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From Curiosity to Impact: Incorporating AI into Student Portfolios and the Creative Process

Dr. Keilin Jahnke, University of Illinois Urbana-Champaign

Dr. Keilin Jahnke is a Teaching Assistant Professor in Innovation, Leadership and Engineering Entrepreneurship in The Grainger College of Engineering at the University of Illinois Urbana-Champaign.

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Abstract

Engineers use both critical and creative thinking skills to apply their technical knowledge and develop solutions to both large- and small-scale problems. Many of these problems and their associated contexts necessitate innovative, novel ideas in order to make a meaningful and lasting impact. Because of this, creativity is an essential skill for engineering students to enhance through understanding theoretical underpinnings and developing skills and experience through deliberate practice. The creative process begins with the cultivation of curiosity and includes problem and opportunity identification, ideation, taking initiative to build and test an idea, and implementation, and there are a multitude of specific techniques that can be utilized in each of these phases. Existing creativity techniques and tools assist individuals, groups, and teams in enhancing their project efficiency and increasing the novelty and effectiveness of their ideas and implementation strategies. With the increasing prevalence and accessibility of generative AI, it is worth exploring how these applications might be utilized for idea generation and in the creative process.

This work describes a deliverable that includes the utilization of generative AI assigned to students within a graduate-level engineering course in creativity at a large university. Similar to the journals and sketches of famous creative individuals throughout history, the Creativity Portfolio is an individual assignment designed to facilitate students' documentation of their discoveries, insights, inspirations, identified problems and opportunities for improvement, ideas, design details, and implementation strategies gained and developed throughout the semester. In a pilot modification to this assignment, students were asked to develop two distinct parts in their Portfolio: one part encouraged students to use a physical notebook and develop content without the use of digital references and tools while the other part necessitated the use of generative AI and inventive prompt creation to identify specific and unique problem statements and ideas. This work highlights the details of this assignment including the formal learning objectives, the purpose and justification for these changes, and initial lessons learned. By incorporating generative AI—a cutting-edge technology that is currently widely accessible to students—into an academic assignment focused on creative thinking, students can gain formal, facilitated experience in seeing both the opportunities and limitations of such tools.

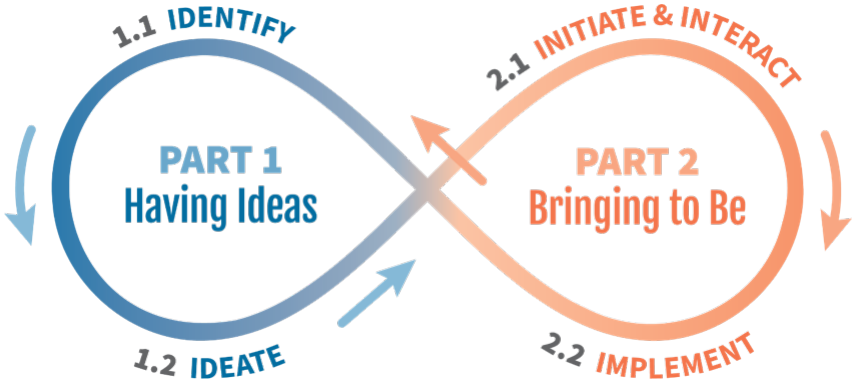
1. Introduction

Creativity is a crucial skill for engineering students to learn and practice so that they might strengthen their ability to develop novel and impactful engineering solutions and processes [1]. This ability to be creative [2]—i.e., to have an idea and bring it to be—is beneficial in a variety of disciplines and professional contexts. Engineering programs can provide students with the opportunity to practice being creative by offering standalone courses in creativity and innovation as well as through incorporating creativity techniques and tools into existing courses and curricula.

Creativity can be taught through a systematic process [1, 3, 4] to promote novel invention and innovation [5]. Curiosity is a critical and foundational component of the creative process in that

it provides a source of inspiration and context for future idea generation and implementation. Litman and Spielberger provide a comprehensive review of curiosity in [6]. Curricular environments provide a context to practice situational curiosity through intentionally designed activities and projects [7]. With this foundation, specific techniques can be learned and practiced to enhance the effectiveness and efficiency of ideation, idea analysis and evaluation, building and testing ideas, and the implementation strategy for a selected idea.

The curricular context of this paper is a course in creativity at a large, midwestern institution. The creative process used as an overarching model within this course is divided into two main parts: (1) having ideas and (2) bringing them to be. As generative AI becomes increasingly prevalent and accessible, it is worth pausing to reflect on if and how various generative AI tools could be used to aid in each specific part of the creative process, including brainstorming [8] and those outlined in the model shown in Figure 1.



PART 1: Having Ideas		PART 2: Bringing to Be	
1.1 Identify	**1.2 Ideate**	**2.1 Initiate & Interact**	**2.2 Implement**
• Cultivating curiosity • Discovering problems and opportunities • Reframing • Understanding • Evaluating • Applying wisdom	• Stockpiling knowledge • Thinking analogically • Connecting • Ideation techniques • Diverging before converging • Tolerating ambiguity	• Taking initiative • Managing risks • Prototyping • Modeling • Analyzing	• Marshaling resources • Collaborating • Managing time • Stewarding money • Persisting

Figure 1. Creative process model used in TE 510: Advanced Creativity course.

Generative AI is being integrated and tested within engineering programs, courses, and assignments [9, 10, 11] and its usefulness studied [12, 13]. These tools have the potential to be used as a helpful resource in many disciplines, including in multiple parts of the creative process. Because of this, there exists an opportunity to explore how to incorporate the utilization of generative AI into existing courses, modules, and deliverables and assessments that have creativity-related learning objectives. This work explores the details of a modified deliverable that intentionally incorporates the use of generative AI models that are currently widely accessible to students.

2. Course Background

TE 510: Advanced Creativity is a graduate-level course offered through The Grainger College of Engineering at the University of Illinois Urbana-Champaign. This course is open to master's and Ph.D. level students from any discipline across campus and is selected as an elective—it is not a primary degree requirement for any specific program.

Students are provided this course description in the syllabus and on the learning management system:

> The purpose of this course is to enhance your creativity through theory and application. Creativity is a necessary skill in any professional endeavor. Creativity is enhanced by becoming proficient with a set of techniques, developing a mindset that favors creative behaviors, and by establishing a lifestyle that promotes having ideas and bringing them to be.
>
> This course explores a wide range of topics including the foundations of creativity, the development of creative confidence and motivation, creativity assessment, ideation techniques, and the role of creativity and innovation in academia, industry, and entrepreneurship. This class will use readings to develop content knowledge and fuel curiosity as well as in-class activities and individual and team assignments to apply learning and enhance creativity. Students will also hear from guest speakers who have utilized creativity principles in their respective domains.

The learning objectives of the course are that upon completion of this course, students will be able to:

1. Describe a framework for creativity and apply it to multiple problem-contexts.
2. Identify problems and opportunities for improvement and understand the complex, contextual framework in which they exist.
3. Apply a set of techniques to generate novel and imaginative ideas and delay decision-making.
4. Systematically evaluate both their own solutions and those of others.
5. Design and build technical solutions and modify based on customer, client, or professional feedback.
6. Lead others in creative thinking and processes.
7. Present work to a variety of stakeholders and communicate effectively.

Class sessions are 80-minutes in length and occur twice a week throughout a 16-week semester. Historically, enrollment has been capped at 40 and the preferred classroom has multiple dry erase boards and moveable tables to situate students in groups. Class time is used for brief instructor- or student-led warm-ups lasting no more than ten minutes, activities utilizing active learning techniques, and small- and large-group discussions and presentations. The typical course topics are briefly described in Table 1.

Week	Course Topic
1	Introduction to creativity: What is it and why does it matter?
2	Cultivating curiosity in professional and academic endeavors
3	BioInspiration [14]: Nature as a driver of problem- and solution-based creativity
4	Problem and opportunity discovery
5	Introduction to ideation techniques
6	Contextual innovation: Need-finding and place-based design
7	Creativity in diverse teams
8	Presenting and pitching creative work
9	Taking initiative: Moving from ideation to implementation
10	Constraints in implementation of creativity and innovative ideas
11	Ethics in creativity, innovation, and entrepreneurship
12	Assessing creativity
13	Creativity and leadership
14	Final Vision to Reality Semester Project presentations
15	Teaching and advancing creativity

Table 1. Weekly course topics.

This creativity course includes a variety of assignments and assessment mechanisms of varying scope and scale. Two assignments constitute the largest portion of the total points for the course. The first is the Vision to Reality Semester Project which can be completed individually or with a partner and is worth 36% of the total grade, divided across multiple deliverables. The second largest deliverable is the individual Creativity Portfolio, worth 15% of a student's total grade. It is this Creativity Portfolio that is the focus of this paper.

3. Description of the Creativity Portfolio

The Creativity Portfolio was developed as a mechanism for students to work towards many of the overarching course learning objectives and to practice multiple components of the course model of creativity including enhancing curiosity, identifying problems and opportunities for improvement, ideating, analyzing multiple solutions, and developing implementation strategies. The provided description for this assignment is as follows:

> Creative individuals throughout history are known for their journals, laboratory notes, files, and sketches that document discoveries, ideas, design details, and implementation strategies. Now it is your turn to document your insights, understandings, experiences, inspirations, and ideas! The goal of this portfolio is to help you document your creativity enhancement throughout this course and to help you build a habit of creativity for your future.

The more nuanced learning objectives of the Portfolio include that as a result of this project, students will:

1. Produce a complete, functional, and appealing system to record and cultivate ideas daily.

2. Enhance their creativity by re-kindling their curiosity, discovering opportunities, and practicing ideation.
3. Practice developing the habit of daily creativity.
4. Experiment with using generative AI as a tool for evaluating and developing detailed, novel ideas.

Students can select any number of physical or digital formats for their Portfolio and can change formats at any time throughout the semester. Common formats include physical notebooks or binders, digital word/text documents, slides, and customized websites. Students can submit physical deliverables either in-person or they can take photos and upload them to the course learning management system as a comprehensive PDF file. This flexibility is allowable given the current enrollment size.

The assignment description recommends to students that they schedule regular, consistent time to work on adding new content to their Portfolio and make it part of their general routine throughout the semester. This is also discussed further in class. There are two major submission checkpoints for the Portfolio: one midway through the semester in which students need to have completed a small number of entries from each section, and a final submission at the conclusion of the semester. The mid-semester submission is positioned as a formative assessment mechanism [15, 16] and students are provided detailed feedback to incorporate into their remaining work.

This assignment was modified for the Fall 2024 semester to strategically incorporate the formal use of generative AI. This was done for two primary reasons: first, it provided students with clear and explicit instructions on where and how they could utilize generative AI and other digital resources while adhering to the course policies; and second, it encouraged and formalized the facilitated practice of using generative AI as a tool in creativity and reflecting on its merits. In its modified, current form, the Creativity Portfolio includes two main parts, one entitled Foundational Creativity and the other AI + Creativity. Figure 2 provides a description for the various sections in the Foundational Creativity part and Figure 3 for the Creativity + AI component.

Part 1: Foundational Creativity

Since these will be extremely specific to you and your schedule for the semester, you should plan on coming up with your own original thoughts and ideas for these sections and you will not need the internet or AI. You are welcome to use a physical notebook or alternative.

1. **Curiosity Inspiration**
   Total entries for this section: 50
   Curiosity is the foundation of creativity! Observe the world around you throughout the semester and record 50 activities, places, and/or interactions that inspire you to be curious this semester. These should be written as brief sentences that explain what made you curious and the context in which you discovered it. These should be new sources of inspiration from this semester, not from the past.

2. **Stockpile of Academic Knowledge and Discoveries**
   Total entries for this section: 50
   Collect 50 pieces of interesting information, observations, questions, and things that make you go "huh?", "why?", and "what if…?" from your life as a student this semester. These could come from your classes, seminars or workshops you attend, research group meetings, teaching responsibilities you might have, interactions with professors, conferences, etc. Some might not seem immediately relevant to you, and that is okay! These should all be new to you this semester and each one should be written as (at least) one sentence.

3. **Problems/Opportunities for Improvement**
   Total entries for this section: 50
   This is your place to nurture your curiosity through problem finding and opportunity identification throughout this semester. Focus on both problems that you encounter in your daily life as well as in areas that are new to you. You are encouraged to emphasize problems/opportunities in your field, area of expertise, and/or research area and these might stem from your stockpile of academic knowledge and discoveries. Each problem/opportunity should be at least one sentence long and thoughtful and specific (i.e., not generic). This will be the starting off point for developing potential solution ideas.

4. **Solution Ideas**
   Total entries for this section: 50
   This is the next step after discovering problems/opportunities. You will use creativity techniques to come up with 50 solution ideas, focusing on developing multiple ideas (at least five) per problem. You should be able to justify these ideas as relatively novel and not generic.

5. **Implementation Plans**
   Total entries for this section: 10
   After ideating solutions, you will choose ten of these solutions to "implement" and practice the skill of strategically developing the steps to make your ideas reality. For each of the ten, you will hand sketch the solution out in detail, describe the specifics about how you might prototype, and create an implementation plan.

6. **Creativity Reflection**
   Total entries for this section: 12
   This section will include reflections on topics such as what you have discovered about yourself, your passions, how you have enhanced your creativity, your thoughts on creativity enhancement, the future role of generative AI in creativity and design, how you might utilize what you have learned in the course, and reflections on what you are learning in the course and the creative process. You should plan on writing at least a few paragraphs in this section every week.

Figure 2. Descriptions for the sections that constitute the Foundational Creativity part of the Creativity Portfolio.

Part 2: AI + Creativity

Now is the time to use AI. For this section, please use your preferred generative AI tool (examples include Microsoft Copilot, Gemini, and ChatGPT) and write down which one(s) you used. Please record every prompt and output (yes, these sections will be long). Make sure your prompts are easy to identify in your submitted documents.

1. **AI + Problem/Opportunity Identification**
   Total entries for this section: 50
   Use AI to help you identify 50 extremely specific and unique problems and opportunities for improvement that you could eventually use as a base for ideation. You should start with five general topics that are interesting to you and/or relevant in your field and then use prompt engineering to end with ten specific problems/opportunities for each topic (for a grand total of 50). You should plan on critically reading and evaluating the outputs and using multiple prompts to generate these lists. Even with generative AI, quantity (of prompts) most often leads to quality (of outputs)! Your goal should be to use AI to generate a list of problems/opportunities in five topic areas that are important to you, are at least two sentences long, and are not easy to replicate by someone else using a generative AI.

2. **AI + Ideation**
   Total entries for this section: 5
   The goal of this section is to create a problem tree (most likely in the form of a list) for 5 distinct problems/opportunities and then engage with the generative AI to develop a comprehensive and novel solution for one aspect of the problem (i.e., one of the causes or effects). You should plan to think critically, review the outputs, and engineer multiple effective and compelling prompts. You will most likely begin by selecting five of your problems/opportunities you previously identified and then asking the generative AI to develop a problem tree for each of them.

   For each final solution, please write a paragraph in your own words about the path you took to reach your final idea, how you devised your prompts, and why you decided to stop at that particular solution. Why do you believe this is a good solution for the original problem/opportunity?

Figure 3. Descriptions for the sections that constitute the Creativity + AI part of the Creativity Portfolio.

Finally, at the conclusion of the Creativity Portfolio, students are provided the following prompt and asked to write a multi-page reflection:

> In other courses a final exam is helpful in providing you with the opportunity to review and synthesize the course content. In this course there is not a final exam, and so it is important for you to synthesize your learning in another way. For the last part of your Creativity Portfolio, develop a written synthesis for your personal benefit and future use,

including key lessons about creativity that you want to remember. Write about what you have learned, how you have changed, and how you might apply what you have learned.

Because students had the opportunity to choose the format, layout, and design of their Creativity Portfolios, it is difficult to quantify the average submitted length of each part and section. As an attempt to provide some degree of context, with typical text size of about 12 and spacing varying between single and double, students submitted final Creativity + AI parts ranging from approximately 15 pages to over 300 pages in total length. This significantly increased the overall length of the Creativity Portfolios from past semesters. To summarize each of the primary modifications to this assignment piloted first in the Fall 2024 semester, descriptions and justifications are listed in Table 2.

Section Modified	Summary of Modification	Justification
Overall	Divided into two distinct parts	Modified to make clear distinction as to where generative AI should be utilized
Overall	Number of total entries for each section changed	Modified to account for additional entries in new Creativity + AI section to maintain overall workload
Curiosity Inspiration	Sources of inspiration should be realized during the current semester	Modified to encourage development of intentional curiosity
Stockpile of Knowledge, Information, and Curiosities	Entries need to originate from specific academic endeavors from the current semester	Modified to connect academic learning to creativity and develop awareness of personalized interests
Problems/Opportunities for Improvement	Encouraged to focus on developing entries that originate from student's academic area of expertise	Modified to promote curiosity in individual fields of study and limit number of more common or universal entries
Creativity Reflection	Added recommendation to reflect on role of generative AI in creativity and design	Modified to encourage intentional thought and reflection on generative AI and ideation
AI + Problem/Opportunity Identification	Section added for intentional use of generative AI	Modified to practice using generative AI as a tool for creativity
AI + Ideation	Section added for intentional use of generative AI and reflection on prompt engineering	Modified to practice using and think critically about generative AI as a tool for creativity

Table 2. Descriptions of modifications to Creativity Portfolio piloted in Fall 2024 semester.

The Creativity Portfolio is assessed using a rubric and individualized feedback is left as comments in the course learning management system. Brief descriptions of the criteria listed on the rubric can be seen in Table 3.

Component	Brief Description	Total Points
Curiosity Inspiration	Describes a variety of compelling sources of inspiration	10
Stockpile of Academic Knowledge and Discoveries	Compilation of knowledge and information based on student's experience throughout semester; written as sentences and may include an additional link/resource	10
Problems/Opportunities for Improvement	Describes problems/opportunities with a diversity of topics; written as at least one sentence each that includes both a succinct description of the problem/opportunity and justification of its specificity	17
Solution Ideas	Includes interesting solution ideas that are of varying degrees of novelty as judged by an expert group (i.e., many ideas have not been thought of and widely distributed by others); demonstrates intentionality in developing multiple ideas per problem	20
Implementation Plans	Includes comprehensive implementation plan (approximately one page in length each, including visuals/sketches) that describe how the idea could be moved from vision to reality	27
Creativity Reflections	Demonstrates evidence of continuous reflection throughout semester on the topic of creativity enhancement and the creative process	13
[Final] Written Synthesis	Exhibits thoroughness and thoughtfulness in reflecting on key course takeaways, growth and creativity enhancement, and specific future application of course material	15
AI + Problem/Opportunity Identification	Includes AI-generated problems/opportunities that are each at least two sentences long; includes multiple prompts and outputs; demonstrates critical and creative thought through engagement with AI tool	20
AI + Ideation	Includes AI-generated problem trees and a novel, comprehensive solution for each one; includes a paragraph written without the use of AI to justify the final selected idea, prompts, and decision to stop at the selected idea; includes multiple prompts and outputs; demonstrates critical and creative thought through engagement with AI tool	18

Table 3. Rubric components, brief descriptions, and designated points (150 total).

4. Discussion

The increased prevalence of the use of both free and paid generative AI tools by students in university settings in the past years necessitates its incorporation into the academic classroom. This facilitated discussion and experience of using AI can help students understand and debate the opportunities, limitations, and ethics of these tools, many of which will be available to them in their future professions.

While it is straightforward to comprehend how generative AI can assist students with rote and formulaic tasks, it is worth exploring how these tools can be utilized to assist with more creative or open-ended prompts and problems. The Creativity + AI part of the Creativity Portfolio is one example of how generative AI can be used to assist in identifying interesting, relevant, and impactful problems and opportunities to address as well as in ideating and developing multiple solutions to a single problem. Overall, submissions from the semester in which this modified Creativity Portfolio was piloted demonstrated that students varied in their ability to generate robust and interesting prompts and that there is merit in providing further instruction on and practice in writing inventive and specific prompts. This specificity is important in creativity and the development of interesting, novel, and impactful problems and ideas. While this assignment was completed individually by students, this could also be effectively utilized by groups and teams. Finally, generative AI has the potential to be helpful in the creative process as a tool to quickly add, eliminate, and modify constraints imposed on an idea or implementation strategy.

The question remains, did the addition of an intentional Creativity + AI component of the Creativity Portfolio decrease the extent to which students used generative AI in the Foundational Creativity section? It was anecdotally evident that the modified Creativity Portfolio assignment description did aid in decreasing the use of generative AI and gleaning content from pre-written lists available on the internet. This was noted by the number of unique entries across different student submissions as well as entries that were more directly related to each students' individual interests and academic backgrounds. Future work, including post-course student surveys, could be conducted to formally quantify and study this insight.

One final point of discussion is the relevance of the Foundational Creativity part in general. If students have access to generative AI tools—and presumably will in their future professional careers—why not allow these tools to be used throughout the entire Creativity Portfolio? The Foundational Creativity section is intentionally designed to provide ample and deliberate practice of curiosity, idea generation, and idea visualization through sketching to strengthen these skills, tolerate ambiguity, and wrestle with cognitive blocks. Encouraging the use of a physical notebook or accessible alternatives also can help students maintain concentration and minimize their likelihood of focus-shifting, which can aid in establishing flow [17] and novel idea generation. However, it is worth noting that in the Fall 2024 semester, only four out of 42 turned in a physical notebook as the final submission of their Foundational Creativity section. There are a number of reasons, including logistics specific to this course, that might account for this, but it is taken as a lesson learned to review and modify for future semesters.

5. Conclusion

This work seeks to serve as an example of how generative AI can be incorporated into existing course deliverables without the need for significant course modification or the minimization of

student learning outcomes. Multiple questions could be used as a starting point to select which singular course module, assignment, or assessment (all consolidated under "deliverable") to modify, including:

1. Which existing deliverable might students be drawn to question whether generative AI could be utilized? In other words, which deliverables—or specific prompts or questions within a deliverable—might students be curious whether generative AI could already answer effectively?
2. Which existing deliverable or prompt is already written in a way that could provide students with an opportunity to practice innovative and thoughtful prompt engineering?
3. Which existing deliverable, if a generative AI component was added, would allow students to meet the associated learning outcome(s) at a higher level than without the incorporation of generative AI?

This third question is potentially the most crucial. Ultimately, all decisions regarding curriculum, delivery format, and deliverable and assessment mechanisms are made to allow for students to most robustly achieve the intended learning outcomes. Learning objectives and outcomes that are thoughtful, intentional, and forward-thinking provide a purpose, direction, and justification for curricular decisions, including if and how technology such as generative AI is incorporated. Backward course design [18] provides an effective structure to accomplish this.

The quantity, variety, and accessibility of generative AI platforms continues to evolve. As these tools become more integrated and embedded into existing digital applications, it is imperative to teach engineering students how to use them effectively and efficiently in their professional endeavors that require both critical and creative thinking skills. Engineers develop impactful, novel solutions to both large- and small-scale problems, and equipping students with the skills and practice necessary for utilizing cutting-edge technology to do so is essential.

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