Using scaffolding to support engineering students in the process of creating technical poems

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Abstract

To encourage students to use writing as a tool for learning technical topics and to gain experience communicating with general audiences, a set of technical poem-writing assignments was incorporated into an upper-level engineering course. However, crafting poems on engineering concepts that are technically accurate and creatively appealing is a complex task. To help students develop the necessary conceptualization and writing skills to complete technical poetry assignments successfully, three in-class activities were designed and developed. These in-class activities focused on identifying and working with a specific voice to ensure the coherence and technical accuracy of the poem, exploring a grammatical structure to further the technical depth as well as the musicality of the poem, and finally experimenting with the tone to enrich the emotional content of the poem. At the end of the semester, the students were required to respond to a reflection prompt to describe their experience and opinions about these in-class activities. A comprehensive analysis of student responses to the reflection prompt revealed student perceptions on the role of proposed in-class activities in developing their skills to create technical poems as well as how these activities enriched their educational experience. This paper presents results of the analysis of students' responses and discusses how the proposed in-class activities can be refined further for future implementation.

Keywords. Scaffolding. Poetry. Inventory control. Supply chain. Conceptual understanding. Creativity.

Introduction

Writing promotes both critical thinking and learning [1]. Hence, writing can be used as a key tool for learning, as the completion of a writing task requires the author to collect and process information to complete the task. While engineering students are required to complete numerous technical writing assignments throughout their engineering education, they are rarely given creative writing tasks in the context of their engineering coursework. While technical writing relies on actual and literal content, creative writing primarily relies on imaginary and figurative content.

To move beyond the traditional focus on technical writing in engineering education, creative writing tasks were incorporated into Inventory and Supply Chain Systems (EIN4343), an upper-level undergraduate course in the Industrial and Systems Engineering program at the University of Florida [2]. Specifically, the students were asked to create several technical poems throughout the semester focusing on deterministic inventory modeling, stochastic inventory modeling, and supply chain systems modeling. Since poetry writing in the context of an engineering course is an unusual assignment that engineering students do not typically encounter, instructional

scaffolding was utilized to provide support for students as they learned and developed the skill to create poems focusing on a technical topic.

Scaffolding is an approach where instructors offer support to students as the students learn a new concept or develop a new skill [3]. Instructional scaffolding is associated with several important benefits in learning, including facilitating increased communication between instructors and students, minimizing student frustration when encountering a novel concept or task for the first time, as well as improving student self-agency and self-confidence [4].

Scaffolding has been shown to be an effective strategy to develop engineering students' writing skills [5]. To support the development of conceptualization and writing skills of engineering students to craft technically accurate and original technical poems, three 15-20 minute in-class activities were designed and developed. In-class activities focused on important elements of poem writing and aimed to demonstrate how these elements can be utilized to craft technically accurate and original poems with emotional appeal on technical topics. In-class work completed by student teams was collected throughout the semester. Also, at the end of the semester, the students were required to respond to a reflection prompt to describe their experience and opinions about these in-class activities. The student reflections are qualitatively analyzed to investigate the following research questions (RQs):

RQ1. Do students think that in-class activities were helpful?

RQ2. What impact have in-class activities had on the experience of the students?

Data Collection

Course. EIN4343 Inventory and Supply Chain Systems is a three-credit hour junior-senior level course in the Industrial and Systems Engineering program at the University of Florida. While this course is required for the production and logistics track in the program, it serves as a breadth elective for students in the other tracks of the program. The course is offered twice during each academic year with about 35-50 students per offering and aims to develop students' abilities to formulate and solve inventory, logistics, and supply chain problems. The first half of the course focuses on the development and analysis of fundamental deterministic and stochastic models of inventory management (such as the economic order quantity, the newsvendor model, and the (q,r) model), whereas the latter half focuses on the use of these basic models to address problems in logistics and supply chain systems. The course emphasizes both procedural and conceptual knowledge acquisition related to inventory, logistics, and supply chain systems.

Poem-Writing Assignments. The students were asked to complete four poem-writing assignments throughout the semester. For all these assignments, the students were asked to follow the "I am" poem structure, which invites the writer to describe themselves through several prompts (see Figure A.1 in Appendix A). At the beginning of the semester, as the first poem-writing assignment, the students were asked to compose a poem about themselves. The purpose of this first non-technical poem-writing assignment was to provide students with an opportunity

to practice creating a poem with the required poem structure on a topic that they are intimately familiar with. During the remainder of the semester, the students were asked to create three technical poems on topics related to deterministic inventory modeling, stochastic inventory modeling, as well as logistics and supply chain management, respectively. The purpose of these three technical poem-writing assignments was to invite students to think more deeply about and connect more intimately with several technical topics that they learn about in the course and express their thoughts and opinions about these topics.

Why Scaffolding? While "I am" poems are straightforward to construct using fill-in-the blank prompts [4], composing a technical poem on a domain-specific topic is still a challenging task. A technical poem needs to serve the purposes of technical writing as well as creative writing. Technical writing is targeted at engineering audiences and emphasizes the clear and direct communication of information or instruction using simple and objective language. In contrast, creative writing is targeted at general audiences and targets the elaborate and original communication of human experience using evocative and subjective language. Technical poem writing requires the consideration of principles of technical and creative writing in an integrated manner, which is a new and complex skill for engineering students.

Ideas for Scaffolding. Detailed analysis of student poems over multiple semesters revealed that while some students struggle with the accuracy of the technical content of these poems, others struggle with delving into their creative aspects [6],[7]. To this end, numerous in-class activities can be conceptualized that focus on different aspects of technical poetry to help students develop their skills to create technically accurate and creatively appealing poems. For this study, the following three aspects were considered:

- *Voice*. Since students are asked to create "I am" poems, the technical accuracy of the poem relies on *who* or *what* the "I" in the poem is. For instance, whether the "I" in the poem is the Economic Order Quantity, q^*, the Economic Order Quantity Model, or the Assumptions of the Economic Order Quantity Modeling matters for technical accuracy. What the optimal quantity could "hope for" is different from what the model would "hope for" which is different from what an underlying modeling assumption could "hope for." Reminding students to re-read each line of the poem that they have written by replacing "I" with the "topic" of the poem can help them conceptualize more technically accurate poems.
- *Rhythm*. Using the same linguistic or grammatical structure repetitively throughout the lines of a poem could help to create a rhythm and enhance the musicality of the poem or build tension to guide its emotional impact or emphasize connections among the ideas presented in it to strengthen the poem's meaning [8]. For instance, if a student decides to write a poem on the steps of an approach or an algorithm, they could simply choose verbs that fit and create a verbal description of the algorithm. Such a poem would be technically accurate but may not stand out or be truly effective as it does not capture and explain how each step is connected to the previous step as well as the next step. Reminding students to use specific linguistic patterns can help them create more technically informative and musical poems.

- *Tone*. Technical writing relies on the use of objective language devoid of any emotion. An "I am" poem that uses objective language can be technically accurate but might not stand out or truly be emotionally impactful because it does not invoke an emotion in the reader. For instance, if a student decides to write a poem on safety stock, they may adopt a tone where the safety stock left unused on the shelf feels sorry for itself, helpless, and is worried about its contribution to increased inventory holding costs. However, the student may choose a tone where the safety stock believes in its potential to save the day when it is called for duty, powerful, and looking forward to ensuring product availability. Reminding students to think about the tone of the poem can help them compose more evocative poems.

In-Class Activities for Scaffolding. To introduce the students to the task of creating technical poems using the "I am" poem structure, three in-class activities were designed and delivered based on the ideas discussed previously. For each in-class activity, a brief corresponding slide deck was created to (i) introduce the purpose of the in-class activity, (ii) describe the task that needed to be completed by the students, and (iii) provide some cues on how to approach completing the task successfully. Upon the completion of the presentation, the students in attendance were split up into groups of 2-3 randomly. After group members moved around the classroom to find their peers whom they would work with, each student group was given a worksheet. Student groups were asked to complete the in-class activity in 8-10 minutes. The facilitator of the in-class activities remained accessible throughout this work period and walked around in the classroom to listen to groups' discussions and answer any questions that the students had. After the student groups completed their work, the facilitator led a brief discussion to invite students to reflect on their experiences and their work.

1. **In-Class Activity 1:** Students were provided with the first stanza of an "I am" poem that contained an error in each line (see Figure B.1 in Appendix B for the student worksheet). This first stanza was designed by the facilitator relying on some of the frequently encountered errors in student-written poems submitted in the earlier iterations of the course. Student groups were asked to go through the stanza line by line and identify the error in each of the lines and suggest a correction. The students were advised to replace the "I" at the beginning of each line with the "topic" of the poem to check the accuracy of the technical information in the line. The purpose of this activity was for students to see how technical poems can be created to avoid common pitfalls and ensure that the stanza maintains a unique voice, i.e., the identity of a technical concept.
2. **In-Class Activity 2:** Students were asked to write a stanza of a poem on the topic of the algorithm that finds the optimal parameters for the (q,r) policy with full backlogging. This algorithm was chosen for two purposes. One, students were studying for the second term exam which focused on stochastic inventory modeling, and approaching the material from a different perspective offered an opportunity to help deepen their knowledge on the topic. Two, students typically can follow an algorithm or a procedure to solve a problem but may not spend a lot of time understanding the connections between the steps of the algorithms. Hence, this in-class activity required students to think about the purpose of each step of the

algorithm and how consecutive steps relate to each other. Student groups were given the option to change some or all the verbs of the given stanza as they see fit (see Figure B.2 in Appendix B for the student worksheet). The students were advised to think about the steps of the algorithm and how the output of one step serves as an input of the next step in the overall algorithm. The purpose of the activity was for students to see how the lines for a technical poem can be created focusing on a specific linguistic structure to build a sense of rhythm while also offering some additional value in technical content.

3. **In-Class Activity 3:** Students were introduced to the Plutchik's wheel of emotion (see Figure B.3 for student worksheet) and provided with different examples of simple (e.g., anger or joy) and compound emotions (e.g., anger + anticipation = aggressiveness or joy + trust = love) [9]. Next, they were invited to think about what the "I" of a poem would say to project an emotion of aggressiveness or love, and some examples were provided. First, student groups were asked to discuss within their groups and choose a simple or a compound emotion to work with. Next, they were asked to write a stanza for an "I am" poem where "I" is The Bullwhip Effect and the tone of the poem evoked the emotion they chose to work with. Again, the students were given the option of changing the verbs as they saw fit. The purpose of this activity was for students to see how a technical poem can be created with a particular tone in mind to evoke a specific emotion adding to the creative appeal of the poem.

Reflection Survey. At the end of the semester, the students were asked to respond to the following prompt: "Throughout the semester, three in-class activities in EIN4343 Inventory and Supply Chain Systems course focused on "I am" poem writing. How would you describe your experience with these in-class activities? Do you think these in-class activities are helpful? If you think that they are helpful, please explain how."

IRB Approval. The data collection and analysis methods for the study were approved by the Institutional Review Board (IRB) at the University of Florida as exempt (Protocol Number: IRB201903008).

Study Data. The data for this study was collected during the Spring 2023 semester. The in-class activities 1, 2, and 3 were completed in weeks 5, 12, and 15, respectively, whereas the reflection survey was distributed in week 16, the last week of classes in the semester. A total of 58 students were enrolled in the course. A survey at the end of the semester asked students if they would consent to having their in-class activity worksheets and responses to reflection prompts being included in a research study, and 43 students out of 58 students consented to participate in the study. Student responses were de-identified by mapping three-digit numbers to student names: 4XX. Since the data collected is a part of a larger study, "4" corresponds to Spring 2023. The two following two digits were randomly assigned from 01 through 43.

Data Analysis

Analysis of the study data was completed in two distinct steps. First, student responses were evaluated from a holistic perspective to understand if the students thought that the in-class

activities were helpful. Next, student responses were studied in detail to identify in what ways the students thought that the in-class activities were helpful. In what follows, note that as student response are included as they are below, some sentences have grammatical issues.

Data Analysis: RQ1. To explore RQ1, "Do students think that the in-class activities were helpful?" responses to the prompt were coded considering three options: (i) positive; (ii) somewhat positive and somewhat negative; and (iii) negative. Three coders (EA, COB, ZL) independently coded the data and had weekly meetings to compare and discuss to reach consensus. For instance, a participant (417) stated "*These experience are super helpful. Since that are group assignment, I can learn from my groupmates about how they think about the specific topics. So that I can use my own understanding and the others to get a deeper understanding.*" This response was interpreted to be positive. Similarly, another participant (408) noted "*I think that the in-class assignments were fun, as it meant that people can interact with other people in doing group assignments. However, I believe they weren't necessarily necessary after the first in class assignment, yet I believed it was a good classmate bonding exercise.*" This response was interpreted to be somewhat positive and negative. Finally, another participant (406) remarked "*I think that class time would be more optimally used in other fashions. While we did collaborate with other classmates, it often took at least half of the class period. With the fast pace of the course, I would have appreciated dedicating the time to doing more practice examples that would be more accurate representations of exam material.*" This response was interpreted to be negative.

There were several responses that did not directly capture the participants' opinions directly but were interpreted by the research team. For instance, one participant (411) said, "*Fun activities*." This response was coded as positive. Similarly, another participant (431) noted, "*I don't think they were any more or less helpful than writing the poems on our own. Even though we could use our peers for assistance in writing the poem, I believe more individual thought and learning goes into the poem when we do it ourselves.*" This response was coded as being somewhat positive and somewhat negative, since it seems that creating a poem individually seems to be a more positive experience for the participant. Finally, another participant (438) stated, "*The in-class portions were a little goofy because the people I've collaborated with never knew what to do. I don't know how to improve this other than perhaps permitting more time to work on it in class since most of the work came in the last 3 minutes of the assignment.*" This response was coded as being negative.

Data Analysis: RQ2. To investigate RQ2, "What impact have in-class activities had on the experience of the students?", participant responses were coded and analyzed using open coding [10]. Specifically, two coders (EA, COB) independently coded the data and had weekly meetings to compare and discuss emerging codes.

Findings

Available Data. While some responses are superficial and short, others are relatively rich and long. However, there is a respectable amount of data to assess student perceptions on the in-class activities. The shortest response is two words long from participant 411, and the longest response is 148 words long from participant 418. On average, a participant response is about 42.6 words long with a mode length of 51 words. Figure 1 illustrates the frequency distribution of the length of student responses.

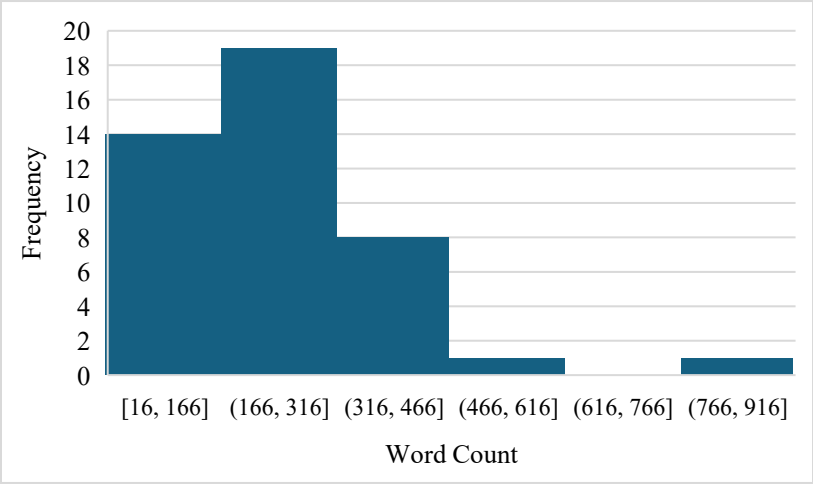

Figure 1. The frequency distribution of the length of participant responses.

Findings: RQ1. Table 1 provides the frequency distribution of the codes. About 44% (19 out of 43) of the participants thought that the in-class activities were helpful in some way. They noted that the in-class activities helped them to deepen their understanding of the conceptual knowledge, showed them how to approach poem-writing assignments, or provided opportunities for peer learning. Similarly, about 30% (13 out of 43) of the participants opined that the in-class activities were partially helpful. While the in-class activities were helpful in various ways, there were also some implementation-related concerns that had some negative impacts on the experience (such as the presence of a time limit to do the work, or being confused about what to do, or being distracted by the upcoming quiz in the same class period). Finally, about 26% (11 out of 43) of the participants stated that the in-class activities were not helpful at all. While a few simply stated that the in-class activities were not helpful in their opinion without providing any justification, others stated reasons such as feeling rushed and not liking working in groups.

Table 1. Frequency distribution of codes assigned to participant responses to explore RQ1: Do students think that in-class activities were helpful?

Code	Count
Positive	19
Somewhat positive and somewhat negative	13
Negative	11
Total	43

Findings: RQ2. Data analysis and interpretation of participant responses yielded 8 major code categories. In what follows, these categories are described, and representative examples are provided from participant responses.

1. *Student Experience*: Analysis of the data generated insights into what the participants thought about their experience of these in-class activities. 'Feelings of pleasure, stress, and challenge appeared most frequently.
    - For some participants, their experiences with these activities were *pleasurable*, i.e., positive feelings of enjoyment and/or satisfaction. They used words like "enjoyed" (403), "was fun" (408), "was very involved and immersed" (432), and "loved" (435) to describe their experiences. They found the experience to be pleasurable either because the in-class activity gave them an opportunity to meet new class members and interact with them or to improve their understanding of the technical concepts or both.
    - For some participants, the experiences were *stressful*. Participants felt "dread" either because the in-class activities were scheduled on the same day as a quiz which was distracting (409) or they would have had to work with people whom they might not have known (437). The time limitation on the in-class activity made them feel "a bit rushed" (414), "rushed sometimes" (418), "too rushed" (419) or "rushed" (433). Consequently, the participants found the in-class activities to be "more difficult" (418) or "restrictive to developing a good understanding" (433). The requirement to work with others to write poems was either something that they "did not like" (419) or "did not enjoy" as they "did not have the most contributing partners" (431) or required them to complete it on their own if their group members were "confused or uninterested in contributing" (434).
    - Some participants said the in-class activities were *challenging*. Some participants found the experience to be "hard" (420), "harder" (415), and "a little more difficult" (427). As a result, the participants noted feelings of confusion, e.g., "was pretty confusing" (422) and "just confused" (425).

    One participant (431) captured both the personal and contextual factors that influences the participants' experience during the in-class activities positively or negatively, "*I didn't really enjoy the first two in-class activities as much as I did the third one. I feel like it was a combination of both my group as well as the actual assignment of ICA 3. The first two felt more dull and I didn't have the most contributing of partners.*"

2. *Understanding: Conceptual Knowledge*: Students indicated that the in-class activities supported their learning of the conceptual knowledge in the course. They noted that the activities helped "understand the basic concepts" (405), "understanding the conceptual knowledge about the topic of choice" (426), and "assess how much I knew conceptually" (443). The in-class activities were "a good way to learn more about the topics" (443) and "helpful in a very similar way to poem assignments" (433) to enhance their understanding

but not “as useful preparing for exams” (426). Some students compared in-class activities on poem writing to the poem-writing assignments in the course and compared their effects on their learning of the course material, and stated that the in-class assignments “could have had the same or more impact being at-home assignments” (418), “were (not) any more or less helpful than writing the poems” (436), and “were less productive and efficient than the ‘I am’ poem assignments” (440). One student (423) noted additional feedback would have helped them to further their understanding, “…we didn't receive feedback from them so I wasn't sure if my reasoning was sound and if my understanding was solid.”

3. <u>*Understanding: Technical Poetry Writing*</u>: Student observations indicated that the in-class activities served as somewhat meaningful scaffolding activities to support technical poetry writing in the course. Some students said that the in-class activities were useful for understanding “how to complete my own ‘I am’ poems from scratch.” (413), serving as “practice for the poems” (416), helping “prepare me for the poem writing” (414), and providing them with more insight into “what was expected of my poems” (421). A student appreciated the live, in-class feedback provided “instructor’s live feedback helped set the standards for these poems” (413). One student noted that the in-class activities were only “slightly helpful in teaching us how to approach these poems” (434), and a respondent supported this view expressing a preference towards a different scaffolding activity: “*While I think the group activities were useful to promote cooperation between classmates, I think a brief lecture and a more individual-focused activity could have been more productive*.”
4. <u>*Community Building:*</u> Analysis of the data suggested that the formation of work groups randomly in the classroom for the in-class activity was a noteworthy aspect that contributed to community building in the course. Through these in-class activities, they get to meet new classmates [e.g., “was a fun way to meet new class members” (432) and “fun to meet other ISE kids (432)] and get to know them [e.g., “were helpful to get to know classmates” (424), “were helpful…getting to know “allowed me to interact with new class mates” (407), and “great way to get to know others in the class” (426)]. As one participant observed, while the in-class activities served as “good classmate bonding exercise (408)” and contributed to community building and developing a sense of connectedness in the class, it was not without some discomfort and social anxiety. One participant (437) captured this as follows: “*I think the most beneficial experience about the in-class activities, even though this is also something I would dread, was when we were mixed up within our classmates and got to meet other students in our class. I didn't much feel that the in-class activities themselves were as helpful as the time spent getting to know the classmates were.*”
5. <u>*Peer Learning*</u>: Data analysis revealed that the in-class activities offered a peer learning opportunity for the students in the class. Participants enjoyed the in-class activities as they offered them an opportunity to “share knowledge on these different topics” (424). Different levels of understanding in the groups exposed students to different points-of view, [e.g., “can learn from my groupmates about how they think about specific topics” (417), “provided a chance to get other students insights” (410), “see their perspectives on the course materials

we were learning" (407), "allowed…to gain more insight into a topic with the input of others" (429), and "could hear different perceptions on the topics I hadn't learned" (423)], perhaps a more well-rounded view of the topic, inviting them to synthesize their own and others' understanding of the topic of interest [e.g., "use my own understanding and the others to get a deeper understanding" (417), "talking with others about the concepts helped to deepen my understanding of the material" (416), and "learn from classmate's understanding of the models in addition to your own" (427)] to eventually form a deeper understanding of the specific topic [e.g., "helped to deepen my understanding of the material" (416) and "learned more deeply" (423)]. However, while different levels of understanding represented in the work groups were helpful, a potential risk associated with peer learning was also observed, i.e., one participant observed that "if all group members had a different level of understanding of the topic it would sometimes confuse other group members" (434). One respondent (435) captured how the in-class activities helped reap the benefits of peer learning, "*I loved the in-class activities just because I learn so much quicker when conversing with other students my age, who speak in the same day-to-day terms and words, and know how we all understand the difficulty of learning completely new topics. Working with each other on these assignments really helped us "dumb down" what was being taught, which ultimately allowed us to build up and critically analyze what we were learning.*"

6. *Group Work*: Students enjoyed the group work aspect of the in-class activities. Participants noted that they "enjoyed collaborating" (403) and "did enjoy…because I worked with my classmates" (423). Students reported having to work in groups for the in-class activities offered some benefits as well as some challenges. Participants thought the in-class activities were helpful because they "promoted collaboration" (429), engaged students "in a creative group discussion." (430), helped students "gain soft skills in communication and discussion" (430) in a group setting. However, several challenges with group work were also noted. While some participants preferred working alone for poetry writing (e.g., "did not like working in groups to write a poem" (419)], others noted the negative impact of their randomly selected partners in the group on their in-class work (e.g., "did not have the most contributing partners" (431), "was often working independently to complete the in-class activities if my group mates were confused or uninterested in contributing" (434), and "people I've collaborated with never knew what to do" (438)]. Further, one participant (441) observed the negative impact of working with people that one does not know well on the group's work, and expressed a preference for self-selected groups, "*I think it would have been nice to be able to select our own groups, as it felt like working with people I didn't know led to my group not talking as much or being as comfortable sharing their ideas for the poem*."
7. *Thinking*: Data analysis revealed insights into how the in-class activities challenged students' thinking processes. The in-class activities required the students to "think and come up with creative solution" (420) and "think creatively" (414). Further, the students had to demonstrate "definitely…a different type of thinking" (422) or were forced to "think out of

the box" (404). In addition, the last in-class activity "lead to a lot of critical thinking" (440) in addition to creative thinking. Furthermore, the time limit required them to "think more quickly" (427) and "think …in such a short time" (420).

8. *Criticisms and Suggestions for improvement*: Several students noted some challenges associated with the design and execution of the in-class activities. At a fundamental level, the incorporation of creative thinking into the course was questioned by a student who said, "I don't think that is what this class is for" (404). Some others observed that the activities were "difficult to make good use of … in a class setting" (415) and "class time would be more optimally used in other fashions" (406). There were some suggestions for redesigning the activities to make them "a more individual-focused activity" (439) to make them more "productive" (439) and consider "different creative assignments" (409) to make them more "effective" (409). Some students appear to be receptive towards poetry writing and suggested "permitting more time to work on it in class" (438) as well as thinking more carefully about the days on which in-class activities can be conducted as "two of the three assignments also overlapped with the same day as a quiz" (418). One student (409) noted. "*I also just think poem should've been covered more because if anyone was like me, I barely knew anything about poetry.*"

Discussion: Preliminary Insights

A careful examination of the code categories that emerged from the data suggests several potential strengths and weaknesses associated with the proposed in-class activities.

Potential Strengths. While the primary purpose of the in-class activities was to help students develop some basic skills to compose accurate and original technical poems, the in-class activities helped them deepen their understanding of technical topics. This was in part due to the in-class activities offering peer learning opportunities for the students, and peer learning facilitated the development of a deeper understanding of conceptual knowledge.

A surprising revelation of this study was how much the students appreciated the community building aspect of the in-class activities. Although not all participants in the study enjoyed working in groups for these in-class activities, they communicated a sense of excitement and appreciation for meeting other students in the course and getting to know them.

Potential Weaknesses. While a few students explicitly noted that the in-class activities helped them understand how to craft better technical poems, the preliminary results suggest that most of the students did not necessarily see how and why these in-class activities completed in groups of 2 or 3 (i.e., editing or creating a stanza with 6 lines) helped them, or could have helped them, prepare towards the more comprehensive task to be completed individually (i.e., creating and editing a complete poem with three stanzas each with 6 lines). The objective of each in-class activity and how it addresses a relevant aspect of technical poetry writing can be described more clearly. Each in-class activity was designed to address a different aspect of poetry writing (i.e., voice, rhythm, and tone) and its relationship to the communication of technical content.

However, the results of the study indicate that some students did not perceive the in-class activities as being uniquely different from each other. For instance, one participant (401) noted, "*They were helpful in the beginning as we were learning to write them but after the first time honestly didn't feel like a productive use of time. It felt redundant and never had a clear objective by the end since we had already done the same thing before.*" Similarly, another participant (408) stated, "…I believe they weren't necessarily necessary after the first in class assignment…"

The preliminary results also suggest that some students felt confused as they worked on the in-class activities. As one of the purposes of scaffolding is resolving confusions by breaking a complex task into manageable steps, perhaps the tasks associated with the in-class activities were not manageable enough in themselves. The in-class activities required students to have mastered conceptual knowledge sufficiently to be able to resolve conflicts or identify inaccuracies in the underlying technical knowledge during the in-class activities.

Some Recommendations for Implementation

Prior to the first in-class activity, a holistic view of what in-class activities are aiming to achieve can be presented to the students so that students understand that each in-class activity addresses a different aspect of technical poetry. In this study, the facilitator did not provide such an over-arching view of the in-class activities, which, if done, could have helped students to understand which conceptualizing or writing skill each in-class activity addressed.

For each in-class activity, the facilitator can provide an example and demonstrate to the students the requirements for the task. For instance, for in-class activity 1, an instructor can point out how to identify technical inaccuracies in a stanza and demonstrate how to edit the stanza to resolve the inaccuracies. This would help set clearer expectations on how to complete the task. After the completion of each in-class activity, the instructor may emphasize how the skills they practiced completing the task on hand could help them to craft better technical poems. In this study, the facilitator did not demonstrate the task via an example, which, if done, might have led to some confusion and related frustration.

The technical topic that is chosen for the in-class activity should be appropriate to the level of conceptual understanding required to successfully complete the task at hand. If the topic is already well understood by the students, then the focus of the in-class activity would shift from closing gaps in the understanding of conceptual knowledge to developing skills for crafting better technical poems. However, the instructor may want the in-class activity to serve dual purpose by not only advancing the understanding of conceptual knowledge but developing skills in technical and creative writing. In this study, the conceptual topics chosen were Economic Order Quantity, the iterative solution algorithm to determine optimal parameters for a (q,r) policy under backlogging, and The Bullwhip Effect.

It is important to make sure that the students are given sufficient time to complete the task. In this study, two of the three in-class activities happened to occur on the same day as a quiz.

Therefore, student engagement with the in-class activity and the impact of the activity were negatively affected. Furthermore, if groups are to be assigned randomly in a large classroom setting for each in-class activity, some additional time can be allocated for a quick warm-up activity that could serve as an ice-breaker so that the students to get to know each other first a bit and can feel more comfortable with each other as they work on the in-class activity.

Limitations

A major limitation of the current relates to the availability of limited data on some code categories. While data suggested saturation in some code categories (e.g., Community Building and Student Experience), additional data is needed to explore some code categories (e.g., Understanding: Conceptual Knowledge and Understanding: Technical Poetry Writing). To date, while these in-class activities have been implemented more than once, data was collected only once.

The facilitator (EA) of the in-class activities was not the designated instructor (TL) for the course during the semester when the data for this study was collected. At the beginning of the semester, the instructor scheduled in-class activities on days when there were no quizzes or exams. However, due to some unforeseen circumstances, the schedule had to be modified, and two of the three in-class activities ended up falling on the same day as quizzes. Consequently, the engagement with and the impact of these two in-class activities (first and second) were impacted negatively, as students were more focused on the quiz that they would be taking at the end of the class period which made a larger contribution to their final grade in the course. Furthermore, due to the upcoming quiz, there was not much flexibility on the duration that could be allocated to the in-class activity. Although the facilitator and the instructor could see that the students could have used more time, the time allocated to the in-class activities could not be extended. Hence, a lot of the participants reported that they were given enough time and that they felt rushed.

Another limitation of the study is the lack of a direct assessment of student learning. That is, although the students may say that the in-class activity helped them learn better or understand how to better craft poems, it is not clear if this would also be reflected in their scores for the poems. In a related on-going project, a technical poem assessment rubric is being developed and tested to capture if student-written poems reflect the conceptualization and writing skills addressed by in-class activities.

Concluding Remarks and Ongoing Work

The study offered some evidence on the benefits of the in-class activities that relate to enhancing the students' (i) understanding of the technical content through peer learning and critical thinking as well as (ii) skills for conceptualizing and composing technical poems that are technically accurate and creatively appealing. To provide additional supporting data based on student work, detailed analysis of the in-class work submitted via the worksheets is ongoing. The analysis focuses on an assessment of both technical accuracy and creative content to investigate whether

the students were able to utilize tools related to voice, rhythm, and tone to craft better technical poems.

While some students enjoyed and benefited from the proposed in-class activities, others neither enjoyed nor could they see any benefits of these activities. Hence, another round of implementation and data collection is on-going to explore whether the latter group's concerns can be remedied by providing clearer work instructions and demonstrative examples as well as eliminating scheduling constraints and providing more time to complete the work.

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Appendix A. “I am” Poem Template

Table A. The verbs and the prompts for the lines of an “I am” Poem

Stanza	Lines
1	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)*
2	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)*
3	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. Worksheets for Student Work

Table B.1. Worksheet for In-class Activity 1: Voice

Instructions: Please study each line and state the inaccuracy/mistake you identify.

Template	**Brief Explanation of the Inaccuracy/Mistake**
I am optimal and annual	
I understand order cost equals inventory holding cost	
I say I minimize costs	
I dream to optimize inventory levels	
I try to minimize the holding and ordering cost	
I hope to order the most efficient quantity	
I am the economic order quantity	**No response is needed here.**

Table B.2 Worksheet for In-class Activity 2: Rhythm

Instructions: Please note that the text in bold cannot be changed. You may change the verbs as you see fit.

Template	**Line**
I understand … **to** …	
I say … **to** …	
I try … **to** …	
I hope … **to** …	
I am … **and** …	
I am the …	**I am the algorithm that finds the optimal parameters for (q,r) policy under full backlogging**

Table B.3 Worksheet for In-class Activity 3: Tone

Instructions: Please state your guiding emotion(s). Note that the text in bold cannot be changed. You may change the verbs as you see fit.

Guiding Emotion (s):_____

Template	**Line**
I understand	
I say	
I try	
I hope	
I am … and …	
I am the …	**I am the Bullwhip Effect**