPT reduced this time to around 30 minutes, resulting in a 25% time savings. The Specs Grading system benefited from this efficiency gain, allowing students to retake assessments with unique versions and support mastery learning.

This efficiency is particularly evident in assessment preparation, where AI-assisted workflows significantly reduced the time required to generate multiple versions of Quests. As shown in Table 5, AI reduced quiz development time by an average of 28 minutes across assessments, allowing instructors to allocate more time to student-centered activities.

Table 5: Time Savings in Assessment Preparation with ChatGPT Assistance

Task	Manual Creation Time	AI-Assisted Time	Time Saved
Stoichiometry Quiz	45 minutes	30 minutes	15 minutes
Limiting Reactant Quiz	43 minutes	30 minutes	13 minutes
Total Across Assessments	88 minutes	60 minutes	28 minutes

In addition to supporting instruction, ChatGPT significantly improved efficiency in routine administrative tasks, such as drafting recommendation letters, summarizing meeting notes, and organizing student performance data. Before using ChatGPT, drafting a recommendation letter took approximately 30 minutes; with ChatGPT, the time was reduced to about 10 minutes, saving 20 minutes per letter. As summarized in Table 6, faculty reported an overall 60% reduction in time spent on these administrative tasks, highlighting AI's role in improving workflow efficiency.

Table 6: Time Savings Achieved Through AI-Assisted Administrative Tasks

Task	Pre-AI Time	AI-Assisted Time	Time Saved per Task
Drafting Recommendation Letter	30 minutes	10 minutes	20 minutes
Summarizing Meeting Notes	45 minutes	15 minutes	30 minutes
Organizing Student Data	25 minutes	10 minutes	15 minutes
Total Savings Across Tasks	-	-	65 minutes

The 60% reduction in time for these administrative tasks has allowed faculty to invest more time in direct student engagement and course development, aligning with studies that show AI's effectiveness in improving operational efficiency (West, 2018; Guan, Mou, & Jiang, 2020). Although ChatGPT streamlines administrative tasks, it is essential to review AI-generated documents to maintain professionalism and relevance. Faculty should check all outputs for accuracy and coherence before finalizing. These findings suggest that ChatGPT is a valuable tool for regional campus faculty, supporting both instructional and administrative efficiency. By automating repetitive tasks, ChatGPT enables instructors to focus on higher-impact activities, such as interactive teaching and personalized feedback, which are essential for enhancing student learning outcomes.

### Limitations

While ChatGPT offers advantages in instructional efficiency and administrative support, its application has limitations. AI-generated content requires continuous validation, as probabilistic models may introduce miscalculations or conceptual errors. Students were explicitly informed to

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use AI-generated worksheets as supplementary resources and to verify all calculations against textbooks or instructor-provided materials. Instructors also conducted in-class discussions to identify and correct any AI-generated inaccuracies before assessments.

Faculty using AI-generated instructional materials disclosed this use to students, ensuring transparency similar to publisher-provided resources (e.g., test banks, slide decks). This helped students critically evaluate AI-generated content rather than relying on it uncritically. Additionally, AI-generated responses were not permitted for graded assignments, and quizzes required students to show problem-solving steps to uphold academic integrity.

This study was conducted in a General Chemistry I course, and findings may not fully generalize to other disciplines where AI-generated scaffolding may function differently. While all students had the same chemistry and math prerequisites, variations in prior exposure, independent study habits, and access to external academic resources may have influenced their performance. Future research with controlled experimental conditions and randomized student groups could provide a clearer understanding of AI's direct impact on learning outcomes.

Although quiz score improvements were statistically significant ( $p < 0.001$ ), it remains unclear whether these gains translate to broader academic success, such as final exam performance or course grades. Since quizzes primarily assess conceptual understanding, future studies should explore AI's impact on cumulative assessments and long-term retention. Survey responses were collected voluntarily, with 95 percent of students (38 out of 40) participating. While this provides useful insights, response bias may exist, as students who found the AI worksheets beneficial may have been more likely to provide feedback. Future studies should consider mandatory feedback collection or randomized survey distribution to ensure a more representative assessment of student perspectives.

While ChatGPT-generated materials supported structured learning, faculty emphasized the importance of critical evaluation to prevent over-reliance on AI-generated responses. As AI continues to evolve, further research should explore structured validation methods to minimize AI-generated errors and improve instructional reliability.

In summary, ChatGPT enhances instructional quality and faculty efficiency by providing structured, scaffolded resources and automating routine tasks. However, careful faculty oversight, academic integrity

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policies, and structured implementation are essential to ensure accuracy and pedagogical effectiveness.

### **Conclusion**

Integrating ChatGPT into teaching and administrative tasks has demonstrated benefits for both faculty efficiency and student learning outcomes on a regional campus. AI-generated scaffolded worksheets, personalized study guides, and multi-version assessments have enhanced student comprehension of complex chemistry topics, increased engagement, and supported mastery-oriented learning through the Specifications Grading framework. Research has shown that scaffolded learning fosters incremental mastery, and AI's ability to generate structured learning materials aligns with this pedagogical approach. The findings indicate that these resources contribute to improved student performance, as reflected in increased quiz scores and positive student feedback on content clarity and overall satisfaction.

Beyond instructional benefits, ChatGPT has streamlined routine administrative tasks such as drafting recommendation letters and summarizing meeting notes, saving faculty significant time. The study results show that up to 65 minutes per day can be redirected toward direct student engagement and course development, ultimately enhancing instructional quality. The automated creation of multi-version assessments also provides students with additional practice opportunities, reinforcing understanding without content duplication—a feature particularly valuable in mastery-based grading systems.

Despite these advantages, AI-generated content requires careful oversight to ensure accuracy, pedagogical soundness, and instructional relevance. Faculty must critically evaluate AI-generated outputs to maintain the integrity of educational materials and administrative documents. This study implemented structured discussions where students compared AI-generated explanations with traditional materials, encouraging them to identify inaccuracies and refine their understanding. Such strategies ensure that AI is used as a supportive tool rather than a substitute for active learning.

The findings suggest that AI tools like ChatGPT can play a transformative role in education, particularly in regional campus settings where faculty often balance high teaching loads with administrative responsibilities. AI-driven solutions support the broader goals of accessible,

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high-quality education by providing scalable, efficient, and personalized learning resources. Future research should explore structured validation protocols to minimize AI-generated errors, examine AI's impact on student retention and long-term knowledge retention, and investigate best practices for faculty training in AI-assisted teaching. Establishing clear guidelines for responsible AI integration will be essential to maximizing its benefits while maintaining academic rigor.

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## Appendix A: AI-Generated Resources for Chemistry Instruction

The following tables summarize the types of instructional and assessment materials generated using ChatGPT to support General Chemistry students. These resources were designed to align with specific Student Learning Objectives (SLOs) and to facilitate mastery-focused learning through scaffolded worksheets, personalized study guides, real-world applications, and multi-version assessments for Specs Grading. Each table provides sample prompts, example questions, and descriptions of how these materials are structured to cater to diverse learning needs. By using AI, faculty can efficiently create adaptive learning materials that support both foundational understanding and complex problem-solving skills.

**Table 7: Summary of AI-Generated Resources and Examples in Chemistry Instruction**

Resource Type	Purpose	Sample Prompt/Description	Example Use Case
Scaffolded Worksheets	Support incremental mastery of complex concepts through structured steps	"Create a scaffolded worksheet on stoichiometry, starting with basic mole calculations and progressing to limiting reactants."	Topic: Stoichiometry Steps: 1) Mole Concept Basics – Calculate moles of NaCl for 5g 2) Stoichiometric Ratios – Identify limiting reactant 3) Applied Problems – Calculate yield based on limiting reactant
Study Guides	Reinforce key concepts and provide targeted practice for self-study	"Develop a study guide for acid-base reactions with key concepts and practice problems."	Topic: Acid-Base Reactions Content: Overview, key concepts, sample problems with solutions
Real-Life Chemistry Examples	Connect theory to real-world applications, enhancing engagement	"Provide examples of oxidation-reduction reactions in everyday life, with explanations."	Examples: Rusting, combustion, photosynthesis, with explanations of each reaction
Customized Worksheets	Adapt materials to different levels	"Generate a worksheet that adjusts stoichiometry	Customization: Vary question complexity based on student proficiency

	of prior knowledge	questions for various student skill levels."	
Multi-Version Quests for Specs Grading	Facilitate mastery-focused retakes by offering varied versions of assessments	"Create three versions of a quest question on molar mass calculation, each with different compounds and masses."	Quest Versions: 1) Yield of H <sub>2</sub> from Zn + HCl 2) O <sub>2</sub> yield from KClO <sub>3</sub> 3) CO <sub>2</sub> yield from C + O <sub>2</sub>
Practice Problems	Provide targeted problem-solving practice with step-by-step solutions	"Create five practice problems on acid-base titration with step-by-step solutions."	Example Problems: Titration calculations, identifying endpoints, acid-base balance

### Appendix B: Sample Response for Scaffolded Worksheet on Stoichiometry

This scaffolded worksheet progresses from simple to complex concepts, reinforcing each step with examples and practice. This approach allows students to build a solid foundation in stoichiometry, setting them up for success in more advanced topics.

#### Prompt:

"Create a scaffolded worksheet on stoichiometry, beginning with basic mole calculations and progressing to limiting reactants."

#### ChatGPT-Generated Worksheet

**Topic:** Stoichiometry – From Moles to Limiting Reactants

**Objective:** This worksheet guides students through the fundamental steps of stoichiometry, starting with mole calculations and advancing to limiting reactants. Each section includes examples and practice problems to reinforce understanding.

#### Step 1: Mole Calculations

- Introduction:** Understanding moles is crucial in chemistry as it allows us to relate masses of substances to the number of atoms or molecules.
- Example Question:** Calculate the number of moles in 10 grams of NaCl.

**Solution:** Molar mass of NaCl =  $58.44 \frac{g}{mol}$

Moles of NaCl =  $10 g NaCl \times \frac{1 mol of NaCl}{58.44 g NaCl} = 0.171 mol NaCl$

- Practice Problem:** Calculate the number of moles in 25 grams of H<sub>2</sub>O.

#### Step 2: Stoichiometric Ratios

1. **Introduction:** In a chemical reaction, substances react in specific ratios. Stoichiometry helps us calculate how much of each substance is needed or produced.
2. **Example Question:** In the reaction  $2 H_2 + O_2 \rightarrow 2 H_2O$ , how many moles of  $O_2$  are required to react completely with 4 moles of  $H_2$   
**Solution:** According to the balanced equation, 2 mol of  $H_2$  reacts with 1 mol of  $O_2$

$$\text{Moles of } O_2 = 4 \text{ mol } H_2 \times \frac{1 \text{ mol of } O_2}{2 \text{ mol of } H_2} = 2 \text{ mol of } O_2$$

3. **Practice Problem:** In the reaction  $3 H_2 + N_2 \rightarrow 2 NH_3$  how many moles of  $NH_3$  are produced when 6 moles of  $H_2$  react?

### Step 3: Limiting Reactants

1. **Introduction:** When reactants are not in perfect stoichiometric ratios, one will run out first and limit the reaction. This is called the limiting reactant.
2. **Example Question:** In the reaction  $2 H_2 + O_2 \rightarrow 2 H_2O$ , if you have 3 moles of  $H_2$  and 2 moles of  $O_2$ , which is the limiting reactant?  
**Solution:** According to the equation, 2 moles of  $H_2$  requires 1 mole of  $O_2$   
$$\text{Moles of } O_2 = 3 \text{ mol } H_2 \times \frac{1 \text{ mol of } O_2}{2 \text{ mol of } H_2} = 1.5 \text{ mol of } O_2$$
Since you have 2 moles of  $O_2$ ,  $H_2$  is the limiting reactant.
3. **Practice Problem:** For the reaction  $2 Al + 3 Cl_2 \rightarrow 2 AlCl_3$ , if you have 5 moles of Al and 5 moles of  $Cl_2$ , which reactant is limiting?

## Appendix C: Real-Life Chemistry Examples

To make complex chemistry concepts more relatable and engaging, ChatGPT was used to generate real-life applications of chemistry principles. These examples help students see the relevance of their studies beyond the classroom, enhancing their understanding and interest in the subject.

### Sample Prompts for Real-Life Chemistry Examples

- Oxidation-Reduction Reactions: "Provide examples of oxidation-reduction reactions in everyday life, with explanations of how and where they occur."
- Acid-Base Reactions: "Generate real-life scenarios where acid-base reactions are essential, such as in cleaning products or food chemistry."

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- Combustion and Energy: "Explain the chemistry behind combustion in engines and how it converts fuel into energy."

### Example Responses from ChatGPT

1. Oxidation-Reduction in Batteries: "Batteries rely on oxidation-reduction reactions to generate electricity. In a zinc-carbon battery, zinc undergoes oxidation while manganese dioxide is reduced, creating a flow of electrons that powers electronic devices."
2. Acid-Base in Cleaning Products: "Many cleaning agents contain bases, like sodium hydroxide, which reacts with oils and greases to form water-soluble substances, making cleaning more effective. Vinegar (acetic acid) is an acid commonly used to dissolve mineral deposits due to its acidic properties."
3. Combustion in Automobiles: "In car engines, gasoline combustion produces energy. The carbon and hydrogen in gasoline react with oxygen, releasing energy in the form of heat and producing carbon dioxide and water as by-products."

### Appendix D: Full List of Likert Survey Questions

*The following survey questions were previously published in Author (2024) and are provided here for reference. The average scores reflect student responses on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).*

1. Clarity of content (M = 4.4)
2. Usefulness in learning (M = 4.3)
3. Preparedness for assignments (M = 4.2)
4. Engagement level (M = 4.3)
5. Ease of application (M = 4.1)
6. Interaction with peers (M = 3.9)
7. Independence in learning (M = 4.0)
8. Preparedness for assessments (M = 4.2)
9. Preference for scaffolded worksheets (M = 4.5)
10. Overall experience (M = 4.5)