Poetry Writing as a Creative Task to Enhance Student Learning

Emma S Atherton, University of Florida

Emma S. Atherton is an incoming Management Consultant and a recent graduate from the University of Florida with a Master of Engineering in Industrial and Systems Engineering, with a concentration in Production and Service Operations. She additionally received her Bachelor of Science in Industrial and Systems Engineering from the University of Florida, with a minor in Sales Engineering.

Prof. Elif Akcali, University of Florida

Dr. Elif Akcali is an Associate Professor in the Department of Industrial and Systems Engineering and the Michael Durham Professor in Creativity at the University of Florida (UF) and a UF Entrepreneurship Faculty Fellow. She is an industrial engineer, a visual artist and an explorer of the interplay between the engineering and the arts.

Poetry writing as a creative task to enhance student learning

Abstract

Most engineering students are rarely assigned creative tasks to think abstractly around mathematical models, other than being asked to apply theory to real-world scenarios. Challenging the traditional pedagogy, students enrolled in inventory and supply chain system design and control, an upper-level industrial and systems engineering course, were asked to complete two poems throughout the semester-long course. The students were asked to construct poems around a concept, model, or topic covered in the course: the first poem was focused on deterministic inventory modeling and the second poem was focused on stochastic inventory modeling. After each technical poem writing assignment, students were asked to respond to several open-ended questions detailing their experience and attitude towards these creative writing assignments. Data was collected during the semesters Fall 2022 and Spring 2023 and of the 84 total students over the two semesters, 64 consented to participate in the study. The participant responses to reflection prompts were analyzed qualitatively using open and axial coding by the two members of the research team to understand how engineering students approached this creative writing assignment and what type of creative processes they utilized to complete these assignments. To this end, the participant responses to reflection prompts were analyzed to identify the intrinsic and extrinsic motivations and their processes toward completing these poetry-writing assignments. In this paper, the research team's findings on why students pick specific topics for their poems and how their reasons for choosing topics influence their effort in their writing as well as the technical accuracy of their poems are presented.

Keywords. Poetry, engineering education, inventory control, conceptual understanding, intrinsic motivation, extrinsic motivation, mathematical modeling.

Introduction

The exploration of creativity and the interworking of human creativity through a research lens began in the eighteenth- or the nineteenth century, and scientific research of creativity has accelerated since the middle of the twentieth century [1, 2]. To date, the exploration of creativity in an educational environment, and the limitations of teaching, learning, practicing, and assessing creativity in such settings, have not been adequately assessed or understood, but the relationship is beginning to be conceptualized in various ways [3].

As an attempt to incorporate creativity training into engineering education and to enhance the creative thinking skills in undergraduate engineering students, poetry-writing assignments were introduced to a large university's upper-level industrial and systems engineering course on supply chain system design and control. A careful investigation into the student perceptions of these poem-writing assignments shed light to the benefits of creating technical poems. There is evidence in the literature how technical poetry writing in STEM fields in general [4, 5, 6] and engineering in particular [7, 8, 9, 10, 11, 12, 13, 14, 15] contributes to a deeper conceptual understanding of technical models while simultaneously engaging students' imagination and unorthodox thinking.

Poetry writing in a technical course, i.e., technical poetry writing, is a form of creative learning. Creative learning is not simply memorizing information and procedures but knowledge acquisition and skill development using creative techniques, where one learns through creating an artifact. Creative learning does not have systematic guidance for educators, which can lead to students feeling dismissed or discouraged when sharing their creative work and potentially abandoning their creative aspirations [16]. To further understand this impact, there is a need to understand why it is that students "create" in the first place, that is, what is the student's motivation. "Without the right kind of motivation, creativity is nearly impossible" [17]. Motivation can be categorized into two types: intrinsic and extrinsic. Intrinsic motivation according to most literature is the motivation to accomplish a task simply because it is personally rewarding, enjoyable, and sparks excitement and interest. Alternatively, extrinsic motivation is the motivation to accomplish a task for some external reward, something unrelated to personal fulfillment and being either an external goal or incentive. According to a previous study, college students who align with intrinsic motivation show superior long-term retention compared to those peers without [18]. Amabile provides a simple, yet powerful, Intrinsic Motivation Principal which states intrinsic motivation is necessary for creativity and extrinsic motivation is almost always detrimental [17].

This paper attempts to develop a preliminary understanding of the type of motivation undergraduate engineering students may align with in creating a poem in a technical course in their engineering curriculum. To this end, the following research questions are considered:

1. Do engineering students demonstrate more intrinsic or extrinsic creative motivations when developing their technical poem-writing assignments?
2. How are the students approaching the process of developing their technical poem-writing assignments?

The remainder of the paper is organized as follows: The course and poetry-writing assignments are discussed in-depth, before describing the data collection methods. After the data analysis approach and results are presented in detail, preliminary insights are discussed. The last sections include limitations of the study with their shared potential exploration avenues and concluding remarks.

Data Collection

Course Overview. The course is a three-credit hour upper-level undergraduate industrial and systems engineering where students' analytic abilities are challenged to formulate and solve inventory, logistics, and supply chain problems faced by today's firms. It is a required course for all students in the production and logistics track in the major and a breadth course for students in other tracks. The course is offered twice a year in the fall and spring semesters with an average enrollment of 45 students per semester. The first half of the course is dedicated to inventory modeling, which serves as a basis for the latter half focusing on transportation, logistics, supply chain design, and demand forecasting. The students develop abilities to model, optimize, and design such systems throughout the course.

Course Material. Students are expected to attend classroom lectures three times a week to receive detailed class notes and participate in group discussions. Class material is made available through slide decks and additional lecture notes are provided including more comprehensive discussions of concepts, technical derivations as well as example problems and the solutions to the example problems discussed during class meetings. The slide decks are designed to facilitate in-person lectures and serve as an outline for the discussions. Supplemental readings for lectures, such as essays and articles from contemporary business literature, are also shared on the course website to aid class discussions and encourage students to relate the technical course material to real-world applications.

Course Design. A student's success in the course is balanced between the procedural and conceptual understanding of the material. For procedural understanding, the instructor works through various example problems within lecture for each topic and provides additional problem sets in the detailed lecture notes for students to solve on their own and check their solutions against. Students are asked to demonstrate their procedural understanding via homework assignments, quizzes, and exams. For conceptual understanding, the instructor identifies news articles or opinion pieces published in news media and leads brief discussion sessions during classroom meetings. Students are asked to demonstrate their conceptual understanding through technical and creative writing assignments, encouraging students to relate their own meaning and integrate their own functional grasp of a certain topic. Technical writing assignments support critical thinking skills development, where creative writing assignments support imaginative and creative thinking skills development. Creative writing assignments require students to complete three graded poetry-writing assignments. While the first poem is about themselves, the second and third poems are technical poems that focus on course material. Also, the students are required to complete reflection questionnaires that aim to understand how they approach these technical poem-writing assignments.

Required Poem Structure. All poems had to follow the structure of the "I am" poem (see Appendix A). In its original form, an "I am" poem invites a writer to describe themselves through several prompts. The simple structure of the poem is easy to describe to engineering students and the basic instructions for the poem are clear; essentially, each line of the poem is a "fill-in-the-blank" type question dismissing any "unfairness" due to varying levels of experience with and/or degree of interest in poetry or any form of creative writing.

The power of language prevails in the embedded persuasion of the "I am" poem structure to encourage writers to convey the personification of a subject. The imagination of an abstract concept in this context would allow the writer to act as the voice of the subject and understand what the adverse effects of the environment surrounding it can look, or even feel like. Personification is a literacy device that uses the attribution of human affect-, cognition-, and/or behavior-based characteristics to be embodied in a non-human object. A writer associating with any person, object, or abstract concept other than the writer themselves capacitates an imaginative environment and perceives reality differently. A deeper look into the prompting language can be helpful to visualize the impact the structure has on the writer. The differentiation in processes between writing a poem about oneself versus a mathematical or technical theory can be drastic, however, students in this course are challenged to explore understanding inventory and supply chain models in an abstract manner. Integrating their knowledge built within the

course, students are asked to write about a concept, model, topic, or issue pertaining to deterministic and stochastic inventory modeling.

Creative Writing Assignments. The first poem-writing assignment required students to create an "I am" poem about themselves. This assignment allowed students to experiment and gain some experience with the specific poetic form on a topic that is personal and well known to them. This assignment is due in the second week of the course to encourage creative thinking early on. The second poem-writing assignment required students to create an "I am" poem about a topic that relates to deterministic inventory modeling and is due after the discussion of the material is complete and before the first term exam is administered. Similarly, the third poem-writing assignment required students to create an "I am" poem about a topic that relates to stochastic inventory modeling and is due after the discussion of the material is complete and before the second term exam is administered. Please see Appendix B.1 for detailed instructions provided to the students to complete the poem-writing assignments.

Reflection assignments were required for students to revisit and share their experience of writing their technical poems within two weeks of submitting the assignment. The reflections were formatted as 60-minute, multiple attempt quizzes on the online course interface. Please see Appendix B.2 for the prompts provided to the students to complete the reflection assignments.

Data Collection. The data for this study was collected over the Fall 2022 and Spring 2023 semesters in the EIN4343 Inventory and Supply Chain Systems in the Department of Industrial and Systems Engineering at the University of Florida. In Fall 2022, there was one section offered with enrollment of 26 students; in Spring 2023, there was similarly one section offered with enrollment of 58 students. The first 6-weeks of the Fall 2022 were recorded online as the course was transitioning from an online environment to a strictly in-person classroom.

A survey at the end of each semester asked students if they consent to their poems and responses to the reflection assignments can be used in a research study: 21 out of 26 students in Fall 2022 and 43 out of 58 students in Spring 2023 consented to participate in the study. Student poems and responses were then de-identified by tagging three-digit ID numbers to student names; the first number in the ID represents the semester from which the data is from, for Fall 2022 it was "3" and Spring 2023 it was "4". The two succeeding numbers are from a randomization assignment from the number of students participating and data entries are then logged in sequential order given this. An example of a *YYY* ID replacement would be "432". For the remainder of this paper, we will be using *X-YYY-Z* to represent specific data entries where the response of participant *YYY* to the prompt *Z* in Poem *X.* Following the previous example, looking at poem 1 and prompt 3, the data entry of interest would be "1-432-3". While Table 1 shows the proportion of students who consented to participate in the study, Table 2 demonstrates the sample size for the data used in this study. Two sample students' poems, in Deterministic and Stochastic inventory modeling, can be found in appendix B.3.

Table 1. The percentage of students who gave their consent to participate in the research study.

	Fall 2022	Spring 2023	Total
Number enrolled	26	58	84
Number consented	21	43	64
Percentage consented	81	74	76

Data Analysis

The participant responses taken from the reflections following Poem 2 and Poem 3 were analyzed qualitatively using open and axial coding by two researchers (ESA, EA).

Topic Selected. Each participant response received a single topic code. Tables 3 and 4 below display the frequency of various topics across both semesters for deterministic and stochastic inventory modeling, respectively. The raw data counts for each can be found in appendix D and tables D.1 and D.2. For the Fall 2022 semester, there was not an explicit question in reflection prompts that inquired the particular topic that the participant chose for their poem, and, therefore, some participants did not report their topic. Those responses are coded as *undeclared.* For the Spring 2023 semester, however, a separate question was included to ensure all participants reported their topic in a clear manner (see Appendix B.2). Aside from *undeclared*, the codes from the analysis of deterministic inventory modeling in Poem 2 are *preliminaries, ABC analysis, EOQ modeling,* and *miscellaneous* whereas the codes from the analysis of stochastic inventory modeling in Poem 3 are *preliminaries, newsvendor, (q,r) policy,* and *miscellaneous.* For participants who chose a topic that did not fall into one of the predetermined categories, their response was tagged to *miscellaneous.* The miscellaneous reports both occurred in Spring 2023, for poem 2 participant [2-424-1] chose to write on speculation within the need for inventories and for poem 3 participant [3-428-1] did not follow instructions and chose to write on ABC analysis from the deterministic inventory methods section.

Table 3. The percentage of topics selected by participants for deterministic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Preliminaries	ABC Analysis	EOQ Model	Miscellaneous	Undeclared	Total
F22	0	24	62	s0	14	100
S23	30	5	63	2	0	100
Total	20	11	62	2	5	100

Table 4. The percentage of topics selected by participants for stochastic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Preliminaries	Newsvendor	*(q,r)* policy	Miscellaneous	Undeclared	Total
F22	0	86	0	0	14	100
S23	5	65	28	2	0	100
Total	3	72	19	2	4	100

Process of Topic Selection. To understand the process of student decision making when selecting a topic for creating their technical poems, Prompt 1 in Fall 2022 and Prompt 2 in

Spring 2023 have students reflect on how and why they chose their topic (see Appendix B.2). The differentiation and growth in question detail between semesters was to enable students to decide if they would rather (1) pick and write on a topic to be done with the assignment, or (2) pick a topic that is not as familiar and take it as an opportunity to learn more. A careful examination of the participant responses to the question revealed that a response can disclose, offer, and communicate several different forms of insights. To elicit these insights four code categories were created: (1) *how,* (2) *why,* (3) *outcome,* and (4) *additional observations*.

Code Category 1: How. This code category aims to understand how a participant chose their topic, i.e., the participant's process. If any is articulated, the process is any stated actions taken to identify the topic among from which the set of topics is allowed for the poem. An example of this is "I went through the slides and picked a topic I was familiar with and knew relatively well" from [2-429-2] where "I went through the slides" was recorded for the how. More examples of this are: "Hesitated between two topics." [3-303-1] and "Reviewed my notes and thought about some of the most important themes covered so far" [2-320-1]. Most participants did not recognize the difference between how and why, choosing to instead only focus and respond to the why. For example, "I picked a topic that I knew well and was also big enough to be able to describe it in depth through the form of poem." [3-443-2] does not discuss the process taken to choose a topic, but rather just their reasoning. Due to this, few responses were recorded for the how and the total number of responses is shown below in Table 5.

Table 5. Number of coded participant responses to how they chose the topic for creating their poem-writing assignment.

	Fall 2022	Spring 2023	Total
Poem 2	3	10	13
Poem 3	1	1	2
Total	4	11	14

Code Category 2: Why. This code category relates to why a participant chose a certain topic, i.e., the participant's purpose. This category focuses solely on the reasons behind the student's decision making to choose the poem topic. Students' motivation in creating their poems can shine through in this question. Specifically, it can help further define the distinctions between intrinsic and extrinsic motivation.

Some participants choose to use creative assignments to learn, and have it served as a tool to study for future benefits (i.e. exams, grades, jobs, etc.), whereas others choose to use it as a rare creative outlet and view the assignment as nothing more than art. There is a difference between art and studying. Studying is not an art but a task, art is a creative outlet to explore imagination. In a complete alternative, some participants simply do not want to waste their time. They have their methods to study, they have their personal creative outlets, and this assignment was just on their list of things to do, which meant completing it with ease and little effort. A way to think of these differences would be comparing a participant choosing to write a topic because it covers the most material which leads to a deeper understanding of the course material versus a participant who chooses to write about a topic that was interesting and wanted to express their creativity in the assignment; these participant possess very different motivations.

With a fundamental understanding of the aspects that contribute to intrinsic and extrinsic motivation in creativity through literature along with the participant responses to why they chose a topic, seven creative motivation types were defined:

- *Ease of completion:* This relates to the participants motivation to minimize the amount of time, effort, and resources required to finish the poetry-writing assignment, thereby seeking an easy path to completing the assignment (e.g., "Easy to depict" [2-417-2], "I found it easier to do the poem based on it" [2-303-1], and "I felt they would be most easily conveyed in a poem" [3-321-1]).
- *Personal interest:* This relates to the participants motivation to some form of pleasure or joy taken from the topic, or some overarching interest in the innerworkings of the concept (e.g., "I picked a topic that I thought would be interesting to explore creatively and analytically" [3-406-2] and "I also like that altering this model creates different scenarios for inventory systems" [2-313-1]).
- *Creatively compatibility:* This relates to the participants motivation to ensure the topic worked well with the vision the participant had for their poem or had enough specifications (e.g., "felt I could put myself in it's shoes to better describe its character" [3-436-2] and "works as a good base for this type of poem" [3-301-1]).
- *Important topic:* This relates to the participants motivation by including any language in their response that signals importance or an explicit statement or mention of the chosen topics importance, being either to them, the lectures, the course, or the world (e.g., "Inventory holding cost is quintessential to inventory modeling" [2-420-2], "it was the main model that was being discussed for our class right now" [3-318-1], and "I thought it would be nice to write a poem on the most important pieces in an inventory" [2-302-1]).
- *Prior knowledge*: This relates to the participants motivation of stored knowledge and includes any mention of prior understanding of the topic before completing the poem from either this course or another course (e.g., "I had a better understanding of that model at the time" [3-304-1] and "I knew it well and was very familiar with its features and characteristics" [2-439-2]).
- *Future assessment:* This relates to the participants motivation to receive some future reward being either with an exam, quiz, grade, job, or impression (e.g., "I wanted to invest extra time in learning the material before the exam" [2-438-2] and "it was exam study time and critical ratio was one of the most important exam topics" [3-432-2]).
- *Enhance understanding:* This relates to the participants motivation to expand their knowledge and includes any explicitly stated desires to understand the topic better through the process of completing the poem (e.g., "I wanted to develop a better conceptual understanding of it" [3-440-2] and "I felt like it was the topic I was least confident about and wanted to know it better" [3-306-1]).

The frequency of identified creative motivation types for Poem 2 and Poem 3 are presented in Tables 6 and 7, respectively. The raw data counts can be found in Appendix D in Tables D.3 and D.4, respectively.

Table 6. Percentage of creative motivation types identified from participant responses on topic choice for deterministic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Ease of completion	Personal interest	Creatively compatible	Important topic	Prior knowledge	Future assessment	Enhance understanding	Total
F22	5.3	15.8	13.2	18.4	18.4	2.6	26.3	100
S23	8.9	8.9	8.9	12.7	34.2	10.1	16.5	100
Total	7.7	11.1	10.3	14.5	29.1	7.7	19.7	100

Table 7. Percentage of creative motivation codes identified in participant responses on topic choice for stochastic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Ease of completion	Personal interest	Creatively compatible	Important topic	Prior knowledge	Future assessment	Enhance understanding	Total
F22	17.9	7.1	14.3	14.3	25.0	3.6	17.9	100
S23	9.4	9.4	7.8	7.8	29.7	10.9	25.0	100
Total	12.0	8.7	9.8	9.8	28.3	8.7	22.8	100

While these topics are forms of manifested creative motivation, many are experienced simultaneously where the participants have motivations feeding into each other and influencing the final product, being the root of the motivation. When looking to broaden the categories back into intrinsic and extrinsic motivations, it will not always be accurate to label a participant based on the creative motivations independently, but rather a comprehensive analysis of a participants' motivations and how they relate to one another. To properly evaluate this, two categories are made for intrinsic and extrinsic motivation counts after the previous distinctions are identified for each data entry. For example, “I picked a topic that I thought would be interesting to explore creatively and analytically. I would say that I knew the topic well, but not particularly more than other topics. I thought the topic had lots of room for my imagination” [3-406-2] received a binary score of 1 for the creative motivation categories: *personal interest* (“interesting to explore creatively and analytically”), *creatively compatible* (“lots of room for my imagination”), and *prior knowledge* (“I knew the topic well”). A preliminary mapping of each creative motivation category to intrinsic versus extrinsic motivation is provided in Table 8.

Table 8. A proposed mapping of creative motivation codes against intrinsic versus extrinsic motivation.

Creative motivation code	Motivation type
Ease of completion	Extrinsic
Personal interest	Intrinsic
Creatively compatible	Intrinsic
Important topic	Extrinsic
Prior knowledge	Intrinsic
Future assessment	Extrinsic
Enhance understanding	Intrinsic

Using the proposed classification in Table 8, each participant’s creative motivation codes were mapped into intrinsic and extrinsic motivation groups to obtain counts. Following the previous example, this participant would have a score of 3 for intrinsic motivation. Another example is [3-410-2] who responded “I picked a topic I was less familiar with to study for the exam” which

was mapped to only *future assessment* and therefore, has a score of 1 for extrinsic motivation. The total counts for the intrinsic versus extrinsic motivations participants experienced are listed in Table 9 below.

Table 9. Intrinsic vs. extrinsic motivation counts for all participants in Fall 2022 and Spring 2023 semesters for Poem 2 on deterministic inventory modeling and Poem 3 on stochastic inventory modeling.

	Fall 2022		Spring 2023		Total	
	Intrinsic	Extrinsic	Intrinsic	Extrinsic	Intrinsic	Extrinsic
Poem 2	28	10	54	25	82	35
Poem 3	18	11	46	18	64	29
Total	46	21	100	43	146	64

Code Category 3: Outcome. This code category captures whether the participant reports any benefits after having written the poem. The category does not encompass initial anticipations, or outcome of the process, or the process itself, but rather the actual results achieved regarding learning. This is coded to fit any language using future tense, meaning, the participant reported they saw some payoff of their work in the poem for their future gain. An example of this is, "I felt that I could conceptually understand it better after I did the poem." [2-413-2] and "I would also say this helped me on the exam" [3-314-1].

The outcome code does not account for or include language that signals a desire for a change of knowledge, meaning, if a participant did not mention an explicit statement of a future outcome, it will not be considered. This can be examined through the response "The exam was upcoming, and I wanted to make sure I understood the model conceptually for the first part of the exam." [3-402-2]. The language signals that the participant wanted a future outcome being that they understood the model for the conceptual portion of the exam, however, there is no direct report of the poem ultimately benefiting the study preparations or not. This participant had no outcome reported.

Code Category 4: Additional observations. This code category allows for researchers to capture and document any provoked thoughts from the data that might potentially provide some useful or insightful information that the participant included about the experience/process of writing the poem. Any responses that do not fit into the categories above will be included in this section to capture any remaining aspects of the response. For example, records of additional information are "Changed my study style in a way recently because I was not performing very well in the last exam. This began with (q,r) policy. I am not the best poet and sometimes find myself stumped to word items correctly." [3-409-2] and "Writing creatively about a topic you do not know much about forces you to look at the material in a different way which ultimately helps you understand a topic." [3-309-1].

Resources. To understand the student process in creating their poems, Prompt 2 in Fall 2022 and Prompt 3 in Spring 2023 ask students to report the resources they utilized. These resources include:

- *Slide decks* are provided throughout the course and serve as the basic material to guide and supplement in-class discussions.

- *Lecture notes* provide detailed text written by the instructor and provide in-depth conceptualizations and example problems with solutions to support the material introduced during lectures via in-class discussions.
- *Class discussions* pertain to the information discussed or explained in class meeting times delivered by the instructor, this could be portrayed as a resource in student responses by mentioning attending lectures or keynoting a piece of information they remember hearing.
- *Personal annotated notes* correspond to students' own notes taken during class meeting times (physical or computerized) or notes taken on top of the provided slide decks supporting the course structure (printed or electronic).
- *Previous assignments* are any homework or quiz assignments students may have looked back on for help.
- *Online research* includes any additional research conducted via the internet identified by the student including, but not limited to, Google, YouTube, Wikipedia, other institution material, etc.
- *Other* corresponds to other inputs the participant could have used as resources such as: "personal real-world experience" from [2-316-2], "personal knowledge" from [3-411-3], or "imagination" from [2-437-3]. Table 8 and Table 9 present the frequency of each resource's utilization within a participant's process in creating their poem.

Table 8. Frequency of resources used by participants for deterministic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Lecture notes	Slide decks	Class discussion	Personal notes	Previous assignments	Online research	Other	Total
F22	5	20	1	5	0	8	1	40
S23	23	41	7	15	3	8	1	98
Total	28	61	8	20	3	16	2	138

Table 9. Frequency of resource used by participants for stochastic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Lecture notes	Slide decks	Class discussion	Personal notes	Previous assignments	Online research	Other	Total
F22	6	20	2	2	0	3	2	35
S23	22	42	4	11	1	4	1	85
Total	28	62	6	13	1	7	3	120

It should be noted that if a participant recorded that they used personal notes, it implies that they have attended the class meetings, however, it is not appropriate to infer they are using information from class discussions; meaning, only participants who clearly state the recall or use of in-class discussions in their response were assigned the class discussion code.

Estimated Duration. To understand the time allocation to a poem-writing assignment, Prompt 3 in Fall 2022 and Prompt 4 in Spring 2023 asked students to report their estimated time to completion duration. There was no specification in the prompt for respondents to answer in minutes versus hours, so all responses were later mapped to minutes in the data transformation phase. There was also no specific format provided for listing the time, so responses are

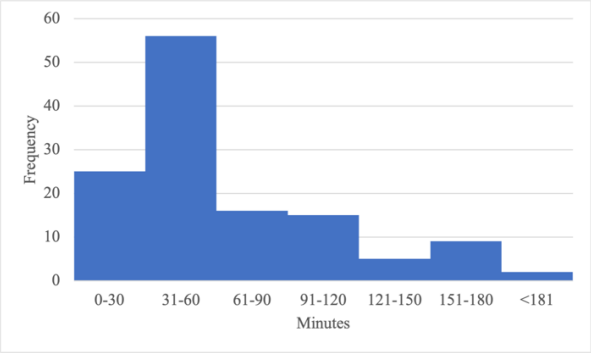
categorized into four broad groups: exact, estimate, bound, and range. Exact responses provided the precise amount of time the participant spent on the assignment (e.g., "1 hour" [2-422-4] or "20 minutes total" [3-309-3]). Estimate responses refer to responses using language signaling reasonable closeness to a time (e.g., "about an hour" [2-301-3], "around an hour" [3-441-4], "close to 3 hours total" [2-420-4], "approximately a cumulative 2.5 hours' [2-438-4]). Bound responses specify an amount of time and provide a qualifier accounting for the associated uncertainty (e.g., "little more than an hour" [2-317-3] or "little over an hour" [2-416-4]). Range responses gave a set of time between a start and end (e.g., "between 1 hour and 1.5 hours" [2-419-4], "roughly about 30-45 minutes" [2-318-3], or "a little over an hour, but no more than 2 hours" [3-430-4]). The parameters for a triangular distribution were generated for each data point in efforts to consolidate the data between the four groups and can be seen below in Table 10.

Table 9. Empirical approach used to estimate parameters of triangular distribution based on the student reported duration of poem-writing assignment.

	Estimated values		
Data input	Minimum	Average	Maximum
x	x	x	x
About/around/approximately, y	y	y	y
A little less/more than, z	$z \pm 1$	$z \pm 1$	$z \pm 1$
Between x and y	x	$(x + y)/2$	y

Following the methodology in the table above, the estimated minimum, average, and maximum were computed for each of the response categories. Little variations prevailed in the distributions of the minimum, average, and maximum values, and consequently, only the average frequency distribution will be used for the remainder of the paper. Figure 1 depicts the total average time to complete a poem-writing assignment from all total participants of the study (e.g., including Poem 2 and 3 from Fall 2022 and Spring 2023). Appendix C provides for individual frequency distribution plots for the estimated average time to complete the assignments per poem and per semester recorded.

Figure 1. Frequency distribution of total average time to complete poem-writing assignment (n=128).



The explanatory depth, or in other words, the degree of detail included in the student responses was another point of variation in this analysis. While some participants responded with an exact answer, as seen before in "1 hour" from [2-422-4], other participants elaborated on the time with their specific allocations in their process such as "I would say 2 full hours. 30 minutes reading

the slides and gathering information, 1 hour doing the actual poem, and 30 minutes reading the poem over and over again to correct mistakes and grammatical errors. I also did a final review to make sure all the lines of the poem made sense and that it looked good overall." [3-303-3]. Here, the participant describes in depth the procedure they took and the affiliated time allocations for each task. Only the time was considered for the responses to this prompt and all other information included was disregarded from further analysis.

Discussion: Preliminary Insights

Topic. Of the 128 data entries, 6 were identified (3 from poem 2 and 3 from poem 3) as having the topic undeclared in the participant reflection responses to the first prompt. The responses were not mapped to their specific poems for further investigation in the topic retrieval. Leaving the responses as undeclared avoids expert bias in recognizing the difference between what the last line of the poem says and how it reads (e.g. topic being EOQ, EOQ model, or EOQ model assumptions). The *preliminaries* shared a small portion of the chosen topics, including a diverse range of inventory and supply chain basics, with poem 2 having 13 and poem 3 having 2.

For Poem 2, the EOQ model was the most chosen topic with 40 out of the 64 participants. This comes at no surprise as the model and its extensions serve as the major topic within deterministic inventory modeling. Similarly, with not much surprise, the Newsvendor model for stochastic inventory modeling was the most chosen with 46 out of the 64 participants creating a poem around it. This topic had significant material following it as it is the first stochastic model the students are introduced to in the course, and it possesses several variants.

Do engineering students demonstrate more intrinsic or extrinsic creative motivations when developing their technical poem-writing assignments? To examine this first research question, the creative motivation scores can be examined. Of the seven identified creative motivations, students on average experienced 1.62 creative motivation categories when completing their poems. Broadening these categories and classifying them as either intrinsic or extrinsic motivations showed that the students complete their creative poetry-writing assignments with more intrinsic than extrinsic motivation; 146 out of 210 counted motivations were intrinsic whereas extrinsic had 64 out of the total. There were more identified motivations for Poem 2 than Poem 3. There could be a number of reasons for this difference, including but not limited to, shorter student responses within the reflection, students approaching a poetry-writing assignment for the first time could light new motivation that lessens with the second, students realized the grade scale is based on completion and not the effort put in, etc.

How are the students approaching the process of developing their technical poem-writing assignments? To examine this second research question, resources used, and time spent by the participant can be examined. Given that Spring 2023 has 43 participants and Fall 2022 has 21 participants, the ratio of participants per semester is nearly 2:1, respectively. From the totals given in Tables 8 and 9, the reported resources decreased by 15% from deterministic inventory modeling (n=138) to stochastic inventory modeling (n=120). This could gauge further investigation as the concepts of stochastic models can be much more complex than the deterministic ones. A potential justification could be the student's realization that the

assignments are graded on a completion scale, meaning the amount of effort they put into the assignment is not considered in the final score.

Resources. Additional analysis shows that the average number of resources used by an individual participant across the entire data set is 1.97 resources. Further, the average number of resources used by a participant in Fall 2022 are 1.90 resources for Poem 2 and 1.71 resources for Poem 3, where Spring 2023 had 2.28 resources for Poem 2 and 2 resources for Poem 3. Of these chosen resources, it can be seen in Table 8 and 9 that slide decks were the most used resource for both Poems 2 and 3 processes in each semester with the lecture notes and personal notes as stable runner ups, respectively.

Estimated Duration. Of the total 128 data entries, 63% of participants estimated they spent less than an hour on the poem-writing assignment; of that percentage, 44% of participants estimated they spent 31-60 minutes. Closely, 13% of participants spent 61-90 minutes and 12% of participants spent 91-120, leaving only 7% of participants spending more than 120 minutes. Ultimately, the average participant was spending anywhere from a half an hour to an hour on their creative process. Aside from the 2:1 sample size of Spring 2023 to Fall 2022, the semesters have similar results from both poem 2 and poem 3. There was a decrease in time duration from Poem 2 to Poem 3, respectively. Poem 2 had 44% of participants exceeding 120 minutes in Fall 2022, and similarly 43% in Spring 2023; Poem 3 only had 24% of participants exceeding 120 minutes in Fall 2022 and 33% of participants in Spring 2023. This fall could be due to the participants again realizing the assignment is graded for completion and the level of effort has no impact.

Limitations

One of the limitations of the study relates to how poetry writing is incorporated into the course. The exploration of a student's motivation in completing a poem-writing assignment is ultimately biased due to the classroom setting and grade basis of the assignment. As each poem-writing assignment is required (i.e., has points allocated towards the participant's final grade in the course), all participants already have a predisposed motivation. Each student is not completing the assignment out of free-willed desire, and they, most likely, experience some form of extrinsic motivation related to receiving the reward of a grade.

Another limitation pertains to the qualitative nature of the investigation. Although each data entry had the creative motivation identifications analyzed comprehensively per participant, previous literature that has explored theories, such as self-determination, were not considered. Self-determination theory (SDT), specifically, sparks interest in this study as it assumed intrinsic and extrinsic motivations can create a positive effect called synergistic extrinsic motivation; this effect is the intrinsic and extrinsic motivations adding up positively [20]. This could be further investigated in this study in the future.

In this study, no formal factor analysis was conducted to compare the correlation of the topic, resources, and estimated duration versus all the creative motivation factors. For instance, does an intrinsically motivated student spend more time complete the assignment? Does a student who

chooses to write a poem on a topic that they know well spend less time to complete the assignment?

The value of the poetry-writing assignments to the students relate to the development of communication skills, creative thinking, and conceptual knowledge acquisition[7]. The results reported here rely on self-report data of the students who participated in the study, i.e., the subjective assessments of the participants. However, the gains in communication skills, creative thinking skills, and acquisition of conceptual technical knowledge of the participants can be measured objectively. To this end, rubrics to assess the level of communication skill developed and creative thinking skill demonstrated needs to be developed. Furthermore, the gains in conceptual technical acquisition can be measured by some standardized questions can be developed. The research team is currently developing and testing such rubrics and standardized question sets.

Concluding Remarks

To engage engineering students in creative thinking by challenging them to conceptualize a personified perspective around an abstract concept encountered in the context of inventory modeling, poetry-writing assignments were assigned in EIN4343 Inventory and Supply Chain Systems course in the Department of Industrial and Systems Engineering at the University of Florida. Data was collected over the course of two semesters, Fall 2022 and Spring 2023, totaling 64 participants. In this paper, some preliminary results on the motivations students expressed or verbalized on why they chose a particular topic to complete a poem-writing assignment and how they approached to create their poems were examined. Seven types of motivations were identified in the study data, which were later categorized into extrinsic and intrinsic motivations. Results so far indicate that intrinsic motivations were expressed more frequently than extrinsic motivations. In the next stage of the study, factor analysis will be carried out to compare the correlation of the topic, resources, and estimated duration versus all the creative motivation factors.

Acknowledgements

This work has been in part supported by the National Science Foundation (2215133). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

1. Becker M (1995) Nineteenth-century foundations of creativity research. *Creativity Research Journal*, 8(3):219–229, https://doi.org/10.1207/s15326934crj0803_2.
2. Runco MA and Albert RS (2010) Creativity research. In *The Cambridge Handbook of Creativity*, pp. 3–19, https://doi.org/10.1017/cbo9780511763205.003.
3. Beghetto RA, Kaufman JC (2009) Intellectual estuaries: Connecting learning and creativity in programs of advanced academics. *Journal of Advanced Academics*, 20(2):296–324, https://doi.org/10.1177/1932202x0902000205.

4. Freeman LH, Bays C (2007) Using literature and the arts to teach nursing. *International Journal of Nursing Education Scholarship*, 4 (1): https://doi.org/10.2202/1548-923x.1377.
5. Peck SE (1993) Monitoring student learning with poetry writing. *Journal of Nursing Education*, 32(4):190–190, https://doi.org/10.3928/0148-4834-19930401-14.
6. Smith MA (1996) The use of poetry to test nursing knowledge. *Nurse Educator*, 21(5): 20–22, https://doi.org/10.1097/00006223-199609000-00010.
7. Akçalı E, Williams J, Burress R, Aguila A, Buraglia M. (2023) In their own words: Student perceptions of technical poetry writing in discipline-specific undergraduate engineering courses: Opportunities and challenges, *INFORMS Transactions on Education*, 24(2):119–199. https://doi.org/10.1287/ited.2023.0284
8. Millan HL (1996) Poetry in engineering education. *Journal of Engineering Education*. 85:157–162.
9. Mourtos NJ (1999) Portfolio assessment in aerodynamics. *Journal of Engineering Education*. 88:223–229.
10. Gunn CJ (2003) Engineers as poets: The need for poetry contests in colleges of engineering. *Proceedings of the 2003 American Society of Engineering Association (ASEE) Annual Conference Exposition*. ASEE, Washington, DC.
11. Christy AD (2004) Renaissance learning and poetry contests in bio-logical and agricultural engineering. *Proceedings of the 2004 American Society of Engineering Association (ASEE) Annual Conference Exposition*. ASEE, Washington, DC.
12. Graf JA, Christy AD (2006) Assessing perceptions of education: a case for increased interdisciplinarity. *American Society of Agricultural and Biological (ASABE) Meeting Presentation* Paper No. 068001. ASABE, St. Joseph, MI.
13. Christy AD, Graf JA (2005) Departmental to inter-collegiate engineering poetry contests. *Proceedings of the 2005 American Society of Engineering Association (ASEE) Annual Conference Exposition*. ASEE, Washington, DC.
14. Christy AD, Owens ME, Faure MJ (2007) Student portfolios, business communications, engineering poetry contests, and grading multiple drafts of technical writing documents. *American Society of Agricultural and Biological (ASABE) Meeting Presentation.* Paper No. 078001. ASABE, St. Joseph, MI.
15. Akçalı E, Buraglia M, Essenfeld A, Williams J (2021) Poetry writing in engineering education: Preliminary results and insights from an exploratory study. *Proceedings of the 2021 American Society of Engineering Association (ASEE)Virtual Conference.* Accessed February 9, 2023, https://peer.asee.org/37585.
16. Beghetto RA, Dilley AE (2016) Creative aspirations or pipe dreams? toward understanding creative mortification in children and adolescents. *New Directions for Child and Adolescent Development*, 2016(151):85–95. https://doi.org/10.1002/cad.20150.
17. Hennessey BA (2019) Motivation and creativity. In *The Cambridge Handbook of Creativity*, pp. 374–395. https://doi.org/10.1017/9781316979839.020.
18. Conti R, Amabile TM, Pollak S (1995) The positive impact of creative activity: Effects of creative task engagement and motivational focus on college students' learning." *Personality and Social Psychology Bulletin*, 21(10):1107–1116.
19. Ryan RM, Deci EL (2000) Intrinsic and extrinsic motivations: Classic definitions and new Directions." *Contemporary Educational Psychology*, 25(1):54–67.
20. Amabile TM (1993) Motivational synergy: Toward new conceptualizations of intrinsic and extrinsic motivation in the workplace. *Human Resource Management Review*, 3(3):185–201.

Appendix A. “I am” Poem Structure

I am *(two special characteristics)*
I wonder *(something you are actually curious about)*
I hear *(an imaginary sound)*
I see *(an imaginary sight)*
I want *(an actual desire)*
I am *(the first line of the poem restated)*

I pretend *(something you pretend to do)*
I feel *(a feeling about something imaginary)*
I touch *(an imaginary touch)*
I worry *(something that really bothers you)*
I cry *(something that makes you very sad)*
I am *(the first line of the poem repeated)*

I understand *(something you know is true)*
I say *(something you believe in)*
I dream *(something you actually dream about)*
I try *(something you make an effort to do)*
I hope *(something you actually hope for)*
I am *(the first line of the poem repeated)*

Appendix B. Student instructions for creative writing assignments

Appendix B.1 Poem-writing instructions

I am Poem 2

"*Scientists study the world as it is, engineers create the world that never has been*."

Theodore von Karman

"*What I cannot create, I do not understand*."

Richard Feynman

"*Engineers are expected to be able to explain a complex technology or product in simple, easily-understood terms not because the executive needs it explained simply to understand it, but as proof that the engineer understands it completely*."

John Gruber

Purpose

The purpose of this exercise is three-fold. First, it invites you to think deeply and make your own meaning of the technical material covered in EIN4343 Inventory and Supply Chain Systems, and, in turn, help you strengthen your conceptual understanding of the material. Second, it exercises your imaginative and creative thinking skills by creating a poem from the perspective of an abstract concept. Third, it provides a venue for you to exercise your skills to communicate a technical topic to general audiences.

This assignment will help you practice your:

- Conceptual thinking skills
- Imaginative and creative thinking skills
- Communication skills

This assignment will help further reinforce your knowledge on:

- The modeling assumptions and analytical approaches covered in EIN4343
- The implications and limitations of these models and analyses in practical settings

Task

This assignment, the second element of creative writing assignments, asks you to write an I am Poem about a topic, issue, model, etc. that relates to either ABC Analysis or the EOQ Model and its Extensions. Although the course focuses on model development and analysis as well as the use of models and analysis to solve problems that can be encountered in practice, conceptual understanding of the assumptions, implications, and limitations of these models and analyses is equally important. Please note the following:

1. For this assignment, you may use the original root verbs in each line of the poem (feel, touch, imagine, pretend, etc.) or change them as you see fit.
2. For this assignment, in addition to the "I am" line that lists two characteristics of the topic, issue, model, etc. that you chose to write the topic about that repeats 4 times throughout the poem, you are asked to include a fourth stanza with a single line that states the topic, issue, model, etc. that you chose to write about explicitly. For example, if you write about the ABC Analysis and have "I am straightforward and helpful" as the "I am" line that repeats multiple times, the 17th line should read "I am the ABC Analysis."
3. For this assignment, you may pick any topic. For instance, in the past, I have seen poems focusing on Class A items only or the ABC Analysis as a whole. Similarly, you can focus on the assumptions of the EOQ model or the derivation of the EOQ model.

Criteria for Success

Future engineering workforce needs an imaginative and creative mindset to address 21st century challenges faced by individuals, families, and communities in the nation and around the world. Furthermore, engineers should be able to

explain technical topics to general audiences in plain everyday language. As such, I encourage you to pick a topic, issue, concept, etc. that you find appealing, think about it more critically, and create a poem to explore, understand, and communicate the topic more deeply. First, you may focus on creating the different lines of the poem quickly to get a first draft. Next, you may focus on editing the lines and organizing the content so that the poem is interesting and informative.

Sample Student Work

Here is an example I am poem on ABC Analysis from a student. Note that the student changed the use of the I am line, which is acceptable. However, choosing two descriptive characteristics and repeating it multiple times in the poem adds to the writing's poetic quality. This poem is somewhat incomplete; I am lines for the second and third stanzas are unfinished. Furthermore, when you go through each line and think about it critically some lines are problematic. For instance, “I understand that 20% of the inventory represent most of the profit” could be technically correct only if the ABC analysis uses unit profit to evaluate the cumulative values for the items, which is not mentioned earlier in the poem. But the line “I say that Pareto principle is my mantra” is deeply profound, as it contextualizes Pareto Principle within ABC Analysis for inventory management.

I am interested on the consumption values
I wonder if all your products are important
I hear that demand differs from product to product
I see that the class A will have the highest relevance
I want to classify your items
I am analyzing your cumulative item values

I pretend to help you prioritize your items
I feel that some items are more important than others
I touch three different categories
I worry about how you utilize your resources
I cry if I cannot help you to improve your inventory
I am (the first line of the poem repeated)

I understand that 20% of the inventory represent most of the profit
I say that Pareto principle is my mantra
I dream that I can help to optimize your inventory
I try to let you know what is more important
I hope you will optimize your stock resources
I am (the first line of the poem repeated)

I am the ABC analysis

Glossary of Terms

None.

Appendix B.2 Reflection prompts

Table B.2.1. Student reflection prompts for Poems 2 and 3 in Fall 2022 semester.

Assignment	Questions
Poem 2	1. How and why did you choose the particular topic for your "I am" poem on Deterministic Inventory Modeling? 2. What course materials and other resources did you use to create your "I am" poem focusing on a topic related to Deterministic Inventory Modeling? 3. Provide an estimate of the amount of time it took you to create your "I am" poem on Deterministic Inventory Modeling from preparation and resource gathering through submission of the assignment.
Poem 3	1. How and why did you choose the particular topic for your "I am" poem on Stochastic Inventory Modeling? 2. What course materials and other resources did you use to create your "I am" poem focusing on a topic related to Stochastic Inventory Modeling? 3. Provide an estimate of the amount of time it took you to create your "I am" poem on Stochastic Inventory Modeling from preparation and resource gathering through submission of the assignment.

Table B.2.2. Student reflection prompts for Poems 2 and 3 in Spring 2023 semester.

Assignment	Questions
Poem 2	1. What was the particular topic of your "I am" poem related to Deterministic Inventory Modeling? 2. How and why did you choose the particular topic for your "I am" poem on Deterministic Inventory Modeling? Did you pick a topic that you know well? Or, did you pick a topic that you did not know well? 3. List all course materials (e.g., detailed class notes in .pdf files, slide decks, personal annotations on slide decks, what you recall from in-class discussion) and other resources (e.g., on-line resources) you use to create your "I am" poem focusing on a topic related to Deterministic Inventory Modeling. If you conducted on-line research and identified additional technical (e.g., Wikipedia, Investopedia, or netsuite.com) and/or literary art (e.g., rhyme finder, or Google translate) resources, please provide as much detail as you can on those that you found particularly useful. 4. Provide an estimate of the amount of time it took you to create your "I am" poem on Deterministic Inventory Modeling from preparation and resource gathering through submission of the assignment. You may prefer to provide an approximate estimate (e.g., x minutes or y hours) or provide a range (e.g., between x hours and y hours)
Poem 3	1. What was the particular topic of your "I am" poem related to Stochastic Inventory Modeling? 2. How and why did you choose the particular topic for your "I am" poem on Stochastic Inventory Modeling? Did you pick a topic that you know well? Or, did you pick a topic that you did not know well? 3. List all course materials (e.g., detailed class notes in .pdf files, slide decks, personal annotations on slide decks, what you recall from in-class discussion) and other resources (e.g., on-line resources) you use to create your "I am" poem focusing on a topic related to Stochastic Inventory Modeling. If you conducted on-line research and identified additional technical (e.g., Wikipedia, Investopedia, or netsuite.com) and/or literary art (e.g., rhyme finder, or Google translate) resources, please provide as much detail as you can on those that you found particularly useful. 4. Provide an estimate of the amount of time it took you to create your "I am" poem on Stochastic Inventory Modeling from preparation and resource gathering through submission of the assignment. You may prefer to provide an approximate estimate (e.g., x minutes or y hours) or provide a range (e.g., between x hours and y hours)

Appendix B.3 Example student-written poems

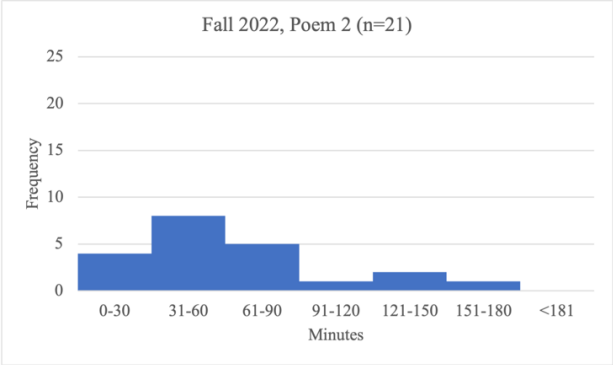
Table B.3.1. Deterministic inventory modeling: A poem on the economic order quantity model by participant ID 312.

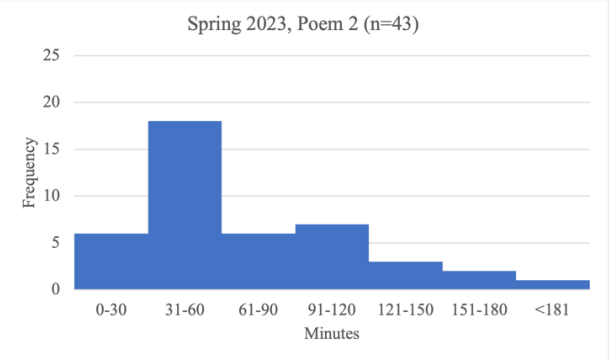
I am simple and fundamental I wonder about the order cost and inventory holding cost I hear that I consist of many assumptions I see that costs will have an influence on ordering quantities I want to help you determine how much to order I am simple and fundamental I pretend that there are no shipping delays I feel that my assumptions are not all realistic I touch the different types of cost I worry that you will not understand the effects of my different variables I cry when my average annual total cost of ordering and inventory holding do not equal I am simple and fundamental I understand that my costs have to have the same unit time I say to reduce the ordering cost by ordering more quantities I dream about the average total cost per unit time equation I try to offset order and holding costs I hope that you will utilize my analysis I am simple and fundamental I am an EOQ model

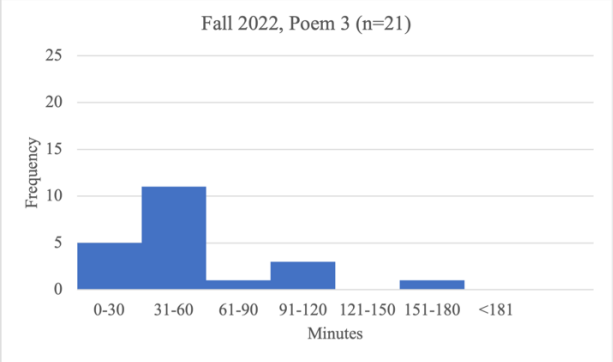
Table B.3.2. Stochastic inventory modeling: A poem on the (q, r) policy by participant ID 443

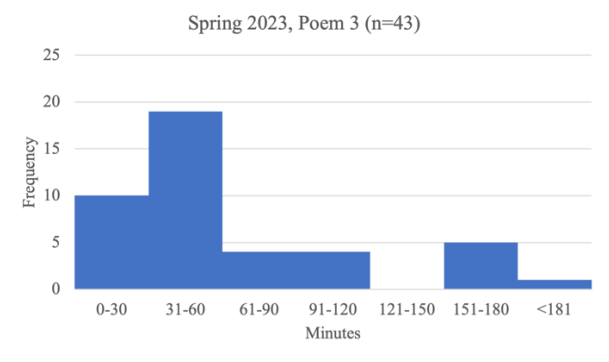
I am interested in the demand during lead time I wonder if my reorder level is greater than my expected demand I hear that there can be multiple approaches to me I see that I can have full backlogging I want to approximate an expected safety stock I am analyzing the cost of inventory I seek to give optimal values I feel that the demand is random I touch reorder level and order quantity I worry about whether my assumptions are all true I cry when order delivery time is unknown I am interested in demand during lead time I understand that my values are continuous I say that there is a fixed cost associated with my orders I dream my algorithm is done in 3 steps I try to be approximated accurately to reality I hope I will converge on the order quantity I am interested in demand during lead time I am the (q,r) policy

Appendix C. Frequency distribution plots for estimated time









Appendix D. Data on poem topic choice and creative motivation types identified

Table D.1. Count of topics selected by participants for deterministic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Preliminaries	ABC Analysis	EOQ Model	Miscellaneous	Undeclared	Total
F22	0	5	13	0	3	21
S323	13	2	27	1	0	43
Total	13	7	40	1	3	64

Table D.2. Count of topics selected by participants for stochastic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Preliminaries	Newsvendor	*(q,r)* policy	Miscellaneous	Undeclared	Total
F22	0	18	0	0	3	21
S23	2	28	12	1	0	43
Total	2	46	12	1	3	64

Table D.3. Count of creative motivation types identified in participant responses on topic choice for deterministic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Ease of completion	Personal interest	Creatively compatible	Important topic	Prior knowledge	Future assessment	Enhance understanding	Total
F22	2	6	5	7	7	1	10	38
S23	7	7	7	10	27	8	13	79
Total	9	13	12	17	34	9	23	117

Table D.4. Count of creative motivation types identified in participant responses on topic choice for stochastic inventory modeling in Fall 2022 (F22) and Spring 2023 (S23) semesters.

	Ease of completion	Personal interest	Creatively compatible	Important topic	Prior knowledge	Future assessment	Enhance understanding	Total
F22	5	2	4	4	7	1	5	28
S23	6	6	5	5	19	7	16	64
Total	11	8	9	9	26	8	21	92