Designing and Conducting Research Using an Ethnographic Approach to Identify Pedagogical Practices in Engineering Education

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Abstract
This paper describes our use of an ethnographic research approach to identify the key pedagogical practices that underpin story-driven learning. This method leverages students' life stories to develop their intrapersonal competencies such as entrepreneurial mindset. In this paper, we describe our research methodology in detail, from the study's design to data collection, analysis, and triangulation of multiple data sources. This work contributes to the literature on the use of the ethnographic approach in engineering education research and offers a practical example that demonstrates how these approaches can improve our understanding of novel and emerging pedagogies.

Motivation

The ethnographic approach, rooted in anthropology and sociology, is a qualitative research method designed to comprehensively understand phenomena as they naturally occur within social contexts (Lofland, 1971; Merriam & Tisdell, 2016). This approach assumes that people's values, attitudes, and behaviors are shaped by the social situation. Consequently, ethnographic researchers gather multiple types of qualitative data such as observations, interviews, and documentary evidence. This allows them to understand the context-dependent nature of people's actions in naturalistic settings. Since the 1970s, educational research has increasingly adopted the ethnographic approach (Gordon et al., 2011; Green & Bloome, 2004). Its application spans various domains in education, including medical education (Reeves et al., 2013), second language teaching (Flowerdew & Miller, 1995), and social science education (Nind & Lewthwaite, 2017). It has also been applied in engineering education research (Case & Light, 2011; Godfrey & Parker, 2010; Stevens et al., 2013).

Recently, story-driven learning has gained attention as an innovative pedagogy within the context of engineering education (Morgan et al., 2021). One of its aims is to improve students' entrepreneurial mindset in engineering education, which aligns well with the broader landscape of engineering education. However, despite the important role of story-driven learning in growing the entrepreneurial mindsets of engineering students (Morgan et al., 2021; Turner et al., under review), there has been little research examining the ways instructors use pedagogical practices that are unique to story-driven learning, and which of these practices are most effective for student learning. Our works aims to help fill that gap by identifying the pedagogical practices instructors used when using story-driven learning in undergraduate engineering classrooms.

We used the ethnographic approach to carry out this work, for two reasons. First, the ethnographic approach generates a rich description of natural and cultural settings through the gathering of a wide variety of data types from multiple sources of information (Walford, 2018, Patton, 1999). This approach mainly involves collecting qualitative data, such as observations and interviews, supplemented by quantitative information (e.g., surveys, Hammersley & Atkinson, 2007; Lofland, 1971). By acquiring multiple sources of information about the same event occurring in a social setting, researchers can integrate and triangulate these data, enhancing the analysis' depth and accuracy. Therefore, in this research project, the researcher engaged in

extensive *first-hand* observation in classroom settings throughout the semester, collected students' written responses reflecting their class, and conducted open-ended interviews designed to validate our findings with students' perspectives.

Second, investigations of instructors' pedagogical practices in naturalistic settings, versus in a laboratory or through lab-based experiments, can yield different findings (Le Compte & Goetz, 1982). Indeed, identifying instructor's pedagogical practices in classrooms, especially those that occur *naturally* and are *not experimentally manipulated*, is limited when explored solely through quantitative data or instructors' self-reflection activities alone (Wilson, 1977). Recognizing this limitation, Lin (2007) showed that the ethnographic approach can be useful to distinguish effective from ineffective pedagogical practices in naturalistic classroom settings.

All in all, this methods paper describes our approach for using the ethnographic approach to identify pedagogical practices of story-driven learning within the engineering education context, which has not been previously explored comprehensively. It covers the entire research process, from study design and data collection to analysis, validation, and data triangulation. Doing so contributes to the existing literature on engineering education research and methods.

Theoretical Framework

Here, we explore the use of an ethnographic approach to unravel a repertoire of pedagogical practices in story-driven learning, specifically within the context of engineering education (Kinnear & Simpson, 2016; Lee & Le Doux, under review; Wang, 2020). Story-driven learning involves students crafting and sharing their non-fictional, personal life stories with others to enhance intrapersonal competencies (Morgan et al., 2021). The intrapersonal competencies include students' identity formation (e.g., self-concept clarity, agency) and an entrepreneurial mindset (characterized by an intention to create value, along with curiosity and a desire to make connections across seemingly unrelated information). The development of an entrepreneurial mindset is a significant goal for many engineering educators (Rae & Melton, 2017).

The story-driven learning approach is grounded in Vygotsky' Social Constructivism (Vygotsky & Cole, 1978), which emphasizes the importance of social interactions and cultural tools in learning. Learners bring their own understanding to social interactions (e.g., instructor-student, student-student) and construct meanings by integrating those understandings with their experiences in context. That is, what an individual learns is influenced by the cultural context they inhabit, which is mediated by cultural tools, language, and other symbols. With this perspective, an instructor's central role is to provide instructional support, scaffolding, and facilitate student active classroom engagement that will help them maximize their learning, in a way that is more effective and goes beyond than merely lecturing or giving students answers.

In short, story-driven learning environments are influenced by the classroom context, which varies from classroom to classroom, requiring instructors to appropriately scaffold and facilitate students in crafting and reframing the meaning of their personal stories (Vygotsky & Cole, 1978; Yager, 1991). This approach allows students to not only share their life stories with others, but also to reflect on and reminisce about them with the aid of instructor facilitation. Students also have the opportunity to explore multiple perspectives on various kinds of life events by listening to other students' stories, which is a form of joint reminiscence (Wang et al., 2017) among students and between students and instructors.

Study Background

Our research is part of a larger initiative that promotes story-driven learning (i.e., using personal stories to drive student learning) as a novel pedagogical approach in biomedical engineering education. This initiative seeks to improve undergraduate students' entrepreneurial mindset. Through this research, we aimed to answer the following three research questions: (a) *what pedagogical practices are identified when instructors implemented story-driven learning in biomedical engineering classrooms? (b) what are the commonalities and differences of expert and novice instructors' pedagogical practices in story-driven learning engineering classrooms?, and (c) what is the nature of student entrepreneurial mindset change in story-driven learning classrooms when taught by expert vis-à-vis novice instructors?*

Study Site. The site of our study was an undergraduate online course in a biomedical engineering department at a large public university in the southeastern United States. The course we investigated, *The Art of Telling Your Story*, is a required class for biomedical engineering students, a one-credit-hour online, synchronous course in which students meet for 2-hour sessions each week of the semester. The course objective is to help students better understand their own identities and potentially enhance their entrepreneurial mindset. Over the course of the semester, students were asked to craft and share personal stories in response to story prompts designed to elicit various life experiences and envision multiple possible futures[1].

We collected data from one section of *The Art of Telling Your Story* course during Fall 2022 and four sections of the same course during Spring 2023. We view the *Art of Telling Your Story* class as a *signature* story-driven learning course in the university, which particularly aims to develop biomedical engineering students' entrepreneurial mindset. The main reason for choosing this course is to have key study samples (i.e., one expert instructor and three novice instructors) to answer our research questions. Specifically, the expert instructor is the most knowledgeable about story-driven learning and can act as representatives in revealing proficient teaching practices in the study settings, while the three instructors (i.e., novice instructors) started teaching the *Art of Telling Your Story* course since Spring 2023. This study was approved by an IRB at a large public university in the southeastern United States. We obtained consent documents from instructor and students necessary to proceed with this research.

Participant Information. We had one participant instructor for Fall 2022 (i.e., one expert instructor) and four participant instructors for Spring 2023 data collection [i.e., one expert instructor (as the same for Fall 2022) and three novice instructors]. Four instructors have various background in content area expertise and teaching experience for *the Art of Telling Your Story* class. We also recruited students taking *the Art of Telling Your Story* class during Fall 2022 and Spring 2023. See Table 1 for participant information.

Study Design

Informed by Lofland's (1971) guidance on ethnographic research, our study was designed to collect data from *multiple participants*, utilizing *various sources of data*, within a *naturally occurring setting*. Instead of implementing purposive manipulation of study variables or examining the effects of experimental manipulation, ethnographic research focuses on the interplay among variables situated in a naturalistic setting (LeCompte & Goetz, 1982). The simplest and most basic feature of ethnographic research is to conduct direct on-site participant observation, involving a sense of "living in" the naturalistic setting while minimizing interaction

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[1] Additional details about student learning outcomes (i.e., students' experience of story integration) in story-driven learning classroom can be found in our other papers (Lee et al., in preparation; Turner et al., under review).

between the research team and study participants. Therefore, we used participant observation in our study of *the Art of Telling Your Story* class, without intervening in the instructors' implementation of pedagogical practices in their classrooms. For example, we did not request instructors to alter their pedagogical practices to enhance student engagement in the classroom.

In addition to collecting data from the instructor's side, we also obtained the data on students' perspectives of their instructors' pedagogical practices. This was to see if the pedagogical practices we observed aligned with and were validated by students' perspectives. This not only enhances the credibility of our findings but also strengthens their robustness (LeCompte & Goetz, 1982). By doing this, we achieved methodological triangulation, enhancing the validity of our study.

We collected data from both instructors and students to obtain multiple sources of data, ensuring a comprehensive understanding of the study context. This approach allows for a rich description of a phenomenon for in-depth investigation of a phenomenon (Patton, 1999). Data from instructors were obtained through ethnographic research methods such as participant observation, classroom observation, field notes, and classroom recordings. Student data were collected via surveys, end-semester interviews, and reflective diary activities, as has been done in previous ethnographic research (Schensul et al., 1999).

Table 1
Participant Information

Participant Instructor Information ($n = 4$)				
	Instructor A	**Instructor B**	**Instructor C**	**Instructor D**
Teaching Experience (for the Art of Telling your Story Course)				
Fall 2022	Yes	Observe instructor A's class during Fall 2022		
Spring 2023	Yes	Yes	Yes	Yes
Participant Student Sample Size				
Diary Prompts[a]				
Pre- and Post-survey[a]	$n = 3$	$n = 10$	$n = 1$	$n = 4$
Interview				
Fall 2022	$n = 3$	Not applicable		
Spring 2023	$n = 3$	$n = 3$	$n = 1$	$n = 4$

Note: [a]Only collected during Spring 2023.

Data Collection

Data on the Instructors' Practices. Classroom observations were carried out during the Fall of 2022 and Spring of 2023 semesters. The first author visited the class from Week 6 to Week 16 for Fall 2022 and from Week 1 to Week 16 for Spring 2023. We primarily employed (a) classroom observation and field notes and (b) making classroom audiovisual recordings, to identify instructors' pedagogical practices in story-driven learning classrooms. While the first author conducted *first-hand* observations of all classes, the first author's presence in classrooms might impact the participants' performance and comfort. Therefore, the first author disabled the video during classes while taking detailed observation notes on the instructor's pedagogical practices. To complement these notes, the first author also video-recorded several sessions, specifically focusing on capturing instructor-student interactions and dialogue. Participants were given advance notice of recording dates through announcements on Canvas.

Classroom Observation and Field Notes. During the Fall 2022 data collection, the first author visited the class, taking notes in association with a list of pedagogical practices implemented by the instructor in classroom teaching. These notes facilitated the development of an initial draft of pedagogical practices for story-driven learning. Although there was no specific field note format for Fall 2022 classroom observation, the research team designed field notes to more effectively capture and record instructors' pedagogical practices and prompts used in classroom teaching for Spring 2023 data collection. Specifically, these field notes recorded class logistics (e.g., welcoming, opening activity), the day's prompts (e.g., prompt for opening connection activity: five senses of yourself), and the types of classroom activities/ pedagogical practices in chronological order. Regarding pedagogical practices, the first author took notes such as task instructions, descriptions of context, and several examples that students shared during class.

Classroom Audiovisual Recordings. While visiting classrooms throughout the semester, we recorded a subset of the sessions. Specifically, we had two recordings from the one section of the class during Fall 2022 and three recordings from each out of four sections during Spring 2023 (i.e., three recordings X four sections= a total of 12 recordings). This approach aimed to mitigate the limitations of human observations in capturing complex interactions in the classroom and to obtain more accurate data records (Derry et al., 2010; Erickson, 2006). We used video recording software (i.e., Camtasia) and an AI-generated transcription service. Subsequently, two research assistants watched and listened to the videos to match speakers of each utterance, reviewed whether there were any mistakes about the transcription, and made corrections as needed. All video data was transcribed, and the verbatim transcription of the video were used for analysis.

Data on the Students' Experiences. For the Fall 2022 semester, we conducted end-semester interviews with each participating student. In the Spring of 2023, we expanded our data collection to include several forms of student feedback: (a) pre- and post-survey, (b) end-of-semester interviews, and (c) reflective diary activities.

Pre- and Post- Survey. We assessed three key variables of interest: self-concept clarity, awareness of narrative identity, and entrepreneurial mindset. We used an established measure that were validated in prior work (i.e., self-concept clarity, Campbell et al., 1996; awareness of narrative identity, Hallford and Mellor, 2017; entrepreneurial mindset, Brunhaver et al., 2018). Each item on each scale was endorsed using a five-point or 10-point Likert scale. As part of an exploratory approach to identify the effectiveness of story-driven learning on expected learning outcomes, we collected baseline and endpoint data from students, as a consequential effect of story-driven learning.

End-of-semester Interviews. Interview is a common method to gather qualitative data in ethnographic research (Schensul et al., 1999). In our study, we interviewed three students at the end of the Fall 2022 semester and eleven in Spring 2023. Instead of asking direct questions or providing explicit prompts (e.g., what do you think of instructor's emotional affirmation of your storytelling?), we posed open-ended questions to students (e.g., what did you like from this class?). These interviews were carried out individually over Zoom, recorded, and transcribed using Zoom's transcription function.

Figure 1

Sample excerpts from field notes

Date/Time	February 7, 2023	February 8, 2023
Module	Module 2: Your leadership story	Module 3: Who am I as leader?
In-class topic	The Power of Motivation: What motivates you or getting under the hood	The Power of Motivation
In-class assignment	When did you feel most aligned with what motivates you or fills you with purpose or excitement? Develop that story.	When did you feel most aligned with what motivates you or fills you with purpose or excitement? Develop that story. (Identifying your sources of motivation).
Class Logistics	1. Welcoming 2. Opening activity – Week 4 This I believe 3. Student G's story lab 4. Prompt 1: Why are we doing this class (picked three students – and J's conversation with three students in a whole class session) 4. Prompt 2: Chapter of your life, and letter to younger self (picked student A and student K—they share their assignment with whole class) 5. Prompt 3: What is your advice for yourself? (3 min individual writing time and whole class discussion) 6. Prompt 4: When did you feel most aligned with what motivates you or fills you with purpose or excitement? Develop that story. (10 min breakout room, 4 people per room → whole class discussion) 7. Closing activity – takeaway from today's class 8. Class reflection	1. Welcoming 2. Opening activity (3 minutes individual work – 3 people per breakout room for five minutes —type partner's most memorable sense into chat box) 3. Prompt 1: Last week's homework assignment review (Whole class session) 4. Prompt 2: Personal striving and motivation (10 min individual work time, and then whole class with Jam board activity) 5. Prompt 3: Reach striving (rating about personal striving; 7 min individual work – whole class session -- story development, 10 min individual work – breakout room activity – whole class to check in) 6. Closing – encourage reflections (Connecting opening activity to Prompt 2 and 3; not asking students to address with classmates).
Instructional activity Notes	Instructor A plays the music and welcoming (Calling student Name, and then "good to see you. How are you? Are you in a new place?") **Opening activity: This I believe statement**: pick one among 20 different things you believe, that pick one that no one else believe (you think). Students having a meal, drinking a coffee, or snacking—instructor A says she is happy to see eating (no hiding) – meantime, encourage students to engage in opening activity. …… **Student G's story lab:** After student G shared their story, instructor A sent "applause" and then followed up with a question for student G: "What did you learn?" instructor A then asked the other students, "Who can relate to student G's story? Does anyone resonate with Student G's story?" instructor A also asked student G if they wanted to add anything else: "Why are we learning this? How will it be helpful?" Student G responded, "To be more prepared later. Then, student C jumped in, saying, "To figure out myself, to listen to myself." instructor A asked student A, "Why are we doing this?" Student A replied, "To figure out the past, to be more confident... how you speak about yourself in an interview."…. instructor A concluded, "This is who I am – the power of your story."	Instructor B's welcoming! **Opening activity: Five senses of self-portraits**: Instructor B's instruction for opening activity --Five senses are touch, taste, smell, vision, and hearing. Connect something important to you, about you. Then, instructor B gives an example (e.g., touch – enthusiastic hugs or shakes, taste – grandmother's pasta). Then, A asks students if they have clarifying/any questions. …… **Prompt 2: Personal striving and motivation:** Instructor B: "this class is building on last week's class, self-defining memory." ← connect last week class and this week's class + remind students of what self-defining memory is. And connects + hierarchy, "Everyday goal" + "Personal strivings". Instructor B introduces two tasks: (a) identity personal strivings (1st phase), (b) identity personal life stories that is positive, relevant to one of our identified strivings (2nd phase). For the first task, students will generate a list of 10 about personal strivings, and be asked to post one/two they feel comfortable to talking about in jam board.

Note: The second column is excerpt from Instructor A's teaching; The third column is excerpt from Instructor B's teaching.

Reflective Diary Activities. Furthermore, we aimed to gather students' perceptions of their instructors' pedagogical practices throughout the semester. To obtain a more fine-grained, detailed description of students' perceptions of their instructor's pedagogical practices, we intentionally synchronized the data collection period for instructors and students. Specifically,

we gathered audiovisual recording data from selected class sessions over three weeks: weeks 4, 5, and 10 for instructors A and C, and weeks 4, 5, and 14 for instructors B and D. During this time, students received a Qualtrics survey link to submit reflective diary entries corresponding to these recorded class sessions. Students were prompted to complete their diary entries within one week after the class session to ensure accurate recollection of their instructor's teaching methods for that week.

For the diary prompts, students were asked to respond to three open-ended questions (i.e., general writing prompt): *(1) describe the most important things you learned in class this week, including what you learned about yourself. Why does it feel important? (2) what was most interesting to you about the course this week? What was least interesting? (e.g., class topic, homework assignment, class activity). Please elaborate on why, and (3) how was your experience with the Zoom class this week? What made you most engaged, affirming, disengaged, or confused? Please explain*. The length of the written response was not specified; however, unexpectedly, we identified students' less engagement from students in completing this prompt (based on word count for each question).

Consequently, we adjusted the open-ended questions for the third diary prompts. Essentially, students were presented with the same three questions (i.e., general writing prompt), but were additionally asked to compose a follow-up question with more details (i.e., situational writing prompt). For example, students were initially tasked with crafting a written response to the question, "describe the most important things you learned in this class this week, including what you learned about yourself. Why does it feel important?". On the subsequent page, we displayed what students had written in the previous pages and presented a situational writing prompt that encouraged students to provide more details. They were instructed to respond to the following prompt: "This is what you are writing on the previous page to answer the prompt", with their answers displayed in blue. Following that, they were instructed to write, "read what you wrote, and image that you are sharing your learning experience with BMED students who are not taking this class yet. Imagine telling future BMED students sticky details about your learning experiences in BMED 4000. Please write below". See Figure 3.

Figure 3
Diary Prompts (Left: General Writing Prompt; Right: Situational Writing Prompt)

After students completing the written response to the open-ended questions, students were asked to rate the extent to which they engaged in the class that week. Three items were displayed: *(1) overall, I tried my hardest to do a good job, (2) overall, I felt the effort it took to do the activity was worthwhile, and (3) overall, I felt the time used for the activity was beneficial.* These statements were endorsed with five options: (a) almost never (less than 10% of the time), (b) seldom (10-30% of the time), (c) sometimes (30-50% of the time), (d) often (50-70% of the time), and (e) very often (more than 90% of the time). We included these questionnaires to exploratorily investigate an association between students' written reports of aspects they were most engaged with during class (i.e., the third open-ended question for diaries) and their self-ratings of classroom engagement.

Data Analysis

Classroom Observation, Field Notes, and Audiovisual Recordings. For classroom observation, field notes, and audiovisual recordings, we employed a combination of deductive and inductive methods to identify pedagogical practices used in story-driven learning. This approach was used, despite the existence of several established observation protocols for capturing pedagogical practices in STEM education (e.g., COPUS[2], Smith et al., 2013; TDOP[3], Hora et al., 2013; RTOP[4], Sawada et al., 2002). This is because these established protocols mainly capture teaching practices focused on students acquiring content knowledge in the STEM domain. Story-driven learning, by contrast, involves students sharing personal, potentially vulnerable, stories to improve their identity formation and entrepreneurial mindset, necessitating the identification of potentially unique pedagogical practices distinct from those used in traditional STEM settings.

We started with a deductive (or top-down) approach, drawing on existing theories and research to anticipate specific pedagogical practices expected in these classrooms (e.g., Ellis et al., 2019; Herbel-Eisenmann et al., 2013; Smith et al., 2013). This helped us hypothesize which pedagogical practices might emerge in story-driven learning classrooms, such as instructors linking past and current topics (Kranzfelder et al., 2019). In the story-driven learning classroom, this entailed instructors connecting the story currently being told with stories students shared earlier in the semester. On the contrary, we applied an inductive (or bottom-up) approach to identify *additional* pedagogical practices based on our direct observations of story-driven learning classrooms, such as instructors prompting students to discuss what they learned from and liked about their peer's personal stories. Combining a deductive approach with an inductive approach (i.e., combining a top-down approach with a bottom-up approach), the first author created an initial coding scheme, by analyzing the data from Fall 2022. This scheme was refined and expanded with the Spring 2023 data. These findings were validated by the second author and another researcher who also observed the classes in Fall 2022, ensuring the reliability of the practices we identified. Following the development of a coding manual by the first author, the analysis was further corroborated with two research assistants who contributed to coding the data. This collaborative process led to the addition or consolidation of categories based on discussions.

Ultimately, we identified a total of 40 pedagogical practices, which we categorized into four dimensions at the micro level: (1) affective/interpersonal interactions with students (6

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[2] The Classroom Observation Protocol for Undergraduate STEM
[3] Teaching Dimensions Observation Protocol
[4] Reformed Teaching Observation Protocol

pedagogical practices), (2) approaches to eliciting students' personal stories and experiences (8 pedagogical practices), (3) facilitation of how students frame the meaning of their stories (10 pedagogical practices), and (4) pedagogical practices related to class logistics and tasks (16 pedagogical practices). Among these four dimensions, we considered the first three dimensions to be unique to story-driven learning classrooms, while the remaining dimension (i.e., the fourth dimension: pedagogical practices related to class logistics and tasks) was deemed not unique to story-driven learning practices. Table 2 includes an excerpt of the coding manual.

Table 2
An Excerpt of the Coding Manual

Category and Description		Examples
Sub-dimension: Instructor-student dialogue interaction		
3-2	Instructors providing students with constructive feedback (e.g., story structure, imagery)	The thing is that I want to see the solution a little bit more. If we can see the other side of it, if we could see it working, that would be cool to you. That'd be kind of a cool resolution to have at the end, very strong.
3-5	Instructors making connections with a story being currently told to stories they were told in the past in the class, or to instructor's own personal experiences (e.g., helps them make connections, see themes, and helps build trust with the instructor)	So this class is building on last week's class in terms of its connection to self-defining memories. And so, this allows us to use our self-defining memories to help us achieve our most important life goals.
Sub-dimension: Student-student dialogue interaction		
3-6	Instructors encouraging/asking students to provide (any types of) feedback to other student's stories, including verbal feedback and written feedback (Zoom chat or on a Jamboard)	I will note that when people are sharing their story in class, it would be great if as listeners, we could be putting our thoughts and feedback and comments and reactions in the chat so we can be actively engaging with them.
3-9	Instructors asking students to share how they resonated/related to a particular student's stories (e.g., Anybody resonates with the story? what relates with you?)	Which one did you feel more connected to you? I'd like to hear a few people what really resonated with them or what they liked about it.

Using this coding manual, the first author and two research assistants independently coded the classroom discourse data. Figure 2 depicts a sample of the coded discourse. Since our focus is on identifying pedagogical practices in story-driven learning classrooms, we only coded instructors' utterances. Each utterance consisted of one single sentence. Inter-rater reliability (e.g., Cohen's kappa) and exact agreement were calculated to validate our data analysis process (Gwet, 2014). All disagreement were resolved through discussion. Then, we summed up each pedagogical practices corresponding to each dimension across four instructors (See Table 3).

Figure 2

Sample of Coded Discourse

Speaker	Transcripts	Code 1	Code 2
Instructor B	I appreciate the additional specificity and details in that,	1-5	1-5
Instructor B	but that is a really helpful in giving us a portrait of what happened and the role you played in it.	3-1	3-1
Instructor B	A couple of additional things I might suggest is to really emphasize the role you played.	3-2	3-2
Instructor B	And so even when it was a collaborative effort and you're saying we a lot like really focus on the eye piece as they're interviewing you,	3-2	3-2
Instructor B	this single person for the job	3-2	3-2
Instructor B	And also, and this is just like this is why we're practicing this right now.	4-2	4-2
Instructor B	Because it helps get this automatic stuff out of our system.	4-2	4-2
Instructor B	Like when you're saying kind of like you're, you're you're you're kind of diminished.	3-2	3-2
Instructor B	It it's so automatic.	3-2	3-2

Pre- and Post-surveys. In this study, students were asked to rate about their self-concept clarity (7 items), awareness of narrative identity (8 items), and entrepreneurial mindset (15 items) at the beginning and end of the semester. Descriptive statistics were then calculated.

End-of-semester Interviews. For analyzing transcribed interview data, we used thematic analysis to identify common and essential themes related to the pedagogical practices the participant instructors implemented in their story-driven learning engineering classrooms. The analysis involved three steps. First, we anonymized the data for privacy and confidentiality by labeling participants as student A and student B. Second, the first author used inductive coding (Braun & Clarke, 2006; Vaismoradi et al., 2013), by thoroughly reading the transcripts and marking relevant sections on pedagogical practices or classroom activities using Microsoft Word's comment feature. Third, this process led to the identification and review of emerging themes from the interview data.

Reflective Diary Activities. To analyze students' reflective diaries, we adopted a descriptive qualitative approach, specifically using thematic inductive analysis (Krippendorff, 2013). We did not have an established, predetermined coding scheme but instead based it on the collected data. The first author read and reread the diaries for data familiarization, and then organized the content into themes (i.e., Category 1 (Column B) in Figure 3). The initial coding scheme were further elaborated and specified through iterative coding processes (i.e., Category 2 (Column C) in Figure 3). An Excel spreadsheet was used for coding. Furthermore, students' self-ratings of classroom engagement was descriptively calculated to explore the level of classroom engagement.

Data Triangulation

Data triangulation in ethnographic research enhances the validity of a study by helping to confirm and enrich our understanding of its findings (Reeves et al., 2008). It addresses frequently

raised concerns about the reliability and validity of findings in ethnographic research (LeCompte & Goetz, 1982). In our study, we analyzed pedagogical practices using classroom observations, field notes, and audiovisual recording data. These findings were further corroborated by students' perspectives on the instructors' teaching, informed by the end-semester interviews and reflective diaries analysis.

Table 3
Example: Frequency Table for Pedagogical Practices

	Instructor A	**Instructor B**
Class Size	21 students	23 students
Class time structure		
Whole class session	74 minutes	63 minutes
Individual work	7 minutes	35 minutes
Small group activities	21 minutes	15 minutes
Total duration	1 hour 42 minutes	1 hour 43 minutes
Pedagogical Practices[a]		
Dimension 1	215 (22%)	78 (13%)
Dimension 2	170 (18%)	91 (16%)
Dimension 3	336 (35%)	159 (27%)
Dimension 4	240 (25%)	257 (44%)
Instructor utterances	961 (100%)	585 (100%)
Word count per each utterance	7.68 words	10.99 words
TA and other instructors' utterances	91	35
Students' utterances	587	159

Note: [a]Instructors' pedagogical practices were captured while students had a dialogic interaction with an instructor in whole class, not including individual work (e.g., individual brainstorming to come up with an idea) or small group activities (e.g., breakout room activities).

Figure 3
Coding Examples for Reflective Diaries

[Note A: Column A and D: Students' written response, Column B, C, and E: Inductive coding]

Conclusion

By adopting an ethnographic approach to investigate unique pedagogical practices in story-driven learning in engineering classrooms, we have made two key contributions. First, this study provides practical insights into applying the ethnographic approach in engineering education research. While our focus is particularly *situated* in story-driven learning, a new and emerging pedagogy in engineering education, the lessons we learned can guide the application of ethnographic methods to other underexplored pedagogical approaches in this field, such as equity-oriented pedagogy for leadership development. These lessons include best practices such as effective use of field notes, analysis of classroom discourse via deductive and inductive approaches that use verbatim transcriptions from audiovisual recordings, designing effective reflective diary prompts, asking open-ended questions in student interviews, and achieving data triangulation from multiple sources of data.

Second, the main goal of this study was to improve our understanding of story-driven learning by examining specific pedagogical practices in engineering classrooms. We used an ethnographic approach to conduct a detailed analysis of these methods, thereby offering valuable insights to the field (for more information on these pedagogical practices, see Lee & Le Doux, 2023; under review), to explore newly emerging pedagogical approaches in engineering education.

All in all, this paper offers step-by-step guidance on employing the ethnographic approach in engineering education research, emphasizing comprehensive, reliable data collection from multiple sources. This is a helpful contribution for the engineering education community, addressing the need for research methods that complement the predominant quantitative research paradigm (Borrego et al., 2009). We believe this method paper offers valuable insights for how to adopt the ethnographic approach in engineering education research that is rigorous, reliable, and anchored in data acquired from multiple diverse sources.

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