

Intentional Infusion of Generative AI in a Human-Machine Systems Engineering Course

Assessment with Adoptable and Adaptable Strategies

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Abstract— Generative artificial intelligence (Gen AI) uses algorithms to create new content including images, computer code, audio, presentations, simulations, animations, and more. In a Human-Machine Systems Engineering (HMS) course, the use of Gen AI was discussed, addressed, and integrated with intentionality. The full infusion process in the course was gradual and measured, and is discussed in the body of this paper. The assignment allowing the most extensive use of AI was called the Expert Seminar for which students were commissioned to create a scholarly research-based presentation on a human-systems integration topic and deliver it to the class with a planned learning activity. In the multistage preparation process, students were allowed to use Gen AI for ideation, framing, locating scholarly sources, and even for helping to create the presentation script. The terms were (1) students were not allowed to read from any notes when presenting, (2) concepts must be drawn from linkable scholarly research, and (3) students were responsible for the accuracy and quality of the seminar content and delivery based on HMS course principles.

Along with the assignment write-up, students were asked to outline the advantages and drawbacks of using AI for such academic work. Of the 56 respondents, there were 115 open-ended responses indicating the merits of using Gen AI for this type of project and 121 responses outlining the less effective and concerning aspects of its use. The primary categories of positive responses reflected how students felt AI benefited them in organizing the seminar framework and in saving time. The most common detriments noted by students related to the effect on their work creativity and ownership as well as AI's tendency to misinterpret course topics and vocabulary.

The codified reflections are very telling and have enhanced the professor's understanding of AI capabilities and students' perspectives. Further, this research has informed future framing of AI use for classes and projects, providing clarity for inclusion of various AI options in future course offerings. This work can help bridge the perceived gap between students and educators on the use of Gen AI by keeping the conversation open.

Keywords—artificial intelligence; AI; ChatGPT, generative AI, Gen AI, academic, higher education,

I. INTRODUCTION

In academia and beyond, AI-generated material is highly accessible with a relatively low-sloped learning curve, making it readily available to those with electronic devices and internet connections. Many students in higher education are now using Gen AI extensively to construct written reports, summaries, presentations, and other compositions, which is the subject of much ongoing discussion and debate [1, 2, 3].

Generative AI has been simultaneously transformative and disruptive in the educational domain. Along with AI's emergence, accelerated development, and ubiquity simmers an ongoing debate about the circumstances, suitability, and admissibility of its use, especially in student work [4, 5, 6]. While Gen AI has its advantages in the ideation process and can assist with writing quality, reference formatting, and countless other configuration tasks, fundamental concerns have been raised relating to originality, independent novel thought, conceptual ownership, and user over-dependence [2, 3, 4, 5].

II. HUMAN-MACHINE SYSTEMS COURSE AND ROLE OF AI

A. HMS Course Profile

Human-Machine Systems (HMS) is a 5-credit senior-level engineering course at Northeastern University, with multiple assignments and laboratory sessions over a 15-week semester. This course focuses on the science behind safe and efficient human performance engineering. Groups of ~4 students team up for many of the assignments.

B. Generative AI in HMS

The HMS course began with an overview of the current state of generative AI and an outline of which types of tools, mechanisms and platforms were included for our course context. In the first week there was a conversation with the class about AI use, and a course survey explaining the general profile of how it was to be used –or not. The survey also asked students to agree to the course policies and allowed for them to provide their input and opinions. As a basis for the survey question, guidelines regarding the use of AI-generated content were clearly established on the syllabus.

C. Permitted Use Cases of AI

As described, intended use cases of AI-generated content were covered at the start of the HMS course. Students knew AI usage was permitted only under very specific guidelines with clearly defined conditions. It was conveyed that opportunities to use Gen AI would be supported and become more apparent when the various assignments were posted and introduced.

D. Prohibited Use Cases of AI

With the exceptions above, the use of AI-generated content to represent student work was wholly prohibited in HMS. Its use was explicitly disallowed for reflection pieces, knowledge checks, self-assessments, expressions of personal opinion, and other submissions that would be unique to each student.

For all other types of student work including in-class activities, the use of AI-generated content was not permitted, while both the professor and students were still in the process of understanding its potential benefits, limitations, and scope.

E. Progressive Infusion of AI into the Course

Several assignments gradually blended AI into the Human-Machine Systems course, each with specific objectives and each illustrating key uses of Gen AI in the learning process:

- General knowledge check with Gen AI supplement: First, students were asked, *“In your own words define a system.”* Then they connected with classmates, sought patterns and collaboratively defined a system. Finally, they could ask an AI platform to define ‘system’ to see how well the definitions matched. A dynamic discussion followed and a sound operational definition of a system resulted.
- AI definition followed by student opinion: Next, a bonus question on an assignment invited the upfront use of AI. Students were asked to explore AI for a specific concept, like *“contextual marketing”* or *“XR Technology”* and relate it to HMS. Once students found and reported the findings, they were invited to provide their opinions on the subject.
- Learning concepts with AI-generated paraphrasing: On the next AI assignment, students worked in pairs. They were to extract several design principles from the textbook, read the description for each one, and *paraphrase each principle in 10 words or fewer*. This mission allowed the use of AI-generated rewrites. This was designed to help them learn the course concepts in any way possible. Students noted that this was helpful, enjoyable, and sparked some great discussions as they learned the principles in multiple ways.
- Expert Seminar AI-aided research and presentation script: Finally, the more extensive team-based Expert Seminar project allowed and encouraged the use of Gen AI with some additional protocols, caveats, and feedback. This is the main focus of this analysis and is described in the Methodology section to follow. For context, some examples of the research-based Expert Seminar topics were:

- Brain-Machine Interface: Possibilities, applications, ethics, and prospects
- Kansei Engineering and Emotional Design: Components, applications, and the underlying science
- Decision Fatigue: Is it a thing? If so, how can we combat it scientifically?
- The Effects of Music on Human Psychology and Energy: According to research
- Wearable Technology: HR, BP, BAC, ROM & Mood - The future and acceptance of wearables and implantables
- The Psychology of Color: Is there science to this?
- Don't Tell Me, Show Me: The advent and development of gesture recognition in human-machine interfaces

III. METHODOLOGY

A. The Expert Seminar Assignment with full AI permissions

As noted above, students were commissioned to create a scholarly research-based presentation on a human-systems integration topic and present it to the class. They were allowed to use AI in any way they chose to prepare the seminar for the class. However, there were some caveats. The terms were:

- Students were not allowed to read from any notes or depend on text-heavy slides when presenting.
- All concepts must be drawn from fully referenced scholarly research, with linkable *doi* sites.
- Teams were fully responsible for –and graded on– the accuracy, quality, and engagement the seminar content and presentation delivery based on HMS course principles.
- In the written portion of the Expert Seminar assignment, students were asked to (1) indicate where in the project they used Gen AI to ideate or create content, (2) report the extent to which they used it, stating the application and amount, (3) name the generating mechanism or app used, and (4) provide the prompts they entered to produce the content.

B. Data Collection

Immediately after submitting the Expert Seminar write-up, students were individually asked for their feedback on the value/benefits and downsides/concerns related to its use.

- Question 1: *“Consider the effect that using generative AI had on your Expert Seminar development and delivery. What aspects of using the tool were beneficial, helpful effective, and/or advantageous? Please explain.”*
- Question 2: *“Consider the effect that using generative AI had on your Expert Seminar development and delivery. What aspects of using the tool did you find to be less effective concerning, or limiting? Please explain.”*

Students asked if they were limited to considering use of Gen AI for the Expert Seminar or if they could form responses relating to other course work. At that point, they were told that they could expand their responses to provide the richest feedback possible. The feedback task was introduced in class and was due in two days’ time, allowing students to reflect and expand on their responses. Results are outlined below.

IV. RESULTS & DISCUSSION

The N=56 student submissions provided 115 open-ended responses describing the advantages of using generative AI for this type of project and 121 responses reporting drawbacks and concerning aspects of its use. As noted, responses primarily related to their experiences defining and researching topics, generating scholarly content, framing the analysis of subject matter, composing/writing, and preparing material to present.

A. Comparison of Positive vs Negative responses

Students responded to the questions posed above, which resulted in each individual offering a total of 0-4 advantages plus 0-4 drawbacks in their commentaries. A number of 0 counts as a response meaning that the student indicated that there were ‘none’ or ‘no advantages/drawbacks’ versus leaving that question entirely blank. Fig. 1 presents the profile of the number of Advantages ($\bar{x}=2.09$) and Drawbacks ($\bar{x}=2.16$) listed by each student.

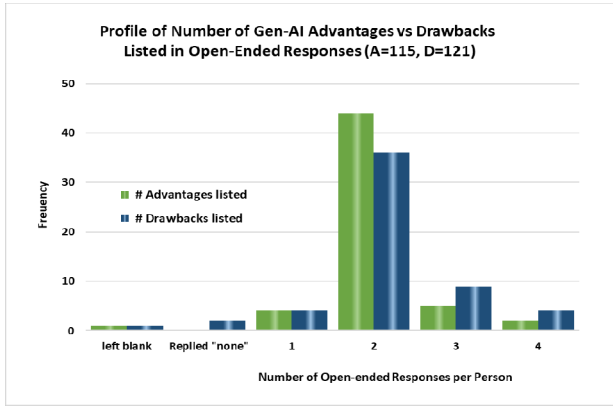


Figure 1. Distribution of number of responses per student for both advantages and drawbacks of the use of generative AI for their work.

The mean tally of Advantages and Drawbacks appeared to be similar, and this was confirmed with an independent t -test: $t(108)$, 0.55 , $p=0.58$, showing no significant difference in the number of remarks per student between the two lists.

B. Positive Aspects of AI use

Table I presents the profile of responses from Question 1 that explicitly listed perceived advantages of AI.

TABLE I. OVERVIEW OF POSITIVE RESPONSES FOR USE OF AI

Tally of Positive Sentiments for AI use		
# Students	# Responses/Student	Subtotal
1	Did Not Answer	0
0	0	0
4	1	4
44	2	88
5	3	15
2	4	8
56	← Totals →	115

Using an abductive approach, systematic content analyses were conducted by multiple raters, sorting student responses into distinct themes, first outlining the advantages related to the use of generative artificial intelligence for this work and then the drawbacks [7]. Thematic analysis stratified each response set into primary subcategories. Fig. 2 illustrates the leading positive sentiments. For the productive value of Gen AI:

- 68% indicated it duly helped frame and organize their topic
- 52% noted it saved time and energy in the writing process
- 30% stated they learned new ways to articulate concepts
- 25% detailed that AI content helped them to validate and ‘legitimize’ the topic and to create conceptual bridges.
- 16.5% were ‘other’ comments primarily related to other forms of expediency, like summarizing passages, finding great slide themes and images, and formatting references.

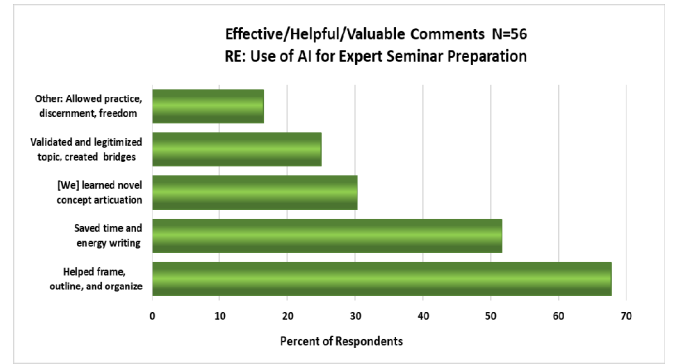


Figure 2. Responses to "Consider the effect that using generative AI had on your Expert Seminar development and delivery. What aspects of using the tool were beneficial, helpful effective, and/or advantageous? Please explain."

Some student quotes have been provided from the commentary they submitted. The most representative remarks are provided here:

"Going to ChatGPT helped us create an outline from our notes to organize the presentation."

"Once we searched on kansei engineering + human factors we saw it was a thing and how they combined together."

"It was so easy to ask AI to format our references, it saved time that was better spent preparing our presentation."

"Claude rewrote my presentation section with more clarity. I couldn't memorize it all, but sounded more professional."

In the 2-week preparation process, students were also provided a full 2:20-minute working lab session expressly dedicated to collaborating, planning, preparing their seminars, and consulting with the professor. From interactions with all 16 teams, it was clear that they were more concerned with delivering accurate content, engaging activities, and quality presentations than just meeting the academic requirements.

C. Drawbacks of AI use

As detailed above, Question 2 requested a listing of any perceived drawbacks, limitations and/or concerns related to the use of generative AI. Table II presents the summary of responses for Q2. Note that of the total 56, two students answered that there were “none” or “no issues” and those were counted as entries of ‘0’. One did not provide any response.

TABLE II. OVERVIEW OF ‘DRAWBACK’ RESPONSES FOR USE OF AI

Tally of Drawback Sentiments for AI use		
# Students	# Responses/Student	Subtotal
1	Did Not Answer	0
2	0	2
4	1	4
36	2	72
9	3	27
4	4	16
56	← Totals →	121

Students were forthcoming in recognizing and describing the potential drawbacks of relying on generative AI for this kind of work. For concerns about and limitations of AI, the following categories emerged through the abductive thematic analyses, which are also set out in Fig. 3:

- 61% stated that it diminished creativity and compromised the personal perspective they were seeking for their topic.
- 54% alluded to the concern that certain words, terms, and concepts did not always have the intended meaning and did not match HMS connotations, leading to inaccurate and illogical material.
- 40% reported that AI made them think it would be easier or take less time, when in fact they ended up sifting through and revising unusable information.
- 21% expressed a concern for not knowing how to set a balance for its use and at times teammates did not agree on the level of reliance on Gen AI.
- 20% of ‘other’ remarks related to becoming too dependent, and feeling out of practice to do one’s own writing, and even feeling like they were ‘cheating’.

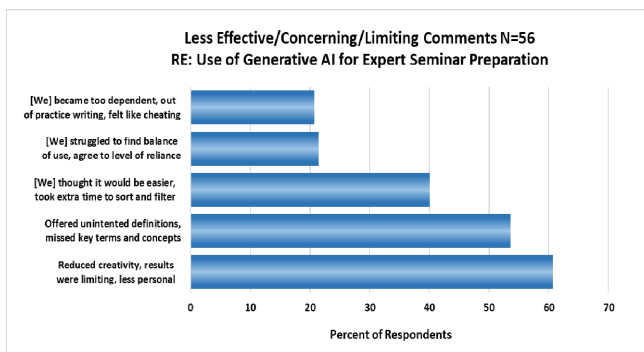


Figure 3. Responses to "Consider the effect that using generative AI had on your Expert Seminar development and delivery. What aspects of using the tool did you find less effective, concerning, or limiting? Please explain."

Student observations regarding concerns, limitations, and drawbacks were somewhat polarized, not readily apparent from the subcategories: On one hand, several students realized in advance that AI was not likely to afford them the creativity and innovative assistance that was required for their topic and thus did not rely heavily on it. However, other students were disappointed that they did not get the inspiration and assistance they initially expected from AI and found themselves needing to do more work and adjusting than they anticipated. Below are some comments from the “Please explain” responses.

“When I searched on wearable technology, I was flooded with info. Narrowing the search to include human factors, scholarly and acceptance helped us more, but it took time.”

“We got a completely different definition of redundancy in coding than we expected so could not use it in our seminar.”

“Some of us searched right away and kept getting the same ideas. Others in our group got creative on their own and came up with some unique ideas to use without AI.”

“Our team had some discussions on what ways and how much to use AI and could not always agree. We decided to just do what we wanted for each of our parts for the seminar.”

“I actually wonder how this affect[s] my learning. Trying not to become too dependent or can’t think for myself.”

C. Overview of Results

In the Expert Seminar assignment, students were also asked to record the prompts they used to elicit AI results. From the data and quotes above, one of the lessons students learned was to form better prompts to benefit from the use of AI for their work. Also seen in the data and remarks above, students in the same course and same program—even those on the same team—did not share the same views on the use level of generative AI.

The analyses above align with previous perspectives on the use of AI, especially for the composition of student work [1, 2, 3]. Advantages were found in the areas of personalized and readily available support and assistance in brainstorming and research, similar to the results found by [1, 3, 4, 6]. Concerns focused on the ‘artificial’ nature of compositions, and extended to worries about AI overdependency and their own personal development. This echoes the findings of [5] who also found from their survey of students “One of the main issues is over-reliance on AI, which may hinder people’s growth, skills, and intellectual development over time.” Clearly there is more work to do and inquiries to make on the moving target that is AI.

The author has already used the results of this work to guide the use of Gen AI for the next offering of the Human-Machine Systems course. Providing the findings and student-based sentiments was instrumental in creating a course culture for the usage of AI tools. This also demonstrates the value of introducing sensible student-guided protocols when outlining policies for the most beneficial use cases of generative AI for coursework. Student-based guidelines can help gain buy-in for the areas in which AI use is controlled, discouraged, or prohibited. Further, this research and its findings have served as a conversational springboard, catalyzing healthy and spirited discussions on this topic with students and faculty alike.

V. RECOMMENDATIONS FOR FUTURE WORK

This research provides an additional set of data points for future inquiry on this topic. Further assessment of students' past experience and current facility with the use of AI tools would be helpful in interpreting the results with added clarity. Research into the potential correlations between students' course grades and response types across the advantages and drawbacks subcategories is underway and may provide insight into how each student's academic level aligns with how they view and choose to use generative AI. While this paper covers students' sentiments on the value, concerns, and general use of Gen AI, the next step would ascertain how their use of it in the future matches with their current perspectives.

VI. CONCLUSIONS

The use of generative AI for academic and scholarly work products has its role and value. First, it is essential to remain current on the capabilities of this emerging phenomenon. Like any new technological tool, exploration, information, training and experience will guide users in sound decision making. It also can be concerning that this tool has the potential to thwart learning and pre-empt the vital discernment, effort and practice that contribute to sound research, writing, and analysis.

A. Summary of Student Sentiments

Student feedback and observations on the use of Gen AI have provided constructive insight into the value it holds in researching, learning, and creating custom work products. As educators, outlining the valid and most productive Gen AI use-cases for students with the supporting rationale can provide helpful guidance. Equally compelling is presenting past student commentary to future classes for their consideration.

The general sentiments are summarized as follows for application of generative AI tools: '+' represents value and/or indicated use cases and '-' is used to list limitations and/or contraindicated use cases:

- + Overcoming inertia: for framing, researching, and staging
- + Saving time and energy in composing new written work
- + Finding new ways to characterize and expand on a topic
- + Confirming a topic is actually valid in the field of interest
- + Providing freedom to explore without consequence
- Can at times, reduce creativity if an AI solution is offered prior to student/teams ideating or generating solutions.
- Sometimes returns incorrect or unintended material, due to not understanding context and/or domain terminology.
- At times, the user believes that using Gen AI may be a shortcut, but it results in more work to rewrite or refine.
- Team members cannot always come to consensus over how and how much to use it on various assignments.
- Users attest to the fact that they grapple with the concept ownership, plagiarism, and/or "cheating" using Gen AI.

B. Suggestions for Educators: Early or Recent Adopters

For educators who have already embraced, introduced, and outlined AI as part of their teaching and learning profiles as well as those instructors who are considering working AI usage into your courses, but share many of the concerns above, here are some suggestions to consider:

1. Introduce and discuss its use at the outset of each course.
2. Place your AI usage guidelines clearly on the syllabus.
3. Ensure students have read and agreed to the use policy.
4. Start small, illustrating your willingness to "go there".
5. Gather open feedback along the way from the students.
6. Mix up the intensity and extent of Gen AI use to provide a variety of learning and reflection opportunities.
7. Reserve the right to alter AI policies with new input.
8. Keep learning from experts, colleagues, and students
9. Continue embracing change and trying new things!

AI usage discrepancies are yet unresolved, and continue to spark productive debate. For classic academic work products, AI usage is now generally favored for rapid comprehensive searches, alternative perspectives, global definitions and re-articulation of concepts. Production of slides and images has also become part of the repertoire. However, on the continuum of personal creativity, ownership, and learning effort, our scales tip in the direction of less AI use and more cognitive investment and exercise on the part of the student.

The insights gathered in this research are highly relevant for educators and have duly enhanced our understanding of AI perceptions and capabilities for academic use. Additionally, this work can help shape future approaches to integrating AI in classes and projects, and offer clarity on incorporating various AI tools into upcoming courses. This work also has helped narrow the divide between students and educators regarding the use of Gen AI by maintaining an open, progressive, and enthusiastic dialogue.

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