

Exploring composite narratives as a methodology to understand and share research findings in engineering education

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Abstract

This methods paper explores the development and utility of composite narratives in engineering education research. Composite narratives combine aspects of multiple interviews into a single narrative. Researchers in engineering education are increasingly beginning to use composite narratives to enable more nuanced understandings of the phenomenon we are studying while mitigating potential issues around participant confidentiality. Because composite narratives are a relatively new methodology in engineering education and higher education more broadly, more examples of how to construct and utilize composite narratives in both research and practice are needed. In this paper, we share how we created composite narratives from interviews we collected for our work to demonstrate how others can adapt this methodology to their research projects. Based on semi-structured critical incident interviews with seventeen engineering managers about their perspectives on adaptability, we developed seven composite narratives reflecting real-life workplace situations to which engineers must adapt. We present a detailed account of how we constructed one composite narrative to demonstrate the quality and trustworthiness of the methodology and assist in the replication of the methodology by other scholars. Further, we share how we modified and enhanced these narratives to connect research to practice and impact engineering students. This approach involved creating scenarios and probing questions from the composite narratives for sharing the research findings in academic and industrial educational settings. Lastly, we discuss the benefits and limitations of this methodology, highlighting the research findings brought into focus using this methodology and comparing and contrasting these results with those that emerged using an inductive-deductive thematic analysis approach to the data also taken in this research project.

Key Words: Composite narratives, Methodology, Participant confidentiality, Research to practice approaches

Introduction

Composite narratives are a way to combine aspects of multiple interviews into a single story. They are a relatively modern qualitative research methodology used in the existing literature for several purposes: to do justice to complex accounts while maintaining participant anonymity [1]–[3], summarize data in a more engaging personal form and retain the human face of the data [2], represent specific aspects of the research findings [3], enhance the transferability of research findings by invoking empathy [4], illuminate collective experiences [5], and enhance research impact by providing findings in a manner that is more accessible to those outside of academia [1]. Composite narratives leverage the power of storytelling, which has shown to be effective in studies of neurology and psychology; i.e., since humans often think and process information in narrative structures, the information conveyed in story form can be imprinted more easily on readers' minds or existing schema [6]. Although composite narratives have been used in several research fields, including sociology [7], medical education [8], and higher education [3], [5], there are questions regarding transparency in their development. Willis [1] specifically mentions

this as the premise for the writing of their paper that outlines methods based on reviewer feedback that questioned the composite narrative methodology. Willis [1] also suggests that other authors be transparent in their use of composite narratives to address any questions of validity. This work hopes to contribute to this conversation, specifically in engineering education.

Engineering education researchers have recently begun exploring composite narratives as an approach to enable more nuanced understandings in engineering education while mitigating potential issues around participant confidentiality (e.g., [9]–[13]). Composite narratives were used in this research to combine the critical incidents from semi-structured interviews with fifteen engineering managers into rich, texturized stories of engineers demonstrating adaptability in the workplace. The composite narratives in this work leveraged several benefits of the methodology, allowing for a more nuanced understanding of adaptability, its dimensions, and its influencing factors to develop. Further, the composite narratives are supplemented with probing questions to stimulate thinking, learning, and discussion in academic and industrial educational settings. Specifically, we used these narratives to develop a scenario-based learning activity rooted in research findings.

In this paper, we share a detailed account of how we constructed one composite narrative to demonstrate the quality and trustworthiness of the composite narrative methodology through transparency and to assist in the replication of this methodology by other scholars. We share how we modified and enhanced the narratives to create scenarios and probing questions to share the research findings in academic and industrial educational settings. Further, we discuss the benefits and limitations of this methodology while highlighting the research findings, which aspects of the data were brought into focus using this methodology and comparing and contrasting these results with those that emerged from an inductive-deductive thematic approach to the data that was also taken in the research project.

Context

Data for this research came from a National Science Foundation-sponsored research project focused on understanding and fostering greater workplace adaptability among the engineering workforce (redacted for review). The project's first phase involved semi-structured interviews with seventeen engineering managers from four companies. These interviews lasted approximately 60 minutes via video call and occurred in the Fall of 2020 and Spring of 2021. The companies represented included a large semiconductor company, a very large semiconductor company, a midsize electronics company, and a midsize medical device company. The managers interviewed included thirteen men and four women; they were white (n=13), South Asian or Indian (n=3), and Middle Eastern/North African (n=1). Most managers were between 40 and 65 years old, with a range of educational levels, and all with over ten years of experience working in engineering.

Methods

The developed interview protocol used the critical incident technique [14] to capture managers' examples of when engineers needed to adapt in the workplace. I (the first-author/lead researcher) conducted semi-structured interviews with managers, asking them to describe the circumstances surrounding the situation, the problems the engineer encountered and how they solved them,

whether the engineer was successful or unsuccessful, and what the engineer could have done differently regarding each incident. In the larger study, I created seven composite narratives to weave elements of different managers' recollections into stories with additional texture and details. Table 1 shows the titles and topics of the other composite narratives developed in this work. We (the research team) will present these composite narratives in a future publication.

Table 1. Composite Narratives Developed

Title	Dimension and Situation
<i>So, we know this is not necessarily what we hired you for...</i>	<i>Dealing with uncertain and unpredictable work situations: Job Role Change</i>
<i>Let's figure out what actually is happening...</i>	<i>Demonstrating interpersonal adaptability: Communicating with an External Supplier</i>
<i>Oh, I didn't know it could fail that way...</i>	<i>Solving problems creatively: A Technical Challenge</i>
<i>The sky is falling...</i>	<i>Handling work stress: Catastrophic Product Failure</i>
<i>When you see something that someone's doing better...</i>	<i>Learning new work tasks, technologies, and procedures: Automation of Work</i>
<i>You can't just be standing on the sidelines...</i>	<i>Demonstrating cultural adaptability: Working Across Different Functions and Companies</i>
<i>The balancing act...</i>	<i>Adaptability Context & Balance: Working in a Male-Dominated Field as a Woman</i>

I identified three critical incidents that contributed to the composite narrative detailed in this paper, in which different engineering managers (Managers 1, 2, and 3) described times when engineers faced a major change to their job role. I chose the title of the narrative based on a direct quote of one engineering manager telling the engineer they were supervising, "So, we know that this is not necessarily what we hired you for..." (Manager 1). The narrative most closely relates to the adaptability dimension, *Dealing with Uncertain and Unpredictable Situations* [15], due to the uncertainty managers described engineers feeling about the changing nature of their job role. However, each manager's recollections were associated with a different cause (e.g., project cancellation, company merger, market change), resulted in a different outcome, and featured varying levels of detail. By choosing three situations from which to create a composite narrative, a complete story that succinctly touches on multiple challenges related to adaptability but is still grounded in the data could be told.

Following the same methodology, I developed each composite narrative using two to four excerpts from the manager interviews. First, I categorized the critical incidents shared by managers by type of incident observed (e.g., whether the engineer was reassigned to a new job role or tasked with communicating with a supplier, etc.) and the most prominent dimension of adaptability (e.g., dealing with uncertain or unpredictable situations, interpersonal adaptability, etc.). I then reviewed these incidents for the level of detail; some incidents were longer with more rich details, while others were shorter with fewer details. Those with richer details and conclusions became the main narrative threads for each composite. Other narratives featuring a

similar type of incident or featuring the same prominent adaptability dimension were then used as supplementary data sources to fill in each narrative. At the conclusion of this process, excerpts were used from fifteen of the seventeen interviews to develop the seven composite narratives. The two interviews excluded had less detailed incidents. Personal characteristics such as gender or name were not always shared within critical incidents; therefore, when developing the composite narratives, I chose pseudonyms and pronouns when not specified in the interview (three male, three female, and one gender-neutral pronoun were used in total).

Bold, *italicized*, and underlined elements in Table 2 and Figure 1 visually represent how the three interview excerpts corresponding to Managers 1, 2, and 3, respectively, came together in the full narrative. Quotation marks denote exact quotes of what managers recounted saying to the engineers, and modifications to the excerpts were made for flow or clarity. We were inspired to present the methodology in this format by [3]. This table shows how the narrative was developed and how each part directly connects to the interview data, with my notes and decision-making captured in the rightmost column. This table, methodology, and parts of this work have been adapted from work submitted in partial fulfillment for a Ph.D. [16].

The composite narratives were written in the third person, mirroring how managers described situations their employees had experienced rather than situations they had experienced themselves. Composite narratives in the literature tend to be first-person accounts [1]–[3], [5]. Even if the composite narratives are presented in the third person [1], the direct quotes still tend to be presented in the first person. In this work, I used direct quotes of what managers indicated they said to the engineers. The composite narratives created in this research are secondhand accounts or critical incidents told by the managers about their supervisees. It is important to note that managers describe what they believe their supervisee was thinking rather than just describing their behavior – these are the managers’ hypotheses based on what they observed. Only the engineer they were describing knows what exactly they were thinking. Although managers were not able to provide these first person details, they provided broader, more detailed accounts of the situations faced by their supervisees due to their unique vantage points as more senior members within their companies. The stories are still powerful in provoking thought and understanding about the types of scenarios engineers face. There was one exception to the accounts being in the third person ("The balancing act. . ."), in which a participant described some of their own experiences as a manager.

There were also instances where the incident managers described had too much or insufficient detail. I drew on my engineering experiences in the workforce to supplement the managers’ accounts in these cases. For example, one manager’s discussion of a design change required omitting some details for the company’s privacy. To maintain anonymity, I changed these details with a more general explanation of the situation based on my own experiences.

Table 2
Composite Narrative Example

Composite Narrative Excerpt	Direct Quote from Manager	Decisions in Developing a Narrative Thread
As a recent graduate, <i>Sofia</i> is excited to be a design engineer – a role she is passionate about and has experience in. She starts her new position, and two weeks later, she gets some disappointing news—the project she was originally assigned to has been shut down. Her manager says, <u>“We’re going have to find you a new job. We don’t know what it’s going be... Sorry, your product is going away. We’re really glad you’re here. Just hold tight. Here’s some training, we have to figure out where we’re going.”</u>	So we had hired in November of last year; an engineer, mid-career probably about 10 years of experience, to come in as a design engineer on a specific project. The project that we had previously mentioned was shut down. We hired her. She joins in December, two weeks later, we decided to shut down the project. So we told her, “Well, we’re really glad you’re here. Just hold tight. Here’s some training, let’s, we gotta figure out where we’re going.” (Manager 1) So I was a leader and here I am delivering this news that, “We’re gonna have to find you a new job. We don’t know what it’s gonna be. Um, sorry, your product is going way.” (Manager 2)	Each of the three excerpts focused on an engineer at a different career stage (late, mid, or early). I chose to use the mid-career design engineer example with the early career context. I combined the dialogue from the two scenarios and summarized the context.

The role is related to her capstone project, so she feels she has relevant experience to contribute.

Sofia's first reactions are loss, fear, and frustration. Sofia has some mentors at the company that she can talk to, and she expresses her concerns: What's going on? What does it mean? What's going to happen? How will it work out? She starts to understand that shutting down the project is the right decision for both the team and the business.

the option of just being 100% focused on his PhD [work] was no longer an option, it's an exciting part because I'm excited, I'm excited about this technology. And he just literally wanted to, go down that path, So they were phenomenal, they knew the computation, the architecture, the mathematics, all behind it, and they were experts. (Manager 3)

Her first reaction was upset, loss. I would probably do ... I mean, I don't want to describe her emotions 'cause I'm not her, but if I was interpreting them, it was loss, frustration, and fear. um, was probably her first reaction. Thankfully by that time I had built up enough of a relationship with her to, to talk through with her. She had some other good coaches and mentors. So I think a good coach and mentor was also important in that situation that was outside of their leader.... I think a key aspect of her being able to be adaptable was her other mentors that she had in the organization that she could go to and say, "Hey, here's what's going on? What does it mean? What's gonna happen? How does that, how does that work?" So I think that initial reaction was that fear and that loss. And then as she worked through it, it was, "Okay, I understand it's the right decision for the team. It's the right decision for the business. I'm gonna be okay." (Manager 2)

The manager talks about a late-career Ph.D. hire that is focused on a technical niche that they are very passionate about. I included this element of being excited about the role but softened it to be a capstone rather than the work of a full dissertation or career.

I summarized this quote.

A few days later, Sofya gets an update,

“All right, you’re going to be on this new team and be focused on a different product. So, we know this is not necessarily what we hired you for, but it’s similar ... similar skillset, similar role, but different projects.”

She knows she is going to have to learn some new skills to work in this new role. The transition is not happening quickly—it is projected to take over a month! So, she takes the time to start learning. She finds small projects she can take on and tries to learn as much as she can. She really takes this new project as an opportunity to learn, broaden her network, get to know more people, and make connections within the organization. She successfully transitions into her new role. She is very open to being able to work on different projects and is having success in this new area. However, as she continues to learn and contribute more, she realizes, ‘This isn’t necessarily

So we know this is not necessarily what we hired you for, but it’s similar. So similar skillset, similar role, um, but different projects.” She was very open to being able to work on a different project, very adaptable, and even buried on a level of managing some of the early efforts from a project management standpoint. (Manager 1)

She did. She was coming from, um, uh, she was coming from [other company], and they use probably, it’s not probably anymore Creo, um, and we use SolidWorks. So she had to learn a new design tool. So it wasn’t that she didn’t have the technical skills, but she didn’t have it in that system. So, learning the new system. So she also was spending a lot of time just getting up to speed on SolidWorks. (Manager 2)

So she really took it as an opportunity to learn, and broaden her network, and get to know more people, and make connections with inside the organization. (Manager 2)
And she was able to complete her work on the team and transition into another team from what I read, everything I’ve heard quite successfully.

I think probably the biggest challenge was the amount of time that it took for that transition

I summarized the activities mentioned of learning new skills, broadening networks, getting to know more people, and making connections within the organization, as well as the successful transition into the new role. I also added details about the time it took mentioned in the quote by Manager 1 and the direct quote regarding not necessarily wanting to continue in the new role to which the new hire had been reassigned.

where I want to be.' Sofia still wants to work on design related to the original project that she was hired for, and she starts to talk to her manager about her career desires.

to happen. We were talking, it was like the course of three, four months. It was a long time by most standards for something that would have happened, because there was just other changes that were going on that prevented it. The business was working as fast as they could, but unfortunately it took longer than anticipated. (Manager 1) but she was more than willing to like, "Hey, I can do this. I can pitch in if that's what you need." So for short time did it, and then identify like, "This isn't necessarily where I wanna be." (Manager 1)

Sofia's manager tells her,

"You [have to] look at what are the other areas that excite you [so] that you can leverage your competency, your energy, and your passion, and [we can] look at where [we can] move you."

So it was very hard for him. So I told him,

"Okay, listen, you gotta look at what are the other areas that excite you that you can leverage your competency, your energy, and your passion, and peripherally kind of look at where can we, move you to, right?" (Manager 3)

I paraphrased the manager's direct quote.

Sofia and her manager work together to assign her to tasks that better match her skill sets and career desires in alignment with what the business needs, figuring out a solution that suits everybody.

So as we, we learned that and her desires in her career, we arranged a few other pieces of the work, to, to better match her skillsets and her desires with what the business needed. . . . And we worked together to figure out how to get her in a spot that was best suited for everybody. (Manager 1)

I paraphrased the manager's direct quote.

Figure 1

Final Composite Narrative

So, we know this is not necessarily what we hired you for...

As a recent graduate, *Sofia is excited to be a design engineer – a role she is passionate about and has experience in. **The role is related to her capstone project, so she feels she has relevant experience to contribute.** She starts her new position, and two weeks later, she gets some disappointing news—the project she was originally assigned to has been shut down. Her manager says,*

“We’re going have to find you a new job. We don’t know what it’s going be... Sorry, your product is going away. We’re really glad you’re here. Just hold tight. Here’s some training, we have to figure out where we’re going.”

Sofia’s first reactions are loss, fear, and frustration. Sofia has some mentors at the company that she can talk to, and she expresses her concerns: What’s going on? What does it mean? What’s going to happen? How will it work out? She starts to understand that shutting down the project is the right decision for both the team and the business. A few days later, she gets an update.

“All right, you’re going to be on this new team and be focused on a different product. So, we know this is not necessarily what we hired you for, but it’s similar... similar skillset, similar role, but different projects.”

She knows she is going to have to learn some new skills to work in this new role. The transition is not happening quickly—it is projected to take over a month! So, she takes the time to start learning. She finds small projects she can take on and tries to learn as much as she can. She really takes this new project as an opportunity to learn, broaden her network, get to know more people, and make connections within the organization. She successfully transitions into her new role.

Sofia is very open to being able to work on different projects and is having success in this new area. However, as she continues to learn and contribute more, she realizes, “This isn’t necessarily where I want to be.” Sofia still wants to work on design related to the original project that she was hired for, and she starts to talk to her manager about her career desires. Her manager tells her,

“You have to look at what are the other areas that excite you so that you can leverage your competency, your energy and your passion, and we can look at where we can move you.”

Sofia and her manager work together to assign her to tasks that better match her skill sets and career desires in alignment with what the business needs, figuring out a solution that suits everybody.

Discussion

Composite narratives as a way to highlight different findings

The composite narrative methodology used demonstrated several advantages over the inductive-deductive thematic analysis approach also taken by this project. First, the composite narratives were better able to illustrate the influence of personal and contextual factors in determining whether and how much an engineer adapts. For example, in two of the composite narratives, having self-awareness contributed to the engineers adapting by helping them recognize that they did not have enough knowledge or information to accomplish their work tasks and needed to ask for help. Other narratives highlighted the importance of support from managers and coworkers to engineers' adaptability. Managers alluded to providing engineers with various forms of help, including reassurance, big-picture context, empowerment, advice, coaching, and role modeling. The narratives emphasize the need for self and situational awareness, compared to the typology.

Second, the composite narratives illustrated the effect of time on engineers' adaptability. In one narrative, an engineer needs time to grieve a catastrophic device failure before being able to pivot directions and move on with their work. In another narrative, an engineer needs time to learn a new skill to expedite their progress, even though it means producing less output in the short term. Time also manifests as experience in the composite narratives. In one composite narrative, more experienced engineers were better ready to resume work after a major project setback compared to less experienced engineers, suggesting that experience on the job helps build a greater propensity for handling work stress. However, in another narrative, engineers who started work directly after undergraduate were more inclined to adapt to new work situations than engineers who had earned advanced degrees before working, suggesting that time spent specializing might be a barrier to navigating changing work situations. These findings demonstrate the nuance of adaptability, particularly the role that experience can play in an individual's willingness or capacity to be adaptable, depending on the context.

A highlight on these contextual factors demonstrated by composite narratives reveals how these choices in qualitative methodology can yield different results from the same data. Both of these methodologies illustrate different approaches to studying human behavior with different theoretical foundations. One focuses on understanding how behavior occurs in the natural environment, while the other focuses on the internal mental processes that underlie that behavior. There is overlap and insights from both methodologies provide a more nuanced understanding of behavior—in this case, related to adaptability.

Finally, the composite narratives help show how multiple dimensions of adaptability overlap and work together. For example, the narrative focused on dealing with uncertain and unpredictable work situations also alludes to learning new work tasks, technologies, and procedures. Likewise, the narrative focused on solving problems creatively suggested that the ability to handle work stress and demonstrate interpersonal and cultural adaptability greatly facilitates engineers to solve complex technical problems they otherwise could not solve by themselves. The ability to simultaneously examine multiple dimensions of adaptability and their overlaps represents a significant advantage over the thematic analysis conducted, where each dimension of adaptability was examined separately. An overlapping view of dimensions working together more accurately reflects what these behaviors may look like in practice.

Composite narratives as a way to bridge research and practice

In addition to helping illustrate the dimensions of adaptability in an easier form for readers, the composite narratives developed as part of this work could be combined with probing questions to stimulate thinking, learning, and discussion related to adaptability in both academic and industrial educational settings. These questions could include: (1) how would you react to this situation, (2) what steps would you take in this situation, and (3) what would you do or say if you saw this situation happen to someone else, as well as other questions more specific to the particular narrative. Examples of probing questions for the composite narrative presented in this paper are in Table 3. The composite narrative could be shared first as a real situation an engineer might encounter in the workplace. The probing questions could then be shared, with the goal of prompting learners to consider the complexities of the situation, how they believe an engineer should adapt to the situation, and that there may be multiple approaches to adapting, depending on the context. This also mirrors situation-based or behavioral interviews that engineering students may face in job interviews and gives students an opportunity to practice these interview skills by articulating what they would do. Importantly, while the composite narratives culminate in a resolution to the situation grounded in the research findings, learners are able to explore alternate endings to the scenario, perhaps informed by their own contexts and experiences. Further, alternative endings from the research findings from the different narrative threads can also be shared. The composite narratives themselves could also act as a starting point for discussing how to best prepare engineers to be adaptable when read by a group of educators.

Table 3

Probing Questions for Composite Narratives

Composite Narrative	Probing Questions
<i>So, we know this is not necessarily what we hired you for...</i> (Dealing with Uncertain and Unpredictable Situations)	If sharing this narrative, it is suggested to consider the following questions: • How would you react to this situation? • What steps would you take in this situation? • What if you were stuck in between roles? • What if you did not enjoy the new role? • What if your manager did not listen to you? • What would you do or say if you saw this situation happen to someone else?

Limitations

The composite narrative methodology has some limitations. First, it relies on the researcher's judgment to develop the narrative [1]. Some scholars have expressed concerns regarding the validity and rigor of this approach because the process can seem opaque, without a clear connection between the original data and the finished product. In response, [1] and [3] specifically address reviews questioning their methods by outlining the development of their composite narratives in their respective papers. This paper similarly mapped out the development

of a composite narrative in detail, providing transparency into the process. One possible improvement to this methodology would be member-checking with participants to ensure that the narratives remain true to the data.

Conclusion

This work illustrates the utility of composite narrative as a way to present and highlight different elements of the data, such as how contextual factors map to and interact with a construct. For example, the composite narratives in this work show how multiple dimensions of adaptability are needed to navigate engineering situations, as well as how dimensions are interrelated. The influence of time, personal, and contextual factors on engineers' adaptability was also demonstrated through the composite narratives. Such nuance can be lost or not a focus when presenting the findings in a thematic analysis or as a taxonomy. More engineering education researchers may want to consider using composite narratives, or narrative analysis in general, as a way to share the complexities and interdependencies inherent in their work more meaningfully.

Composite narratives can also act as a way to share research findings in a practical format that can easily lend to scenario-based learning. The composite narratives in this work were translated into scenarios and paired with probing questions for use in academic and industrial educational settings. Engineering education researchers who use narrative-based methods in their work may wish to consider how these narratives can be used to make their findings more accessible to different audiences.

Lastly, as the use of composite narratives within engineering education proliferates, researchers are encouraged to transparently document their methods so that field knowledge and the use of composite narratives continue to grow. This paper detailed one account of composite narrative creation, situated in literature, to demonstrate the methodology's quality and trustworthiness and assist in the replication of the methodology by other scholars. Additional examples are needed, especially as they relate to covering more sensitive research topics and more vulnerable participant populations.

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