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Implications of AI-assisted Assignments for Cognitive Engagement and Emerging Ethical Themes in Humanities, Design, and STEM: A Pilot Study Utilizing Bloom's Taxonomy

ABSTRACT

This exploratory mixed-method pilot study investigated students' experiences with artificial intelligence (AI)-guided assignments across selected humanities, design, and STEM courses in higher education during the academic term beginning in August/September 2024. Using a custom survey tool grounded in Bloom's taxonomy, the study assessed AI's perceived effectiveness in enhancing cognitive engagement and explored students' ethical awareness through open-ended reflections. A literature review, interdisciplinary collaboration, and iterative refinement using Copilot prompting informed survey questions in order to ensure cross-disciplinary applicability. Quantitative data came from Likert scale responses, while the researchers drew qualitative insights from coded action verbs and thematic analysis of open-ended responses. Preliminary findings indicated generally positive perception of AI, with mean scores above three across all six cognitive levels. The results underscore AI's potential to support critical thinking as a layered cognitive process, rather than a discrete skill. Students often reported having engaged productively and skeptically with AI rather than over relying on it. Reflections highlighted concerns about query refinement, content verification, and responsible use, suggesting a meaningful link between ethical AI engagement and critical thinking development. Due to the small sample size and reliance on self-reported data from students, findings are not broadly generalizable. Future research should incorporate longitudinal and triangulated methods to better capture evolving student behaviors and align perceptions with actual AI use.

KEYWORDS

AI-assisted learning, Bloom's Taxonomy, critical thinking, higher education, AI ethics

INTRODUCTION

Higher education classrooms have increasingly utilized artificial intelligence (AI), impacting teaching and learning (Crompton and Burke 2023). Since 2022, the public release of generative AI tools like ChatGPT, Microsoft Copilot, Google Bard, DALL-E, Adobe Firefly, RTutor, and so on sparked a proliferation of studies on AI. While much of this work focused on the AI's potential to enhance student learning across disciplines, fewer studies examined how students perceive its role in shaping their thinking processes, particularly in cognitive engagement and in ethical decision-making. As AI became more accessible, research into its uses in higher education rose as well (Crompton et al. 2023).

Researchers widely recognize critical thinking as an educational goal, and yet, defining it presents numerous challenges, because it is a multidimensional process involving analysis, evaluation, and reflection (Spector and Ma 2019). In an extensive 2011 research report for Pearson, Lai concluded that "although a concrete definition of critical thinking on which most researchers can agree remains elusive, common areas of overlap exist among the various approaches," which include "analyzing arguments, making inferences by using inductive or deductive reasoning, judging or evaluating, and making decisions or solving problems" (41–42).

Because all disciplines value students' critical thinking, research has consistently explored how educators might develop these skills in their students (EL YAZIDI 2023). The meta-analysis by Abrami, Bernard, Borokhovski, Waddington, Wade, and Persson (2015) found that while critical thinking is a complex skill, course instructors can effectively nurture it across disciplines and educational levels through approaches such as discussions, problem-solving, and mentoring. Given the centrality of critical thinking in learning and the rapid integration of AI tools in higher education, we need to examine more closely whether these emerging technologies can truly enhance students' critical thinking skills. Rather than attempting or adopting a universal definition of critical thinking, using established frameworks (such as Bloom's taxonomy) may prove a manageable way to understand its relationship with AI.

Aviles (2000) noted that while such frameworks do not define critical thinking tout court, they could help us understand how it occurs: "Bloom's taxonomy does not explicitly define critical thinking. Rather, it includes six knowledge levels that constitute the construct of critical thinking" (4). According to Lubbe, Marais, and Kruger (2025), generative AI supports the higher-order levels of Bloom's taxonomy, as it was revised by Anderson and Krathwohl (2001), particularly creation and evaluation. However, they emphasized the need for further research in order to understand how critical thinking could be effectively scaffolded within these cognitive domains.

While numerous and valid concerns about the use of AI abound (and we will address these more fully in the results section), Rasul et al. (2023) saw potential in leveraging AI platforms in the context of student learning: "By engaging students in conversation and encouraging them to participate in the learning process, ChatGPT can scaffold their prior knowledge and experiences to help them construct new knowledge" (43). De Matas (2023) even perceived AI's drawbacks (e.g., biases, hallucinations, and so on) as "metacognitive moments for students to go beyond simply generating responses and into the realm of critical inquiry" (2), so long as faculty actively encourage students to reflect on their interactions with AI and to analyze what it produces (see also Duenas and Ruiz 2024; and Rasul et al. 2023). By explicitly including AI as a learning tool, scaffolding its use, and clarifying boundaries for its use (e.g., Duenas et al. 2024), course instructors can leverage AI as a tool to hone students' critical thinking capabilities.

While these and other studies examining the relationship between AI and critical thinking pointed to some promising outcomes, their scope remained somewhat narrow, often focusing on one specific discipline or type of assignment. Our team successfully developed and tested the tool in this pilot study in a variety of disciplines, with AI-guided assignments ranging from text to text-images, image-making, data analysis, and image-data analysis.

RESEARCH METHOD

We conducted this pilot study, sponsored by an institutional challenge grant, in the academic term beginning in August/September 2024. The research team consisted of faculty from English, art history, graphic design, interior design, math, civil engineering, and computer science. Class sizes varied according to the teaching assignments of the course instructors and co-investigators—Leda Cempellin, Nathan Serfling, Marisa Ten Brink, Matthew Biesecker, Sahand Abbasi, Kwanghee Won, and Mostafa Tazarv—encompassing a wide range of instructional contexts. These included larger lower-division courses such as History of World Art (ARTH 211) and Math Seminar (MATH 230); smaller graduate-level seminars such as Seminar in Teaching Composition (ENGL 605); mid-sized courses like Composition I (ENGL 101); and upper-division courses including Graphic Design (GDES 402, GDES 415), Interior Design (ID 351, ID 451), Engineering (CCE 443), and Computational Studies (CSC 445). Data collection adhered to human subject protocols and followed Peter Felten's *Principles of Good Practice in SoTL* (2013). In alignment with Felten's (2013) emphasis on the "different environments of faculty work" (123), we adopted a mixed-methods approach that accounted for variations in class sizes and instructional contexts. This design, incorporating both quantitative and qualitative components, enabled us to extract meaningful data across diverse teaching environments.

The study applied Bloom's taxonomy in the model revised by Anderson et al. (2001) to gain insights into students' experience working with AI in assignments designed by faculty specifically for each class. The team aimed to explore ways to integrate emerging AI technologies into class assignments across various humanities, design, and STEM disciplines involving text, images, and numbers, and then measure students' perceptions of how AI affected their critical thinking.

Bloom's action verbs data collection

Lists of action verbs as descriptors of the six cognitive domains of Bloom's taxonomy are widely available online, typically compiled by university teaching and learning centers, though they often vary slightly across institutions. Claudia Stanny (2016) analyzed action verbs from 30 such lists—all based on the cognitive processes appearing in the Bloom's taxonomy revised by Anderson et al. (2001)—and discovered that researchers and institutions inconsistently categorized some verbs across different cognitive levels. Building on this work, Das, Das Mandal, and Basu (2022) applied a classification algorithm to reclassify each of the verbs as unambiguous, ambiguous, and/or transitional. From Das et al.'s (2022) categories, our team selected a subset of the action verbs with the highest frequency, narrowing them down to six action verbs for each of Bloom's six cognitive levels. We then inserted each of the action verbs into a sentence describing a cognitive operation involved in assignments. Through discussions involving all team members and assistance from AI (Copilot), we progressively reworded and recalibrated these sentences to be as broadly multidisciplinary as possible, while remaining specific to their own cognitive domain. Table 1 shows the survey instrument that the team developed.

Table 1. Survey instrument with selected action verbs from Bloom's taxonomy[1]

Bloom Level 1 - Remember	**Question 9 (Q9):** Bloom Level 1 - Remember						
	The use of AI in my assignment has enhanced my ability to **list** key concepts or elements related to the topic.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N/A or don't know
	† improved my ability to **recall** specific details or information relevant to the subject matter.						
	† helped me **state** facts or principles clearly and accurately.						
	† made it easier for me to **identify** important features or components within the material.						
	† assisted me in **selecting** the most relevant information or examples for my work.						
	† enhanced my ability to **relate** different concepts or ideas to each other.						
	Question 10 (Q10): Select 2 verbs among the 6 in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb: **list / recall / state / identify / select / relate**						
Bloom Level 2 - Understand	**Question 11 (Q11): Bloom** Level 2 - Understand						
	The use of AI in my assignment has enhanced my ability to **explain** concepts or processes clearly.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N/A or don't know
	† improved my ability to **paraphrase** information accurately (e.g., restate in different words or in layman's terms).						
	† helped me **discuss** topics more effectively.						
	† made it easier for me to **interpret** data or information.						
	† assisted me in **classifying** information or concepts accurately.						
	† enhanced my ability to **compare** different ideas or concepts.						

	Question 12 (Q12): Select 2 verbs among the 6 in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb: **explain / paraphrase / discuss / interpret / classify / compare**						
Bloom Level 3 - Apply	**Question 13 (Q13):** Bloom Level 3 - Apply						
	The use of AI in my assignment has enhanced my ability to **use** tools or resources effectively.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N/A or don't know
	† improved my ability to **apply** knowledge to specific situations or scenarios.						
	† helped me **demonstrate** skills or knowledge effectively.						
	† made it easier for me to **discover** information or insights.						
	† assisted me in **choosing** the best options or solutions.						
	† enhanced my ability to **relate** different concepts or ideas to each other.						
	Question 14 (Q14): Select 2 verbs among the 6 in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb: **use / apply / demonstrate / discover / choose / relate**						
Bloom Level 4 - Analyze	**Question 15 (Q15):** Bloom Level 4 - Analyze						
	The use of AI in my assignment has enhanced my ability to **analyze** complex information, visualizations, code, or data.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N/A or don't know
	† improved my ability to **differentiate** between similar concepts or items.						
	† helped me **appraise** the value or quality of content or images or solutions.						
	† made it easier for me to **criticize** or provide constructive feedback on work.						
	† assisted me in **distinguishing** between relevant and irrelevant information.						

	† enhanced my ability to **compare** different ideas, concepts, images, or content at a deeper level.						
	Question 16 (Q16): Select 2 verbs among the 6 in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb: **analyze / differentiate / appraise / criticize / distinguish / compare**						
Bloom Level 5 - Evaluate	**Question 17 (Q17):** Bloom Level 5 - Evaluate						
	The use of AI in my assignment has enhanced my ability to **judge** the effectiveness or quality of work or information.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N/A or don't know
	† improved my ability to **rearrange** elements or ideas to create a new structure.						
	† helped me **appraise** the value or significance of different elements (such as arguments, or designs, or theorems).						
	† made it easier for me to **defend** my ideas or solutions with evidence.						
	† assisted me in **estimating** values or outcomes accurately.						
	† enhanced my ability to **compare** different ideas or concepts or processes of great complexity.						
	Question 18 (Q18): Select 2 verbs among the 6 in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb: **judge / rearrange / appraise / defend / estimate / compare**						
Bloom Level 6 - Create	**Question 19 (Q19):** Bloom Level 6 - Create						
	The use of AI in my assignment has enhanced my ability to **design** effective solutions or projects or complex assignments).	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	N/A or don't know
	† improved my ability to **arrange** elements or ideas in a coherent manner.						
	† helped me **organize** information or resources or images effectively.						

	† made it easier for me to **construct** detailed and accurate assignments or outputs.						
	† assisted me in **producing** high-quality work.						
	† enhanced my ability to **prepare** comprehensive and well-organized assignments or projects.						
	Question 20 (Q20): Select 2 verbs among the 6 in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb: **design / arrange / organize / construct / produce / prepare**						

† denotes removed text for brevity: "The use of AI in my assignment has . . ."

The survey asked students to rate selected action verbs on a Likert scale from one (strongly disagree) to five (strongly agree), or to mark N/A (not applicable) if they believed that a specific action verb did not apply to that assignment. A follow-up question at the end of each level asked students to select two out of the six action verbs that best represented the cognitive operations that they employed during the AI-assisted assignment and to provide an example. Finally, the open-ended question, "What are your overall perceptions on this AI-assisted assignment?", aimed to capture a holistic view of the students' experiences with AI, complementing the more targeted insights gathered from the previous questions. For each class included in this study, a team member teaching that course designed an AI-assisted assignment, implemented it with the students enrolled in the study, and invited them to complete this survey. While the instrument remained consistent across all courses, the AI-assisted assignments were discipline-specific and therefore differed substantially from one another.

Course assignments

The following is a concise description of all the courses that were included in this study, except for Composition I (ENGL 101), which had only one participant, and we therefore removed it from the study.

Group 1: Humanities

In the graduate course Seminar in Teaching English Composition (ENGL 605), the course instructor asked participants to use Copilot to generate lesson plans for the first-year writing courses they were teaching, compare this process to their typical lesson development, and to reflect on the results.

In the lower-division undergraduate course History of World Art I (ARTH 211), the course instructor asked participants to use Copilot to brainstorm a thematic paper, followed by an extensive reflection. The thematic paper required students to choose an artwork they liked from the course's chronology and then prompt Copilot to find another three that had a human condition as the thematic connection, perform visual and contextual analysis of all the pieces, compare and contrast them, and find a couple of peer-reviewed sources to reinforce the thematic connection. The course instructor developed a prompting line and provided it to students, requesting them to make significant interventions during their chat with Copilot and to reflect on the results.

In the upper-division undergraduate course History of Graphic Design (ARTH 312), with assistance from Copilot, students examined the context of the US in the early 20th century, produced posters inspired by Futurism, named the new futurism-inspired movement; then, they reflected on their experience. This was the only fully online class in this study.

Group 2: Design

In the upper-division undergraduate courses Interior Design Studio III and V (ID 351 and ID 451 respectively), participants chose a generative AI tool and asked it to help them generate concept statements, goals, objectives, mood boards, and concept boards related to the specific class level. Students documented and compared AI-generated work with their own original work.

In the graphic design upper-division undergraduate course Publication Design (GDES 415), participants designed a book cover and interior. The course instructor encouraged them to use AI in order to understand the themes of their book, brainstorm ideas for the cover, and generate images/assets for use in their design.

In the graphic design upper-division undergraduate course Portfolio Design (GDES 402), the course instructor encouraged participants to use AI to develop their personal brand, which included creating a logo, brand system, résumé, biography, and cover letter.

Group 3: STEM

In the lower-division undergraduate course Math Seminar (MATH 230), the course instructor gave students two datasets of football players from the years 1971 and 2019. They then explained the differences between populations in terms of height, weight, role, college attended, and so on. Students could use AI technologies of their choice to assist them in the analysis of these populations and in developing research questions.

In the civil engineering upper-division course Matrix Analysis of Structures (CEE 443-543), participants asked an AI image generator to create four images of a bridge with truss elements. Subsequently, they made a 2D structural model of the bridge, analyzed it for a given truck loading, and practiced different structural design methods.

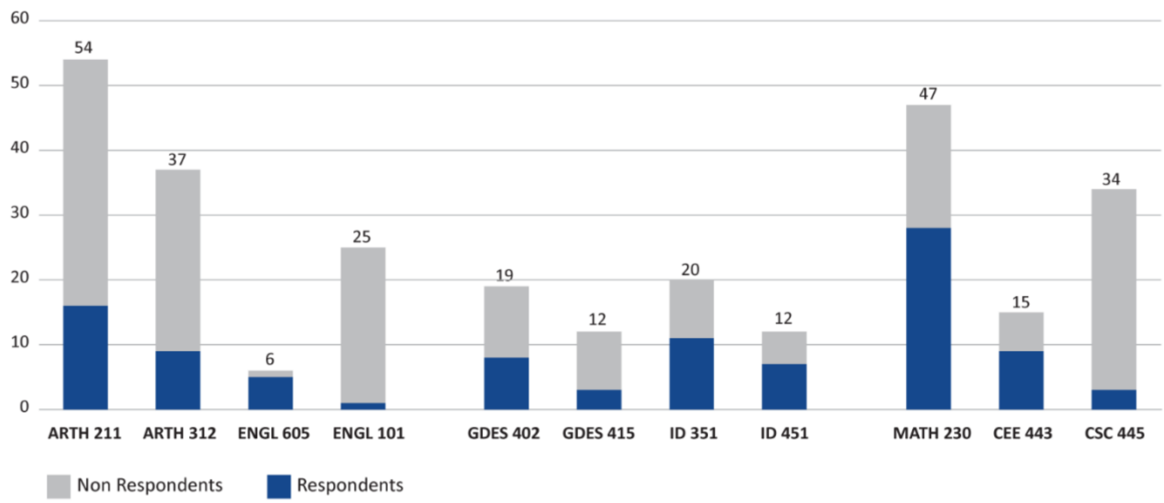
In the computer science upper-division course Introduction to Theory of Computation (CSC 445), participants first listed the closure properties of regular languages and context-free languages. Additionally, they compared two types of finite automata, Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA), focusing on their computational capabilities. Next, students analyzed the computation and acceptance result of a given string based on the state transition graph of a machine provided as a form of an image. Finally, students designed a machine capable of recognizing a given finite language. While students could choose any AI tools, the majority chose ChatGPT, crafting their own prompts for the tasks.

DATA ANALYSIS

Student class population and participation rate

This pilot study consisted of 11 courses, representing the combined teaching load assigned to our team members for the academic term that began in August/September 2024. We removed the undergraduate English course Composition I (ENGL 101) from this study, since it only had one respondent. We retained other courses with three or more respondents, since the quantitative data had been successfully tested for reliability.

Figure 1. Class size and respondents in all the courses originally included in this study



The classes included in the study ranged from undergraduate lower-division to upper-division to graduate level. Some courses, such as those in graphic design and interior design, were composed entirely of majors, while others, like art history, consisted solely of nonmajors (general education or supportive coursework for a major); some others, like the sophomore math seminar, included two or more affiliated majors; one English class was a graduate course. Figure 1 indicates a generally low student response rate. The graduate English teaching composition class had the highest response rate, which suggests higher motivation by graduate students and future teachers to discover more about pedagogical uses of AI. Courses in art history (ARTH 211 and ARTH 312), Composition I (ENGL 101), Publication Design (GDES 415), and computer science (CSC 445) had low response rates between 4 and 30%. Participation was more significant in courses such as math (MATH 230), civil engineering (CEE 443), Portfolio Design (GDES 402), interior design (ID 351 and ID 451), and the graduate English course (ENGL 605), ranging between 40 and 83%. There were no observable direct correlations between class levels nor major versus non major, nor face-to-face versus online classes. Most of the respondents had already used AI in some capacity prior to this study.

The remaining 10 classes were divided into three groups:

- **Group 1: humanities,** composed of two undergraduate art history classes at lower and upper division levels and a graduate English class.
- **Group 2: design,** composed of two graphic design and two interior design classes, all at upper division level.
- **Group 3: STEM,** composed of one large undergraduate lower division math class, a civil engineering upper division-graduate class, and an upper-division computer science class.

RESULTS AND DISCUSSION

Across all courses in this pilot study, the number of students who responded to each survey question varied, ranging from 92 to 99 respondents per question. Each respondent rated the six action verbs listed in each of the six levels of Bloom's taxonomy (Q9-knowledge, Q11-comprehension, Q13-application, Q15-analysis, Q17-evaluation, and Q19-creation).

The students responded on a Likert scale 1–5, ranging from one (strongly disagree) to five (strongly agree), with an option for N/A or don't know (Table 1). While reviewing the student responses, we dropped the small number of N/A responses from the analysis because they were not assigned a numerical value within the Likert scale. These responses functioned as an opt-out option for students who felt that a particular action verb did not apply to their assignment, thereby avoiding the need to provide an inaccurate rating that could skew results.

All the action verbs selected for this study received responses with a mean value greater than three, both in the case of the total population and when grouping students by discipline, suggesting that students generally agreed that AI enhanced their ability to perform these operations.

When examining the combined mean scores for all classes, we observed a range between 3.40 and 4.21:

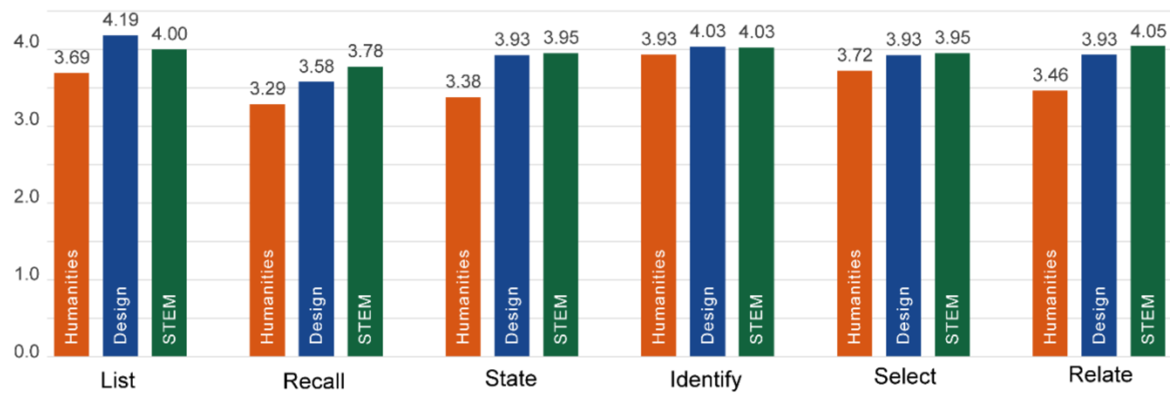
- Between 3.57 to 4 in Level 1 (knowledge)
- Between 3.69 and 4.04 in Level 2 (comprehension)
- Between 3.63 and 4.21 in Level 3 (application)
- Between 3.43 and 3.88 in Level 4 (analysis)
- Between 3.40 and 3.81 in Level 5 (evaluation)
- Between 3.53 and 3.75 in Level 6 (creation)

This distribution suggests a moderately stronger positive response at the lower levels of Bloom's taxonomy (knowledge, comprehension, and application) compared to the higher levels of analysis, evaluation, and creation. This means that students tended to agree more that using AI enhanced their ability to perform foundational tasks than those requiring deeper cognitive engagement. Approximately 36.73% of students across disciplines described engaging with AI as a productive partnership, using it to support learning rather than replace cognitive effort. This aligns with the lower-order skills, where AI tools can effectively scaffold comprehension and application. However, 14.29% of students showed signs of overreliance, suggesting that some may have used AI to bypass more demanding intellectual work. This raises concerns about the potential erosion of higher-order thinking skills, such as ethical reasoning, contextual analysis, and nuanced interpretation, through uncritical AI use. Meanwhile, skepticism remained relatively consistent across disciplines (34.69%), indicating that a substantial portion of students were still cautious about AI's role in learning. The unclear category (14.29%) reflected ambivalence, underscoring the need for further pedagogical investigation and clearer guidance on how to integrate AI in ways that preserve and enhance critical thinking.

We evaluated the differences between groups with the Kruskal-Wallis test. While in most cases, the differences were not statistically significant, a few interesting variances emerged. On Q9 - "State" ($p=0.018$), Q13 - "Choose" ($p=0.028$), and Q19 - "Produce" ($p=0.041$), the means for the STEM and design groups were similar, and the humanities had significantly lower mean response. On the other hand, four cases where the STEM response was significantly higher than the other two groups were Q11- "Interpret" ($p=0.018$), Q13 - "Use" ($p=0.047$), Q15 - "Analyze" ($p=0.012$), and Q19 - "Estimate" ($p=0.028$). The latter two results may be attributed to prevalence of those terms in STEM disciplines.

The following section (Figures 2–7) illustrates the Likert scale results from the quantitative data extracted from Q9-11-13-15-17-19 of Table 1. The discussions following the figures are extracted from Q10-12-14-16-18-20, respectively. They examine the most prevalent action verbs across disciplines, using selected examples from students' responses to the open-ended question that followed each Likert scale item at Bloom's six levels. These examples help reveal the disciplinary contexts in which students engaged in various cognitive operations. In this question, which was the same for all six levels and all classes, we instructed students to "select two verbs among the six in this list, indicating operations you have done more frequently with this assignment and explain how by providing at least one example for each chosen verb" (see Table 1).

Figure 2. Analysis of action words for Bloom's Level 1–Remember, selected by larger discipline areas (humanities, design, STEM)



The analysis of the six selected words for Bloom's Level 1 (Remember—Q10) revealed that across disciplines, students consistently used AI to "list" and "identify" foundational elements—whether artworks, design variations, or computational properties. Students frequently noted "List" in design and STEM fields, while "identify" showed a more balanced distribution across disciplines.

For instance, an art history student used AI to help them "create a list of alternative art works related to one similar," as the beginning step toward their thematic assignment (ARTH 211). A graphic design student wrote that:

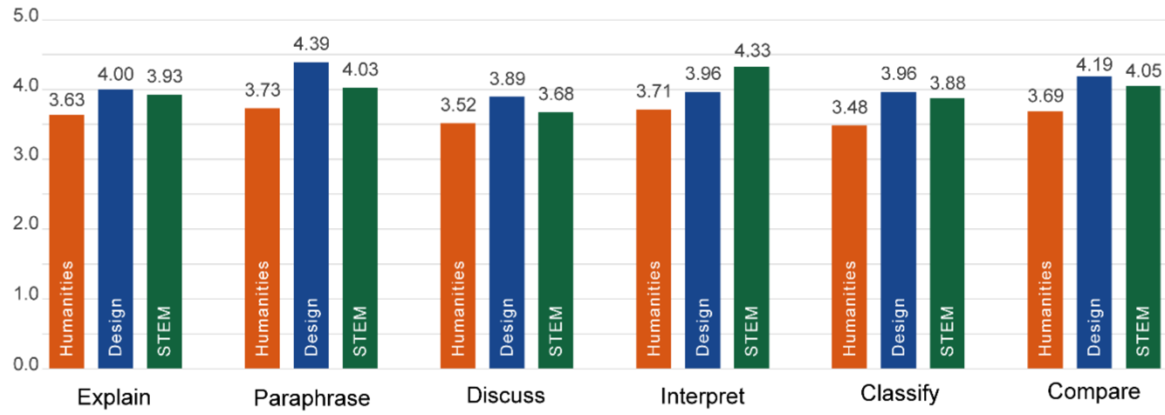
> I was able to make a list or rather a gallery of generated images that would later allow me to brainstorm a variety of different ideas that would've taken me forever to do individually, such as generating different cursive styles to imagery. (GDES 402)

A student of MATH 230 stated that:

> In many cases, I've been tasked with identifying specific pieces of information based on the context. For example, when asked to provide information about a specific topic, 1identify [sic] the key elements in the question to provide a relevant response.

These patterns suggest that students use AI to retrieve and organize foundational elements—whether terms, images, or data—as a cognitive starting point for deeper engagement, where students begin to see patterns and correlations that prepare them for higher-order thinking.

Figure 3. Analysis of action words for Bloom's Level 2–Understand, selected by larger discipline areas (humanities, design, STEM)



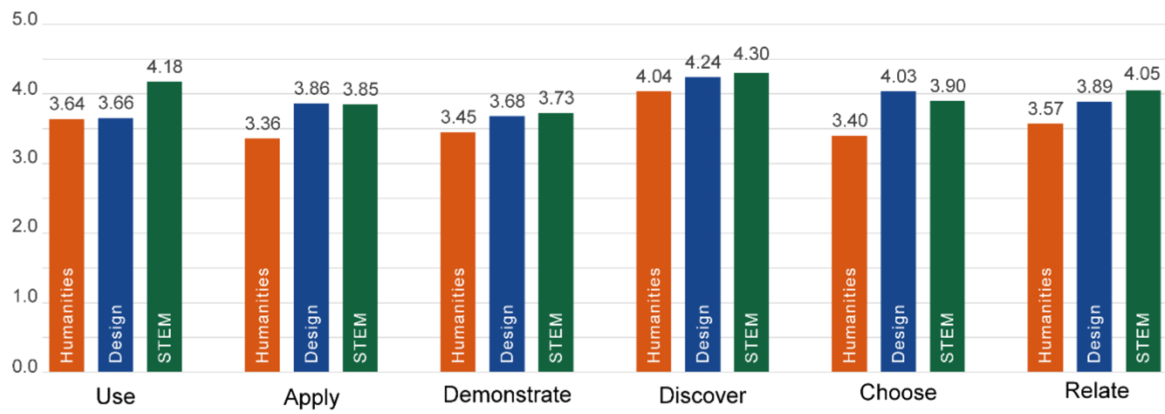
The Q12 analysis of the action verbs chosen for Bloom's Level 2 (Understand) revealed that students across disciplines reported using AI to "paraphrase" information, suggesting a widespread application of AI to restate information in simpler or alternative terms, a core comprehension skill.

In the humanities, a student in ENGL 605, noted that AI helped "put into words concepts I wanted to present explain more clearly." In design, a GDES 402 student used AI to "paraphrase and rewrite drafts for letters or basic texts for design purposes." A MATH 230 student observed that "I used Al tools to paraphrase some tougher information, so I could understand it and use it," and a CEE 443–543 student shared that "AI has assisted me in restating multiple assignments in a clear and consise [sic] manner," though they observed that the AI often took a more professional tone than their own.

This broad use of paraphrasing across disciplines suggests that students are not only retrieving information (Level 1) but actively transforming it to suit their understanding, as well as their communicative and disciplinary needs. The shift from listing to paraphrasing reflects a cognitive progression—from organizing basic elements to interpreting and rearticulating them in meaningful ways.

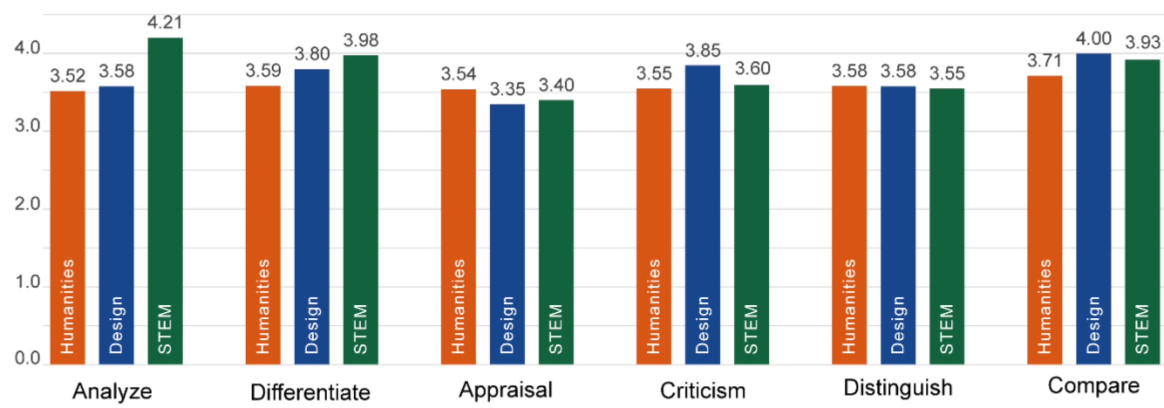
At Bloom's Level 3 (Apply), a compelling cross-disciplinary theme emerged in Q14: students consistently described AI as a tool for discovery, a term that appeared frequently across the humanities, design, and STEM. This shared language suggests that students perceived AI not merely as a source of information, but as a catalyst for uncovering new information, insights, or connections and applying them in discipline-specific contexts. In the humanities, students emphasized AI's capacity to expand research horizons: for instance, one student observed that, "using Copilot with this assignment helped to discover things about each artwork that would've taken me a long time to find myself" (ARTH 211), underscoring how AI facilitates deeper inquiry. In design, a GDES 402 student shared that "AI helped me discover various iterations of different ideas and further explore more images that related," highlighting AI's role supporting visual exploration and refinement of design concepts. STEM framed the discovery through technical application, with a MATH 230 student writing, "AI has helped me discover information that I may not have known at the moment to aid me in my work."

Figure 4. Analysis of action words for Bloom's Level 3–Apply, selected by larger discipline areas (humanities, design, STEM)



These examples illustrate how students across fields use AI not just to retrieve information but also to generate new insights and apply them to concrete tasks—from building arguments in the humanities to refining design concepts and solving technical problems in STEM. This exploratory function of AI naturally bridges into the analytical skills observed at Level 4.

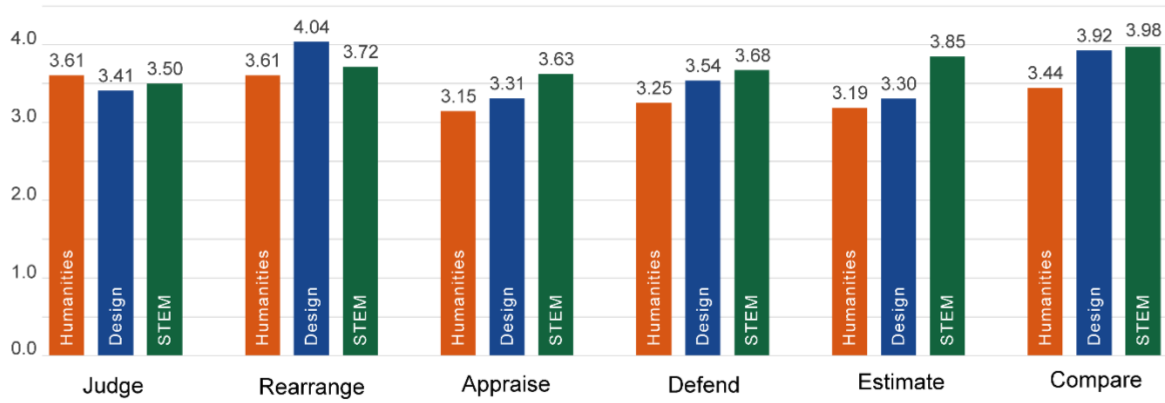
Figure 5. Analysis of action words for Bloom's Level 4–Analyze, selected by larger discipline areas (humanities, design, STEM)



At Bloom's Level 4 (Analyze), student responses across disciplines in Q16 revealed a shared emphasis on analytical thinking, particularly through the recurring use of verbs such as "compare" and "differentiate," with "analyze" being the strongest in the STEM disciplines. While the specific applications varied by field, these verbs signaled a common cognitive process: using AI to break down, contrast, and evaluate information in discipline-specific ways in order to acquire additional insights. A student in ENGL 605 shared that "I saved all versions of the lesson plans so that I could compare them accordingly to examine how AI adjusts according to prompts," demonstrating how AI supports iterative analysis. Design students similarly engaged in comparative analysis, but with a visual and client-centered focus: a GDES 402 student appreciated AI's help in comparing "logo designs or different ways of creating cursive lettering," and a student in ID 351 observed that AI helped them "distinguish the differences between client values," a critical step in developing a mood board that incorporated spatial arrangements, materials, and visual qualities aligned with the client's needs and preferences. STEM respondents approached analysis through a structured and data-driven approach to breaking down problems: a CSC 445 student used AI to "compare DFAs and NFAs and identify the main differences and if they contribute to the computation power of two types of machines," applying analytical reasoning to computational models.

While the content and context of analysis differed, students across disciplines consistently used AI to dissect, evaluate, and contrast ideas, whether in textual interpretation, design iteration, or computational modeling. This analytical engagement built directly on the discoveries made at Level 3, suggesting that students are not only uncovering new possibilities but also critically interrogating them. Using AI to refine understanding through contrast helped students acquire disciplinary insight and prepared them for evaluative judgment at Level 5.

Figure 6. Analysis of action words for Bloom's Level 5 – Evaluate selected by larger discipline areas (humanities, design, STEM)



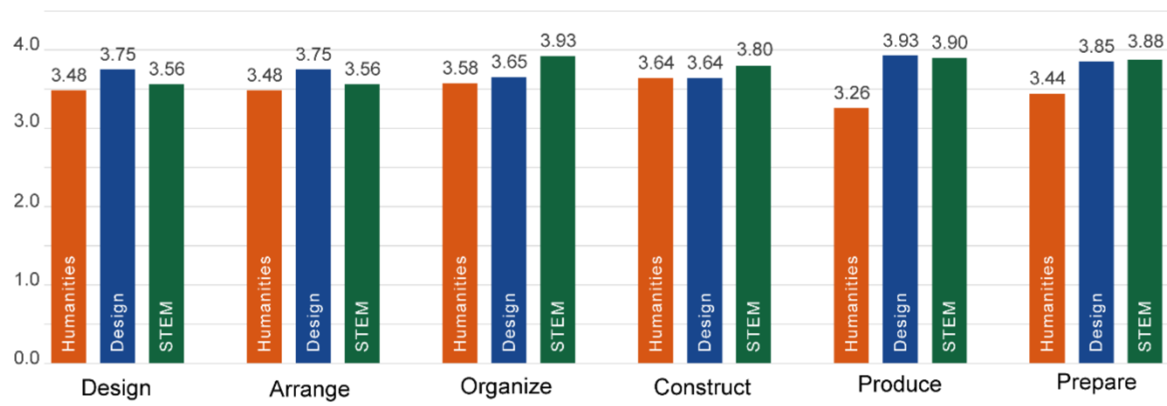
The widespread use of the verb "rearrange" across humanities, design, and STEM disciplines at Bloom's Level 5 in Q18 (Evaluate) suggests that students in all fields valued AI's ability to help them restructure ideas or elements to improve clarity, coherence, or effectiveness, moving toward a final product, although its application varied by discipline.

In the humanities, students used AI to rearrange content in ways that strengthen the flow of arguments, as one ARTH 211 student noted: "Rearrange: telling Copilot to adjust the order that the topics were written in or to arrange it into one solid essay." In design, students used AI to organize visual and conceptual elements for clearer presentation and ideation, as seen in comments like "it also helps arrange your information well so it makes the presentation clear" (GDES 402) and "AI has helped me rearrange my ideas into organizational levels that make more sense and are easier to understand" (ID 351). In STEM, students applied AI to sequence technical components or data logically, such as in a math class: "Rearrange—When coding, there are many ways to go about solving a problem, some more effective than others. AI has helped me find more consistent and line effective ways of solving certain problems" (MATH 230). An engineering student corroborated their choice of the action verb "rearrange" by stating that:

> Recently I have been using AI to help me while using Excel on some homework. At first I was surprised how well it could assist me with functions on Excel. After awhile it started recommending ways I could layout the information on Excel so it was in a clear and concise manner. For instance it would recommend which each column should be and would give examples of the functions needed per column. (CEE 443–543)

This evaluative process built on the analytical comparisons made at Level 4, suggesting cognitive progression from identifying differences to making informed judgments about structure and effectiveness. Whether refining an essay, organizing a design presentation, or optimizing a spreadsheet, students used AI to make strategic decisions about how best to present and communicate their ideas, demonstrating evaluative thinking that is both context-sensitive and cognitively advanced.

Figure 7. Analysis of action words for Bloom's Level 6—Create, selected by larger discipline areas (Humanities, Design, STEM)



From the analysis of the six selected words for Bloom's Level 6 in Q20 (Create), several action verbs stood out, with "construct" showing a more balanced distribution across disciplines and indicating that students used AI to support the generation of detailed and structured outputs.

In the humanities, students used AI to help them build ideas and activities that could be integrated in the complexity of course delivery, as one ENGL 605 student noted: "It gave me ideas of activities I can construct." An interior design student noted about their choice of the action verb "construct" that: "AI has helped me organize my thoughts into registers that are easier to understand" (GDES 351). In STEM, students applied the term "construct" in a technical context, such as in CEE 443–543, where a student used AI to "construct an element stiffness matrix using code." A math student choosing "construct" explained that AI "was able to guide me through various types of plots in R, some using separate packets, others using base R" (MATH 230), basically helping the student learn how to create different kinds of data visualizations in the R programming language. An engineering student claimed that AI helped them to "construct a scenario where . . ." (CEE 443–543).

These examples demonstrate that while the core cognitive process of creation involves constructing an output, the form and function of construction varied by discipline—from assembling course activities through brainstorming, to designing visual prototypes, to coding structural models. This creative engagement built on the evaluative restructuring observed at Level 5, where students used AI to refine and organize ideas. At Level 6, students advanced to original production, synthesizing components into novel discipline-specific outputs. Whether composing essays, designing layouts, or generating code, students demonstrated how AI supported the transformation of organized and evaluated ideas into purposeful creations.

Ethical boundaries of using AI: Overreliance, skepticism, or productive student-AI partnership?

Our research using the Bloom instrument (Table 1) focused on students' perceptions of AI use related to their cognitive processes while completing course assignments across various disciplines. Its configuration, featuring a question at the end of each level that asked students to select two verbs from those six measured through the Likert scale and explain the operations they performed most frequently, was not designed to directly address ethical concerns. Fortunately, we included an open-ended question at the end of the survey in order to allow students to express anything they wished but that was not captured in the instrument. The question— "What are your overall perceptions of this AI-assisted assignment?"—further elicited students' feelings about using AI and revealed some of their ethical worries.

Numerous concerns exist regarding the ethics of AI use, the larger issue being overreliance. Zhai, Wibowo, and Li (2024) conducted a systematic review examining how students' excessive dependence on generative AI models for academic tasks can diminish key cognitive skills, such as "decision-making, critical thinking, and analytical reasoning" (31). Overreliance typically occurred when users accepted AI suggestions without scrutiny and when students failed to employ critical thinking to what AI generates. Another study by Stojanov, Liu, and Koh (2024) sought to understand how students used AI, starting from the premise that it was not clear whether students use AI "to enhance understanding of the subject matter or circumvent learning by having ChatGPT complete the learning task for them" (2). They employed a survey instrument asking students to self-assess on a seven-point scale the degree to which they approached the use of ChatGPT with a critical mindset by proactively evaluating the accuracy of its responses, as opposed to blindly depending on its answers, discovering a complex relationship between skepticism and AI use.

Duenas et al. (2024) presented a more balanced approach to the technology's use, arguing that AI integration may lead to adaptive shifts in human cognition. While they acknowledged the possibility that some skills, such as ethical reasoning, contextual analysis, and nuanced interpretations, could be underutilized and thus risk decline, they also highlighted how other skills, such as information retrieval and problem-solving, may benefit. Rather than accepting this shift as desirable, their work highlighted the importance of fostering a balanced relationship in which LLMs support, rather than replace, essential cognitive functions. Ultimately, developing sound pedagogy that critically engages students' minds will be crucial to rebalance these cognitive functions.

Three frameworks informed our coding of the survey's final open-ended question, "What are your overall perceptions of this AI-assisted assignment?" First, Duenas et al.'s (2024) balanced approach suggested the potential for establishing a productive partnership between students and AI through sound pedagogy. Second, Zhai et al.'s (2024) literature review highlighted concerns about overreliance on AI. Third, Stojanov et al. (2024) introduced the concept of critical usage, framed as a "skeptical mindset" (2). Drawing on these perspectives, we categorized student responses according to whether they reflected overreliance on AI, skepticism, or a balanced and productive partnership. We coded answers from respondents that did not align with any of these themes as unclear. While these answers did not directly relate to any of Bloom's six cognitive levels, they offered valuable insight into students' awareness of the ethical boundaries surrounding AI use.

Figure 8. Coded student reflections on AI: Self-reported attitudes from final open-ended responses; data from individual courses

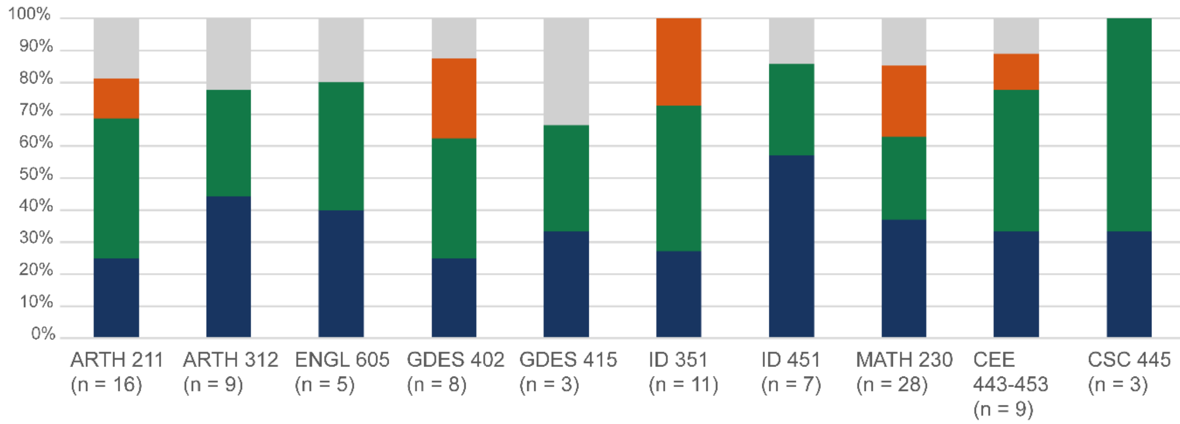
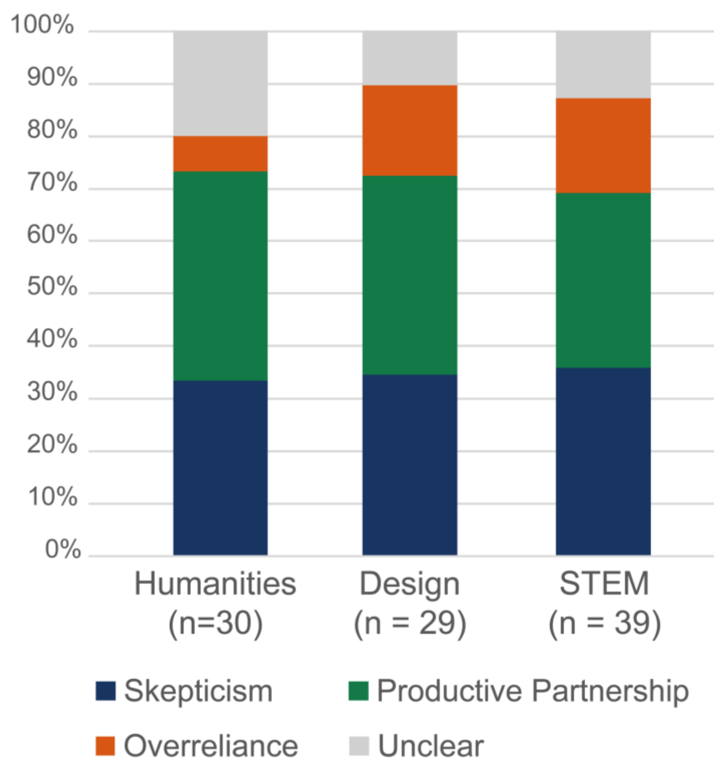


Figure 9. Coded student reflections on AI: Self-reported attitudes from final open-ended responses; data grouped into three disciplinary categories: Humanities, design, and STEM



Importantly, skepticism did not preclude the use of AI; rather, it encouraged students to engage with AI critically, maintaining an awareness of its limitations while utilizing its capabilities. Stojanov et al. (2024) claimed that:

> A student could be highly reliant on ChatGPT, but not use it in a critical manner when they blindly accept its output. Similarly, a student could be using ChatGPT critically alongside with other tools without being heavily reliant on it. (2)

Some respondents in our study recognized this. For example, a graphic design student indicated that AI "is a helpful tool but can not soley [sic] be relied on as some of the information it gives is not accurate and cannot curate a human like image successfully" (GDES 415).

Despite the limited number of respondents, the results shown in Figures 8–9 demonstrated a notable degree of consistency. Students across all disciplinary areas (humanities, design, STEM) were more likely to report either a productive partnership with AI or a skeptical stance toward its use.

Interestingly, a pattern started to emerge potentially linking AI overreliance with courses predominantly composed of sophomores and juniors: the course History of World Art I (ARTH 211) was predominantly composed of sophomores and juniors; Portfolio Design (GDES 402) consisted almost entirely of juniors; Interior Design Studio III (ID 351) included only juniors; and Math Seminar (MATH 230) was primarily taken by sophomores. In contrast, Intro to Theory of Computation (CSC 445), which also had high AI overreliance, was the only course predominantly composed of juniors and seniors. Courses where overreliance on AI was less prevalent tended to be senior-level or graduate courses: Publication Design (GDES 415) included only seniors; History of Graphic Design (ARTH 312) was primarily juniors and seniors; Interior Design Studio IV (ID 451) consisted exclusively of seniors; Matrix Analysis of Structures (CEE 443–543) was almost entirely seniors; and Seminar in Teaching Composition (ENGL 605) was composed entirely of graduate students (see Figure 8).

We observed some encouraging overlaps between our findings and those of Stojanov et al. (2024), which surveyed 490 students on their self-reported reliance on AI. Their study found that 38.2% of respondents had low reliance on AI—closely mirroring our study's average of 34.7% of students who expressed skepticism toward AI. Conversely, only 10.4% of their respondents reported high reliance on AI, which is comparable to our 14.3% average. This alignment is noteworthy, especially given the smaller sample size in our study (one-fifth the size of Stojanov et al.'s study).

The examples provided below demonstrate that, in most cases, students were keenly aware of ethical boundaries when using AI, regardless of discipline.

Examples of AI overreliance:

- "Overall this assignment was pretty easy because AI was doing all the work but I feel bad for using AI even through [sic] I had to for the assignment" (ARTH 211)
- "AI is a very smart tool and it is quite scary how smart it really is." (GDES 402)
- "Al has helped me a lot when it comes to this assignment" (MATH 230)
- ". . . in the future it may completely replace my preliminary work" (CEE 443–543)

Example of AI skepticism:

- "A response from AI should always be questioned, analyzed, and not taken at face value." (ARTH 312)

- "I think it will be a useful tool but I am unsure of the longer term and heavier use might lead to." (ENGL 605)
- "In my opinion, it takes me longer to use AI than the benfits [sic] I get. It does not have much capacity for design work." (GDES 402)
- "I didn't really care for how AI came up with the mood board and concept boards, after multiple attempts it did not understand what I was looking for within the photos I wanted to include." (ID 451)
- "I think Al can be helpful for some assignments but students still have to finish the assignment by making the information make sense and sifting through what is correct and relevant [sic]. Using Al can be a helpful tool but does not eliminate all work." (MATH 230)
- "I think Al is a great thing that can also be abused. I think that teachers should encourage the use of Al in ethical ways (like practicing for tests or questions). However, the issue is students use it to cheat, not learn." (MATH 230)

Example of student-AI productive partnership:

- "As a busy college student this is a fantastic tool we need to be taught how to properly use in a world that relies on technology instead of a library." (ARTH 211)
- "I think AI-assisted assignments are helpful in interpreting and simplifying complex assignment prompts and requirements." (ENGL 605)
- "I enjoyed using AI, it has helped me organize my brainstorming sessions to create more complex ideas that I can use to further develop my projects." (ID 351)
- "I know it can be used as an answer machine, but this assignment really but [sic] it into the perspective that it should be used more as a tool, where paired with the correct knowledge, can be extremely beneficial in learning." (CSC 445)
- "Using AI for assignments provides a helpful resource . . . it doesn't replace my thinking but enhanced my process . . ." (CCE 443—543)

These student reflections revealed a nuanced spectrum of engagement, ranging from overreliance to productive integration and critical skepticism. Students who over relied on AI generally talked about the ease of the assignment and expressed awe at its speed and productivity, without evaluating the response they received. In contrast, students across disciplines who expressed skepticism toward AI use acknowledged AI's productivity and potential but emphasized the need for human judgment, often finding its responses lacking in nuance or creativity. These students questioned the boundary between assistance and plagiarism and highlighted the importance of human critical thinking. Meanwhile, a third group demonstrated a balanced, productive partnership with AI. These students concluded that AI could enhance their learning process without necessarily replacing their intellectual contributions by simplifying complex issues, brainstorming, and selecting helpful information to further pursue, with some uses yet to be discovered.

Perhaps the most consistent ethical insight students shared in their responses related to accuracy. Across all levels of Bloom's taxonomy and disciplines, students demonstrated awareness of the inaccuracies in AI outputs. At Level 1 (Remember), humanities and design students reported rephrasing queries to improve AI comprehension, fact-checking outputs, and struggling to achieve design results comparable to manual work. At Level 2 (Understand), humanities students noted that flawed input led to poor comparisons, while STEM students pointed out AI's shortcomings in interpreting data. At Level 3 (Apply), a design student expressed concern that AI's comprehensiveness could discourage exploration of other available resources. At Level 4 (Analyze), humanities students scrutinized AI's accuracy, and design students observed that AI often failed to come up with the best fit or did not achieve the desired look in image-making. At Level 5 (Evaluate), students across disciplines emphasized the need to correct AI's inaccuracies. Finally, at Level 6 (Create), design students criticized AI-generated designs as inferior to their own creative work.

Students' ethical reasoning across disciplines and Bloom's levels suggested that even when they used AI extensively, many respondents were aware of its limitations and emphasized the importance of personal engagement and critical evaluation of the outputs it generated.

CONCLUSION AND LIMITATIONS

This pilot study explored how students across humanities, design, and STEM disciplines engaged with AI in course assignments, using Bloom's Taxonomy as a framework to assess cognitive impact. The findings indicated that students across all disciplines perceived AI as supporting their critical thinking, with mean scores exceeding three on a Likert scale from one (strongly disagree) to five (strongly agree). Across all six levels of Bloom's Taxonomy, students reported that AI helped them perform key cognitive tasks: "list" and "identify" (Bloom Level 1—Remember), "interpret" and "paraphrase" (Bloom Level 2—Understand), "discover" (Bloom Level 3—Apply) "differentiate" and "compare" (Bloom Level 4—Analyze), "rearrange" elements (Bloom Level 5—Evaluate), and "construct" their assignments (Bloom Level 6—Create).

While students generally received AI positively across disciplines and cognitive levels, most demonstrated a clear ethical awareness of AI's limitations, noting the need to restate queries for clarity, verify the accuracy of AI-generated content, and remain cautious of overreliance, especially when AI outputs were incomplete, inaccurate, creatively lacking, or unable to interpret complex data.

However, we must acknowledge several limitations. First, as a pilot study, the sample size was limited, reducing our ability to detect statistically significant differences across groups, therefore limiting the generalizability of disciplinary trends. Second, the study relied on self-reported data, which may have been influenced by respondents' biases or by varying levels of AI familiarity. Third, while Bloom's taxonomy provided a structured framework for assessing cognitive engagement, its application through action verbs may not have fully captured the depth and complexity of students' critical thinking processes, particularly in open-ended, interdisciplinary contexts. The survey instrument's design, while effective in identifying cognitive operations, could not detect ambiguities and nuanced ethical reasoning as well, which emerged spontaneously and episodically only in the final open-ended question.

Overall, this study contributed to the growing body of literature on AI in education, offering valuable insights into its benefits and areas for improvement. By addressing the identified limitations and pursuing further inquiry, educators and researchers can better harness AI's potential to enhance student learning outcomes and experiences.

RECOMMENDATIONS

Building on this pilot study's findings, future research should explore a balanced integration of AI and traditional disciplinary methods. Comparative studies using control groups could help determine whether AI fosters or diminishes critical thinking. Future full-scale studies may also assess the accuracy and reliability of AI-generated information across different disciplines. Given preliminary indications that AI overreliance may be more prevalent among lower-level undergraduate students, further research could investigate how academic level and disciplinary context influence students' engagement with AI tools, identifying specific areas where AI tends to falter and proposing solutions that enhance its dependability. Further research could also include additional disciplines or could become a longitudinal study to track the evolution of students' perceptions of AI use. Such research could reveal whether repeated use of AI tools leads to greater trust and dependency or more refined critical scrutiny. Importantly, it could assess how an increase in AI-assisted learning influences the development of students' higher-order thinking skills. Finally, integrating additional data sources (e.g., class discussions, discussion boards, usage logs) would allow for better triangulation between faculty intent, student self-perception, and actual AI use, providing a more holistic understanding of how AI shapes learning behaviors and outcomes. Addressing these areas could provide valuable insights into the consequences of AI in education and could guide the development of more effective AI-driven pedagogies.

NOTES

1. We noted inconsistencies in the use of terminology related to Bloom's taxonomy. Benjamin S. Bloom (1956) originally defined six cognitive levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (201–207). Lorin W. Anderson and David R. Krathwohl (2001) later revised these into verb forms (remember, understand, apply, analyze, evaluate, and create), reframing them as "cognitive processes" (66–68). While both Stanny (2016) and Das et al. (2022) adopted this updated framework, they diverged in usage: both retained Bloom's term knowledge for Level 1, while Das et al. used Bloom's comprehension for Level 2, favoring noun forms for most of the remaining levels. These variations in nomenclature inadvertently influenced our use of knowledge and comprehend in questionnaire titles, though the questions themselves used accurate action verbs. To prevent confusion, especially in disseminating a table that might be used as a pedagogical or research tool, we corrected these in Table 1 to remember (Level 1) and understand (Level 2). This distinction is crucial for capturing students' attitudes toward AI, whether marked by overreliance, skepticism, or productive partnership. Bloom's use of knowledge reflected a constructivist view that blurred student cognition and AI output, while Anderson et al.'s model offered a more precise framework: retrieval (remember) involves either student recall or AI retrieval prompted by students.

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DATA AND MATERIALS

Raw data and materials correlated to this study are not made publicly available, but requests via email can be examined by the Corresponding Author: Leda.Cempellin@sdstate.edu The data has been collected in compliance with human subject research, with exemption claimed under exemption criterion 1 outlined in 45 CFR 46, section 104(d), approval letter by SDSU Program Director of Research Integrity and Compliance on August 8, 2024.

AI DISCLOSURE STATEMENT

The authors designed this mixed-method study and collected, managed, and analyzed all student raw data. Microsoft Copilot was used to help refine survey-question wording through an iterative prompting process during instrument development, to provide some feedback on draft interpretation descriptions, and to assist with copyediting of the manuscript. The authors retained full responsibility for the study design, data analysis, interpretation, and conclusions.

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