



What can we learn from narratives? Unpacking engineering stories from the periphery

Wenqian Gan, Anne Gardner, and Scott Daniel
University of Technology Sydney
Corresponding Author Email: Wenqian.Gan@student.uts.edu.au

ABSTRACT

CONTEXT

Qualitative research is commonly used in conjunction with quantitative studies in engineering education research. However, they are also increasingly used to illuminate aspects that do not fit the dominant discourse, for example, the experiences of marginalised populations. Many of these studies focus on learning from small numbers, and often do so by collecting participant narratives (or stories). Narrative studies can take on many different forms – for instance, the researcher may use narratives as data or method, or conduct analysis paradigmatically or narratively.

PURPOSE OR GOAL

This paper aims to address the following research question: “How might we use narratives to understand the experiences of marginalised populations?” It will do so by providing a landscape of narrative studies within engineering education research and discuss narrative features in relation to each study.

APPROACH OR METHODOLOGY/METHODS

Studies from selected journals that mention ‘narrative’, ‘story’, or ‘journey’ in the title or abstract were identified and reviewed. Five papers were selected to guide understanding on some distinctions within narrative research. For each paper, an overview of how narratives were collected, analysed and presented was discussed.

ACTUAL OR ANTICIPATED OUTCOMES

Narratives can be used as data (where it is *collected*) or method (where it is *constructed*). Two types of cognition (modes of thought) can be used when analysing narratives: *paradigmatic* cognition, which focuses on identifying common themes or concepts from stories; and *narrative* cognition, which focuses on making sense of stories. Findings from narrative studies can be organised by participant or by topic, and participant narratives can be presented in first person or third person with direct or indirect quotes.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Narratives can be collected, analysed and presented using a wide range of approaches. This paper highlighted five distinct approaches and discussed how the purpose of each paper informs methodological considerations. We argue that narrative methods can lead to impactful findings in understanding intersecting identities and complex factors of marginalised populations.

KEYWORDS

Narrative, Methodology, Method, Diversity & Inclusion

Introduction

Context

In engineering education research (EER), qualitative research is often used in conjunction with quantitative studies (i.e., mixed research methods). For researchers interested in mixed research methods, Borrego, Douglas, and Amelink (2009) adapted a useful typology of design types (triangulation, embedded, explanatory and exploratory) based on the timing of quantitative and qualitative phases (concurrent or sequential), relative weighting of quantitative and qualitative components (equal or unequal), and when quantitative and qualitative phases are integrated (during analysis, or one phase informed by the other).

However, studies on diversity and inclusion have increasingly used qualitative research as the sole research method due to its ability to illuminate aspects that do not fit the dominant discourse. While quantitative studies on diversity and inclusion have useful implications, Foor, Walden, and Trytten (2007) argued that statistical analysis can 'bury the voices of underrepresented groups' (Borrego, Douglas, & Amelink, 2009), while Pawley (2019) discussed the unintended implications of racial or gender categorisations that often leads to deficit framings.

A discussion that is often held in parallel with the need for qualitative research is the importance of learning from small numbers (Pawley, 2019), which allows researchers to conduct in-depth studies on marginalised populations. In response to critiques that large sample sizes are necessary for 'theoretical saturation', Malterud, Siersma, and Guassora (2015) proposed the concept of 'information power', where sample size is guided by the aim of the study, sample specificity, use of established theory, quality of dialogue, and analysis strategy. As an example, if a study requires participants with highly specific characteristics, a small sample size will be more appropriate to address the nuances of each participant.

One model that is used to learn from small numbers is *narratives* (Pawley, 2019). Cruz and Kellam (2018) described their narrative study as a "holistic, 'bottom-up' account" of participants, as opposed to a 'top-down' approach where studies are framed by existing developmental or educational models. However, studying narratives does not necessarily imply a lack of theory or rigour, which we will discuss later in this paper.

Purpose

This paper aims to address the following research question:

"How might we use narratives to understand the experiences of marginalised populations?"

As the term 'narrative' is used to describe a broad range of methods, this paper will present a landscape of narrative studies within engineering education research (EER) by outlining five studies that draw from distinct approaches to studying narratives. We will also discuss what aspects of marginalised populations these studies focused on, and how these studies understood the experiences of marginalised populations through narratives.

Narratives

To set the scene on what we mean by narratives, we start with what Kellam, Gerow, and Walther (2015) described as a 'nagging feeling that something important was missing' when data is broken into smaller pieces and fails to capture the 'complex, nuanced, and distinct identities of participants that can resonate deeply with the reader and lead to different types of insights during analysis.' What they have described as missing is the impact of narratives, which Kim (2016) described as a way of 'personalising social problems or socialising personal problems.'

'Narrative' is defined in many ways - it may refer to a story told by a participant, a researcher's account of a participant's journey, or even conversational data collected as part of a study. Case and Light (2011) further discussed what scholars consider as narratives, but for the purpose of

orienting this paper we present some distinctions within narrative research to guide researchers who are interested in conducting a narrative study. It is important to note that these distinctions are laid out with the intention to simplify overlapping terminologies and distinctions in the literature and should be used in tandem rather than subscribing to 'either-or, binary thinking' (Kim, 2016).

Two dimensions along which narrative studies can be framed are 1) whether narratives are used as data or as a methodological approach (or both), and 2) how the narratives are analysed.

Narrative as *data* and *method*

The researcher's definition of 'narrative' influences the way narratives are used, and vice versa. When narratives are used as *data*, narratives can refer to any data collected in the form of a narrative e.g., an interview with a participant on their journey through engineering. These narratives can be analysed using any qualitative method e.g., thematic analysis (Pawley & Phillips, 2014) and need not be presented as a narrative. When narratives are used as *method*, narratives are used as an analytic lens to interpret data e.g., a constructed account of how a participant decided to do engineering. The data collected need not be in the form of a narrative, but the analytical outcome is typically presented as a narrative. In short, with narrative as data, narratives are *collected*. In contrast, in narrative as method, narratives are *constructed*.

Paradigmatic and narrative cognition

Another important distinction is how the narratives are analysed. Bruner (1986) proposes two distinctive types of cognition (i.e., modes of thoughts): paradigmatic cognition and narrative cognition. *Paradigmatic* cognition focuses on identifying common themes or concepts from stories, while *narrative* cognition focuses on making sense of stories (Polkinghorne, 1995). As an example, *paradigmatic* cognition may be applied to answer research questions such as what factors or stages lead to engineering attrition, while *narrative* cognition may be applied to answer research questions such as how a participant decided to leave engineering.

The above distinctions serve as a starting point for conducting narrative research and are not isolated from one another. For example, a researcher using narrative as *data* will be inclined towards *paradigmatic* cognition while a researcher using narrative as *method* will be inclined towards *narrative* cognition. These decisions will in turn inform whether narratives are presented across case (where findings are organised by themes) or within case (where findings are organised by participant). They will also inform whether researchers analyse on the macro-level (plot) or micro-level (language and intention).

As the purpose of this paper is to present a landscape of how narratives are used in engineering education research (EER), we will not delve into every methodological decision listed above in detail. Instead, readers who are interested can refer to method papers from engineering education researchers using narrative methods, which include detailed steps taken to conduct and analyse narrative research (Mondisa, 2016), different ways of presenting the findings from a narrative study (Kellam, Gerow, & Walther, 2015), and considerations on narrative research quality (Pawley & Phillips, 2014).

Narrative Studies in Engineering Education Research (EER)

In this section we present five distinct narrative studies in EER. We found these studies by searching for papers that mention 'narrative', 'story' or 'journey' in the title or abstract within three engineering education journals: the Journal of Engineering Education, the European Journal of Engineering Education, and the Australasian Journal of Engineering Education. While we identified other journals and keywords that lead to relevant studies on narrative research through snowballing, the purpose of this paper is to provide an overview of how narratives are used in EER, not to develop an extensive typology of narrative studies. Hence, we focused on highlighting work from different groups of authors to guide understanding on the distinctions mentioned in the earlier section, rather than developing an exhausting catalogue.

For each paper below, we will provide a brief context, summarise how narratives were collected, analysed and presented, and discuss the approach undertaken. A comparative summary of how each of the five papers used narratives (as data or method), analysed narratives (paradigmatically or narratively), organised findings and presented narratives is presented in Table 1.

Paper 1: Maps of meaning: Journeys of first year engineering students (Kopparla, Nguyen, & Woltering, 2022)

This paper focused on undergraduate STEM retention, where the authors sought to understand factors that make the engineering major challenging, and individual factors that help or hinder first-year engineering students to persevere in the major.

- **Collection:** Participants were asked to draw an illustrated road map of their journey through their first year in the engineering program followed by a semi-structured interview.
- **Analysis:** The road map was used to identify salient and story-worthy events in the narratives using critical visual methodology (guiding questions are further discussed in the paper). Recurring themes were identified from the narratives, and narratives were restructured chronologically.
- **Presentation:** The narratives from each of the 8 participants were presented separately (along with their illustrated road maps) in third person with direct quotes from participants, followed by a discussion on common themes across all participants.

The approach taken by this paper allowed space for participants to construct their narratives through metaphors, which allowed the researchers to understand the participants' experiences on a more personal level. For instance, when one of the participants, Jon, illustrated his first semester, he drew himself dodging from arrows labelled chemistry, a subject he found difficult. In the second semester, however, he drew himself shooting arrows to targets labelled by the subjects he took, indicating a shift in perceived control. Another paper in EER that used road maps to elicit narratives is *Engineering Dropouts: A Qualitative Examination of Why Undergraduates Leave Engineering* (Meyer and Marx, 2014).

Paper 2: Analysis of social media forums to elicit narratives of graduate engineering student attrition (Berdanier et al., 2020)

This paper focused on graduate engineering student attrition, where the authors investigated relationships among factors that contribute to consideration of departure from graduate engineering programs.

- **Collection:** Narratives were collected through the online forum Reddit (details of the process of identifying relevant threads and inclusion/exclusion criteria further are further discussed in paper), and 28 posts related to engineering graduate school attrition were identified.
- **Analysis:** Emergent themes were identified through open coding and refined through axial coding to establish primary themes and connections among themes.
- **Presentation:** Each theme was first explained, followed by 4 narratives in first person (i.e., posts from 4 different users on Reddit) selected by the authors to provide voice to main themes. Each narrative was directly followed by the authors' analysis of the connections among themes.

This paper was presented as an example of collecting narratives without participant contact. The authors further discussed the limitations of this approach in the paper, but one feature that is both a strength and limitation is the anonymity of participants. On the one hand, participants can be honest without fear of repercussions, which may result in additional insights that are not mentioned in exit interviews. On the other hand, the lack of interaction between researcher and participant may limit the accuracy of how narratives are interpreted, especially in the context of internet discourse.

Paper 3: Beginning an engineer's journey: A narrative examination of how, when, and why students choose the engineering major (Cruz & Kellam, 2018)

This paper focused on students transferring into engineering from other majors, where the authors aimed to get a better understanding of how engineering students enter the engineering field by comparing commonalities across their experiences.

- **Collection:** Semi-structured interviews with 21 students were conducted, mainly prompted by “Think about your experiences in engineering as far back as you can. Could you tell me the story of how you got to where you are today?”
- **Analysis:** Each narrative was first coded structurally based on Campbell's hero's journey, which is based on the argument that all narratives include a series of archetypal events that follow a similar trajectory (Campbell, 2004; Cruz & Kellam, 2017). Codes consist of stages such as ‘call to adventure’ and ‘freedom to live’ (which signifies the beginning and end of a plot). After the narratives were broken down into stages, each stage was analysed thematically across all participants.
- **Presentation:** Findings were organised by the four stages of Campbell's hero's journey, and authors discussed the themes identified from each stage. In the analysis, the number of participants who referenced a particular theme was pointed out, with brief quotes from participants inserted to elaborate on the theme.

This paper is significantly different from the two papers presented previously. Firstly, it did not present participant narratives as findings. Secondly, a structural analysis was conducted before a thematic analysis to allow for a more organised comparison of participant narratives. This methodological decision is likely due to higher participant numbers (compared to Paper 1) and longer narrative lengths (compared to Paper 2). The authors noted that while the purpose of the paper is to highlight commonalities, it may exclude unique and telling experiences that do not fit the structure. Other papers in EER that use Campbell's hero's journey include *Understanding engineering educators' pedagogical transformations through the Hero's journey* (Boklage, Coley and Kellam, 2019) and *“Racing the Sun”: A Narrative Analysis of Engineering Graduate Students' Journeys Navigating Public-Inspired Science Work* (Lightner et al., 2021).

Paper 4: Learning from small numbers: Studying ruling relations that gender and race the structure of U.S. engineering education (Pawley, 2019)

In this paper, the author explored how gender and race are built into engineering education's institutional structure through the concept of ruling relations developed by Smith (1990, 2005, as cited in Pawley, 2019).

- **Collection:** Interviews with 17 engineering undergraduates (persons of colour and/or women) were conducted, mainly prompted by “How did you get to be where you are?”
- **Analysis:** Repeated readings of the transcript were undertaken to analyse narrative structure, references to ruling relations and participant voice (Pawley & Phillips, 2014). Parts that were most relevant to the purpose of the study (uncovering instances of ruling relations) were identified and collected from narratives.
- **Presentation:** Four topics that illustrate ruling relations were presented with extended direct quotes from participants.

Like the papers presented before, this study collected narratives from participants. However, the analytical process was more heavily informed by narrative theories, which involved examining the structure of the narrative, not just the content communicated by the participant (distinction between structure and content is further discussed in the paper). This approach is significantly different from previous papers that applied thematic or structural analysis (which are forms of paradigmatic cognition) as the author uncovered ruling relations through ‘sustained stories from participants’ using narrative analysis. Rather than strictly abiding to a structured analytic approach and presenting findings as themes, the author shifted to a flexible interpretive approach and illustrated topics that resonated strongly.

Paper 5: Supporting the narrative agency of a marginalised engineering student (Secules et al., 2018)

This paper is centred on support for underrepresented groups in STEM, where the authors applied narrative as a resource for understanding the process of supporting marginalised student agency.

- **Collection:** Longitudinal interview (first 3 of which were analysed in the paper) with 1 female undergraduate engineering student that emerged from interactions as part of the first author's role in instructional support.
- **Analysis:** During initial viewings, data was analysed linguistically for aspects such as emotional salience and expressions of powerfulness or powerlessness. Early in the analytic process, three prominent themes were identified to guide focused analysis (process is further discussed in the paper).
- **Presentation:** Three central narratives were presented with extended direct quotes from participant.

Throughout the paper, the authors frequently noted that the narrative was co-constructed by the interviewer and interviewee. Framing a study around one participant allowed for an extensive discussion on the researcher-participant relationship, which was discussed to a lesser extent in previous papers. In describing their approach, they argued that narratives have liberatory potential for participants, as the interviews 'provide space for narrative construction and validation' (p. 195). Narratives should therefore not be solely viewed as a vehicle for knowledge production, as researchers should consider the impact on research participants. While distinct in analytic approach, another paper in EER that has drawn on narratives from a single participant include *Rethinking 'disadvantage' in higher education: a paradigmatic case study using narrative analysis* (Marshall and Case, 2010).

Discussion

From the papers discussed above, all papers (except for Paper 1) recruited participants from underrepresented demographics in engineering (persons of colour and women in Papers 4 and 5) or participants whose journeys are under-researched in engineering education research (graduate students who intend to leave in Paper 2, engineering students who transferred from other majors in Paper 3). Most papers were framed as studies that address attraction, retention or attrition in engineering, and were conducted to better understand and support students. This finding speaks to the impact of narratives in illuminating aspects that do not fit the dominant discourse.

How narratives were used: All papers used narratives as data, mostly elicited through interviews with participants (apart from the use of illustrated road maps in Paper 1 and online forums in Paper 2). Notably, Papers 4 and 5 used narratives as both data and method, which reiterates the need to refrain from either-or, binary thinking when considering the distinctions presented in this paper and other narrative literature. An aspect that was not discussed in this paper due to the scope was the use of narratives as data in different methodologies such as case study or grounded theory, and distinct features of narrative methods that differ from methodologies such as phenomenology and ethnography. We recommend this as a possible direction for future work, to tell a more complete story of how narratives can be used in engineering education research.

How narratives were analysed: Papers 1 and 2 used thematic analysis while Paper 3 used thematic and structural analysis. Both thematic and structural analysis are forms of paradigmatic cognition (Kellam, Gerow, & Walther, 2015), which focuses on identifying common themes or concepts from stories. Papers 4 and 5 used both forms of cognition - narrative cognition to make sense of the narrative at a micro-level (by interrogating language and intention), and paradigmatic cognition to structure the narrative at a macro-level (by topic or central narrative). While the analytic approaches used in Papers 1, 2 and 3 may appeal to engineering education researchers due to its systematic structure, the interpretive approach demonstrated in Papers 4 and 5 are equally rigorous. Approaches to assess the quality of interpretive research are further discussed by Walther, Sochacka, and Kellam (2013).

Table 1: Comparative summary of how narratives are used, analysed, and presented in EER

	How narratives were used	How narratives were analysed	How findings were organised	How narratives were presented
Paper 1: Kopparla, Nguyen & Woltering (2022)	<i>As data</i> – collected narratives from illustrated road maps and interviews	<i>Paradigmatic cognition</i> – narratives analysed to identify recurring themes	Findings organised by participant, followed by overall analysis of themes	Narratives presented in third person with direct quotes
Paper 2: Berdanier et al. (2020)	<i>As data</i> – collected narratives from online forum	<i>Paradigmatic cognition</i> – narratives analysed to establish primary themes and connections among themes	Findings organised by participant, each narrative followed by an analysis of themes	Narratives presented in first person - posts extracted directly
Paper 3: Cruz & Kellam (2018)	<i>As data</i> – collected narratives from interviews	<i>Paradigmatic cognition</i> – narratives analysed by plot structure, then by theme	Findings organised by plot structure to present themes	No narratives presented – brief direct and indirect quotes inserted to accompany analysis
Paper 4: Pawley (2019)	<i>As data</i> – collected narratives from interviews <i>As method</i> – applied narrative theories	<i>Narrative cognition</i> – narratives analysed for narrative structure and participant voice <i>Paradigmatic cognition</i> – narratives analysed with reference to theoretical framework	Findings organised by topics	Narratives presented and analysed in third person with extended direct quotes
Paper 5: Secules et al. (2018)	<i>As data</i> – collected narratives from interviews <i>As method</i> – adopted view of narrative construction as theory-building activity	<i>Narrative cognition</i> – longitudinal interview allowed space for co-construction <i>Paradigmatic cognition</i> – narratives analysed with reference to central narratives	Findings organised by central narratives	Narratives presented and analysed in third person with extended direct quotes

How findings were organised: Papers 1 and 2 introduced the participants at an individual level through narratives before presenting the researchers' analysis of the narratives. Papers 3 and 4 organised findings by structure and topic respectively, and embedded narratives from different participants throughout their analysis. Paper 5 organised findings by themes but presented

narratives from the same participant across multiple interviews. While not all papers explicitly discussed how they chose to organise their findings, their chosen approach broadly reflects their purpose of using narratives. Researchers seeking to compel readers may present individual narratives to 'personalise social problems', while researchers seeking to prompt action may present collective narratives to 'socialise personal problems' (Kim, 2016; Pawley & Phillips, 2014).

How narratives were presented: All papers (except for Paper 2) presented narratives in third person. Paper 3 used a mix of brief direct and indirect quotes from participants, while Papers 1, 4 and 5 used direct quotes in varying lengths, ranging from a few sentences to a few paragraphs. Similar to how findings are organised, the decision on how narratives are presented are largely influenced by the purpose of the study. Kellam, Gerow, and Walther (2015) classified three different ways to construct and present narratives, which are not discussed in this paper as most papers presented sit in between classifications, which may be a cause of confusion.

While this paper focuses on the range of methodologies used in narrative research, we note that each of the 5 studies is informed by the authors' perspectives on whether studies should be conducted on a psychological, sociological or structural level. However, within these narrative studies there is an underlying consensus that attraction, retention and/or attrition are informed by a confluence of factors rather than a single contributing factor (as discussed in Paper 3) and that studying the connections between these factors would lead to deeper insights (as demonstrated in Paper 2). Papers 1 and 3 have situated their studies in narratives as the commonly used 'leaky pipeline' metaphor undermines the complexity of personality and experiences. The authors of Paper 5 also pointed out that intersectionality is an important consideration in such studies, while the author of Paper 4 argued that her method facilitates 'analysing data intersectionally'.

Conclusion

In this paper, we provided an overview of distinctions within narrative research, presented five examples of narrative studies in engineering education research, and discussed narrative features present in these papers in relation to its intended impact. We acknowledge that we may have missed a significant number of publications that used narratives as data and/or method. However, by providing a landscape of narrative studies, we believe that this paper contributes to an emerging conversation on narrative methods, and how it can be used to understand marginalised populations' individual experiences to inform relevant action.

References

- Berdanier, C. G. P., Whitehair, C., Kirn, A., & Satterfield, D. (2020). Analysis of social media forums to elicit narratives of graduate engineering student attrition. *Journal of Engineering Education, 109*(1), 125-147. doi:10.1002/jee.20299
- Borrego, M., Douglas, E. P., & Amelink, C. T. (2009). Quantitative, Qualitative, and Mixed Research Methods in Engineering Education. *Journal of Engineering Education, 98*(1), 53-66. doi:10.1002/j.2168-9830.2009.tb01005.x
- Bruner, J. S. (1986). *Actual minds, possible worlds*. Cambridge: Harvard University Press.
- Campbell, J. (2004). *The hero with a thousand faces*. Princeton, N.J: Princeton University Press.
- Case, J. M., & Light, G. (2011). Emerging Research Methodologies in Engineering Education Research. *Journal of Engineering Education, 100*(1), 186-210. doi:10.1002/j.2168-9830.2011.tb00008.x
- Cruz, J., & Kellam, N. (2017). Restructuring structural narrative analysis using Campbell's monomyth to understand participant narratives. *Narrative Inquiry, 27*(1), 169-186. doi:10.1075/ni.27.1.09cru

- Cruz, J., & Kellam, N. (2018). Beginning an Engineer's Journey: A Narrative Examination of How, When, and Why Students Choose the Engineering Major. *Journal of Engineering Education*, 107(4), 556-582. doi:10.1002/jee.20234
- Foor, C. E., Walden, S. E., & Trytten, D. A. (2007). "I Wish that I Belonged More in this Whole Engineering Group:" Achieving Individual Diversity. *Journal of Engineering Education*, 96(2), 103-115. doi:10.1002/j.2168-9830.2007.tb00921.x
- Kellam, N. N., Gerow, K. S., & Walther, J. (2015). *Narrative Analysis in Engineering Education Research: Exploring Ways of Constructing Narratives to Have Resonance with the Reader and Critical Research Implications*. Paper presented at the ASEE Annual Conference & Exposition, Seattle, Washington. <https://peer.asee.org/24521>
- Kim, J. (2016). *Understanding narrative inquiry : the crafting and analysis of stories as research*. Los Angeles, CA: SAGE Publications, Inc.
- Kopparla, M., Nguyen, T. T., & Woltering, S. (2022). Maps of meaning: journeys of first year engineering students. *European Journal of Engineering Education*, 1-20. doi:10.1080/03043797.2022.2037522
- Malterud, K., Siersma, V. D., & Guassora, A. D. (2015). Sample Size in Qualitative Interview Studies: Guided by Information Power. *Qualitative Health Research*, 26(13), 1753-1760. doi:10.1177/1049732315617444
- Mondisa, J. (2016). *Capturing Our Stories in Our Voices: Constructing a Narrative Analysis Study of African-American STEM Mentors*. Paper presented at the ASEE Annual Conference & Exposition, New Orleans, Louisiana. <https://strategy.asee.org/26448>
- Pawley, A. L. (2019). Learning from small numbers: Studying ruling relations that gender and race the structure of U.S. engineering education. *Journal of Engineering Education*, 108(1), 13-31. doi:10.1002/jee.20247
- Pawley, A. L., & Phillips, C. M. L. (2014). *From the Mouths of Students: Two Illustrations of Narrative Analysis to Understand Engineering Education's Ruling Relations as Gendered and Raced*. Paper presented at the ASEE Annual Conference & Exposition, Indianapolis, Indiana. <https://peer.asee.org/20524>
- Polkinghorne, D. E. (1995). Narrative configuration in qualitative analysis. *International Journal of Qualitative Studies in Education*, 8(1), 5-23. doi:10.1080/0951839950080103
- Secules, S., Gupta, A., Elby, A., & Tanu, E. (2018). Supporting the Narrative Agency of a Marginalized Engineering Student. *Journal of Engineering Education*, 107(2), 186-218. doi:10.1002/jee.20201
- Walther, J., Sochacka, N. W., & Kellam, N. N. (2013). Quality in Interpretive Engineering Education Research: Reflections on an Example Study. *Journal of Engineering Education*, 102(4), 626-659. doi:10.1002/jee.20029

Copyright statement

Copyright © 2022 Wenqian Gan, Anne Gardner, and Scott Daniel: The authors assign to the Australasian Association for Engineering Education (AAEE) and educational non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The authors also grant a non-exclusive licence to AAEE to publish this document in full on the World Wide Web (prime sites and mirrors), on Memory Sticks, and in printed form within the AAEE 2022 proceedings. Any other usage is prohibited without the express permission of the authors.