

## Storying Mathematical Identity Narratives

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*This paper presents an analytical framework called storying stories. It was used to analyse narrative data that was collected as part of a PhD study into the mathematical identity of science and engineering students (MISE). This framework was selected because it relies on the co-construction of meaning between researcher and participant. Mathematical identity is commonly assumed to be a co-constructed phenomenon and thus, narrative methods of data collection and analysis have regularly been employed by mathematical identity researchers. However, the storying stories framework presented in this paper appears to have been overlooked, or perhaps discounted, by these researchers.*

*This stage of the PhD study involved one participant who took part in a pilot narrative interview concerning their mathematical identity. Although thematic analysis allows the development of themes that are common across participants, a new method of analysis was required to use narrative inquiry as a descriptive tool for an individual participant. This paper will present how this method for analysing and presenting such data was applied to this interview.*

### Introduction

The focus of this paper is the PhD research of the first author, conducted under the supervision of the second and third authors. The purpose of the study is to investigate the mathematical identity of science (including science education) and engineering students (MISE). This work builds on previous mathematical identity research conducted in Ireland (Eaton et al., 2013; see also Howard, 2019, p. 140). The overall aim of this research is to characterise and compare participants' mathematical identities and investigate how these identities change over time. To explore this, I conducted an online open-ended questionnaire, which I analysed using thematic analysis (Howard et al., 2019). I followed-up with focus groups to clarify these themes, explore any additional aspects and examine the changes in their mathematical identities during this time.

The focus of this paper is a pilot interview with one science education student who had previously participated in the open-ended questionnaire. The participant had experience teaching mathematics and physics at post-primary level through placement as part of their course. The purpose of the interview was to investigate how the participant's mathematical identity changed over time. Through the reflective process of a narrative interview, I hoped that reconstructing their mathematical identities would endow the participants with "a new sense of meaning and significance" (Clandinin & Connelly, 2000, p. 42) about their relationship with mathematics. Below, I will describe three concepts: mathematical identity, narrative inquiry and the *storying stories* framework for analysis. Secondly, I will demonstrate how this framework was applied to narrative interview data in MISE. Finally, I will present the results of the analysis and some conclusions.

## Literature Review

In their seminal paper, Sfard and Prusak (2005) defined identity as “collections of stories ... that are reifying, endorsable and significant” (p. 16). Thus, they reimagined identity as a “communicational practice” centred on narratives rather than relying on static and extra-discursive notions of who one is (p. 16). Since that important reimagining, it has become more common to consider identity and narrative as related rather than synonymous (Howard, 2019, p. 140; Machalow et al., 2020). Following this viewpoint, I define mathematical identity to be the multi-faceted relationship that an individual has with mathematics, including knowledge, experiences and perceptions of oneself and others (Eaton & O'Reilly, 2009, p. 228). In this study, I consider mathematical identity to be “storied ... through narratives” (Radovic et al., 2018, p. 28, Table 2). This implies that mathematical identity is fluid and that narratives are “enactments of identity, constructed in the moment” (p. 29). I also embrace the view of Kaasila (2007, p. 206), who explains that “one’s mathematical identity is manifested when telling stories about one’s relationship to mathematics, its learning and teaching.”

## Methodology

### *Narrative Inquiry*

This study is situated in the area of narrative inquiry, which has been recommended for understanding experiences (Clandinin & Connelly, 2000, p. 20). It is appropriate for longitudinal studies such as MISE, because it is “a collaboration between researcher and participants, over time” (p. 20). This collaborative property aided me in positioning the participants as co-researchers who “shape the research process” (Cohen et al., 2007, p. 37) and whose agenda can predominate my own (p. 376). The telling of narratives “allows for growth and change” (p. 71) since narratives, like mathematical identity, are constructed and reconstructed as they are told, and over time (Howard et al., 2019, p. 1454; McCormack, 2000a, p. 286, 2004, p. 220).

In general, narrative researchers are concerned with “everyday or natural linguistic expressions, not with decontextualized short phrases or with abstracted counts” (Polkinghorne, 1995, p. 6). Such researchers acknowledge that context is important for sense-making (Clandinin & Connelly, 2000, p. 32) and aim to position the participant as the expert in order to represent and understand *their* experiences from *their* point of view. Narrative inquiries frequently feature semi-structured interview protocols and open-ended questions that “allow the speaker to ‘hold the floor’ beyond the limits of a usual [speaking] turn” (Mishler, 1991, p. 74).

I designed my interview protocol in a manner consistent with narrative inquiry and with Mishler’s *interview as conversation* (Mishler, 1991). Narrative interviewing is a method of data collection that facilitates co-construction of meaning between interviewer and participant (p. 52). This is important because we are complicit in the creation of the world that we study (Clandinin & Connelly, 2000, p. 61). I was drawn to narrative interviewing because “[t]he goal of the narrative interview is to get the interviewee to tell stories about things that are important to him or her” (Kaasila, 2007, p. 207 emphasis added). To empower participants

to do this, one must change the traditional interviewer-interviewee relationship to one of listener-narrator, where control of the conversation does not rest only with the interviewer (Mishler, 1991, p. 117).

### ***Storying Stories***

The *storying stories* framework is rooted in research concerning *life story* (Rosenthal, 1993) and *life history* (Schütze, 2008), both of which can be studied in terms of specific relationships (Szczepanik & Siebert, 2016, p. 287), i.e. relationship with mathematics. It seeks stories as data and generates stories through emplotment, which means it represents an analysis of narrative and a narrative analysis respectively (McCormack, 2004, p. 220; Polkinghorne, 1995). Previously, I used thematic analysis to focus on elements of mathematical identity that were common across participants in the questionnaire data (Howard et al., 2019). This constituted an analysis of narrative, since it allowed the development of themes that hold across the narrative data. To use narrative inquiry as a descriptive tool for an individual participant required a new method of analysis.

I used this framework for several reasons. Although stories/narratives occupy a central position in narrative interviewing, McCormack (2004, p. 219) points out that the task of analysing narrative data is “daunting” and that narrative research literature has been “largely silent” about how to do this. Furthermore, the “ordering principles” (Svašek & Domecka, 2012, p. 108) of stories have great potential for illuminating mathematical identity through the “dynamics of self-perception, self-projection, personal experience and transformation” (p. 108), all of which are present in the definition of mathematical identity given earlier.

This framework relies on the work of Schütze in the 1970s, who claimed that the three constraints of narration (to condense, to be detailed, to close the narrative at the end) significantly limit what a person says when telling stories and how they say it (Schütze, 2008, pp. 14–16; Svašek & Domecka, 2012, p. 110). By drawing from several other authors (Labov, 1972, 1982; McCormack, 2000a, 2004; Rosenthal, 1993), I compiled the following definitions of the five *narrative processes* that are used when telling stories about oneself:

- **Story:** Identified by “recognizable boundaries – a beginning and an end” (McCormack, 2000a, p. 288). A story is required to have a sequence of linked events/actions.
- **Description:** Details about static structures (Rosenthal, 1993, p. 8), such as people, places and routines (Schütze, 2008, p. 15), which reduce the “information gap” (p. 61) between interviewer and participant. They help the listener to get a more complete picture of the other narrative processes (McCormack, 2004, p. 224).
- **Argumentation:** Abstracted elements outside the story which present the perspective of the present (Rosenthal, 1993, p. 8). They add meaning to the other processes.
- **Theorising:** The narrator’s general orientation at the moment (Rosenthal, 1993). Reflecting or trying to work something out (McCormack, 2000a, p. 290).
- **Augmentation:** Adding to, or expanding on, previous stories (McCormack, 2004).

The story is the main unit of this analysis. The other four processes may elaborate on these stories or they may include other elements from outside the stories. McCormack (2000a, pp. 288–289), taking inspiration from Rosenthal (1993), defines a story as having a recognisable beginning and end, along with a sequence of linked events/actions which together explain why the story was told (the point of the story). These events/actions can be organised chronologically or thematically (Mishler, 1991, p. 87; Rosenthal, 1993, p. 8). As such, a story consists of five distinct elements, two of which are optional:

- **Orientation (beginning):** Describes the general situation before, or at, the time of the first action. *Who, what, when, where?*
- **(Optional) Abstract:** Summarises the point of the story. Substance of the story as viewed by the narrator. *What was this about? Why is it being told?*
- **Linked events/actions:** *Then what happened?*
- **(Optional) Evaluation (the point of the story):** The narrator steps out of the story to explain what was in their mind at the time and how they felt about what was happening. Conveys the teller's emotions and attitudes to the narration. They may compare things that occurred and what might have occurred. This is the title of the story. *So what?*
- **Coda (end):** Finishes the story and brings the listener back to the present. *Then what happened? Nothing, I just told you what happened.*

Labov (1972, p. 370) proposed each of the guiding questions in italics above. Evaluation is an almost universal feature of narratives given by adults, since stories limited to events/actions don't always make a *point* to the listener (Labov, 1982, p. 226). Some authors consider narratives limited to events/actions to be *unreportable* (p. 227) or *unnarratable* (Georgakopoulou, 2007, p. 62), such is the proven importance of the evaluative element (Mishler, 1991, p. 83).

## Methods

The first task was to identify the stories in the data. A story has three required features: a beginning (*orientation*), a middle (*linked events/actions*) and an end (*coda*); it may also contain *abstracts* or *evaluations*. When locating a story, the coda is easiest to pinpoint because it brings the listener away from the narrative and back to the present (Labov, 1972, p. 365). It signals that the participant's turn to speak has finished and the interviewer should speak next. Labov's definition of a narrative in terms of *narrative clauses* (p. 375, Table 9.1) was useful for distinguishing the other narrative processes from the linked events/actions, which indicate that a story is present.

With reference to Labov's definition, I identified the other narrative processes: *argumentation*, *description*, *theorising* and *augmentation*, which helped narrow the list of twenty-one potential stories down to ten. These were sufficient to categorise the narrative data since all parts of the interview were matched with one of the five narrative processes. To determine how these processes "enrich these stories ... to help the listener get the point" (McCormack, 2000a, p. 286), I examined the relationship between them by creating a spreadsheet to track which processes referred to a topic discussed earlier in the interview;

augmentations always do, but theorising and argumentation may also be connected to previous parts of the interview.

In the previous section, I emphasised the importance of evaluation in endowing stories with meaning. Most of the ten stories included an evaluative element without prompt from the interviewer. On one occasion, an evaluation arose when the participant noted that I might be getting the wrong message from their story about the maths learning centre (MLC):

ID069                      Yeah so we worked together ... in smaller groups.

FH                              Ok, so the collaboration.

ID069                      Yeah, but like, we didn't go [to the MLC].

In four of the stories, the coda included a general evaluation. For example:

ID069                      [W]e'd never done like, college exams and stuff, so it was just kind of all, *it was just a very different experience I think than secondary school.*

Often, this merging of coda and evaluation served to answer a question posed by me to the participant, or by the participant to themselves. For example, I asked “which modules influence your teaching practice?” and one minute later, the participant ends a story with the following coda:

ID069                      [I]t was really helpful to have the reference to different things as we were doing them like.

As expressed by the literature, the coda sometimes explains the effects of a narrative (Labov, 1972, p. 365) or is merged with the final linked event/action (Labov, 1982, p. 226), both of which can be demonstrated by the following example from this interview:

ID069                      So yeah ... I feel like a lot, not a lot like some of them understood it and some of them didn't.

This extract demonstrates how narratives processes of theorising and description can be used mid-story.

## Results

This section presents the results of applying the storying stories framework to a narrative interview with a science education student. Ten stories were located in the data, the titles of which are shown below, along with the contributions from the four other narrative processes in italics. Note that some entries in italics added to a story, while some entries offered entirely new information. The titles are:

1. How you study maths in college and how you study maths for the Leaving Cert I think are different. (*I've learned how to learn maths now.*)
2. I know I was good at algebra before, but I'm really good at teaching it now. (*Which modules influenced me more?*)
3. The module just clicked in with lots of other mathematics that we came across.
4. If my student gets it one way, I'll go back and do it another way maybe. (*Teaching has made me more confident. I was inspired by my teacher in secondary school.*)
5. I worked really hard to stay in LCH maths and did better than I expected.

6. TY maths seemed like a waste of time, (*but there were some positives*).
7. I wasn't getting back like "do you understand this" from my students.
8. I wouldn't personally use the area model, I don't really like it, but the male students did. (*Girls get stressed out about maths, whereas guys find it easier*).
9. In first year, I stopped going to the MLC (maths learning centre) because it was intimidating *but it has changed a lot*.
10. I started going to the MLC again because I needed to learn how to do certain things so I could keep doing them on my own until I kind of got it.

Since the evaluation and abstract explain why the story was told (McCormack, 2000a), the title for each story was drawn from these elements using the participant's own words. Even though the sections of text matched with each process varied in length, it became clear that this interview was dominated by descriptions and theorising (57 of the 91 extracts from the interview). The process of argumentation, although used sparingly by this participant, contributed an important contextual framing of their experiences so they could be better understood by the interviewer.

## Conclusions

The aim of this paper was to apply the *storying stories* framework to narrative interview data concerning mathematical identity. Since I conducted this interview using themes developed from a mathematical identity questionnaire, I wondered whether this type of narrative analysis would be applicable. Although Rosenthal (1993) proposed *life story* as the subject of the narrative biographical interview, other authors have noted that it can be presented in the context of specific relationships (Szczepanik & Siebert, 2016, p. 287). I further noted that the narrative processes were sufficient for categorising the interview transcript in this study, which indicates that discussing mathematical identity could be thought of as discussing one's *mathematical life story*. Thus, the framework presented in this paper was successfully applied to data arising from such discussions.

In the interview, while they were mostly free to talk about anything they wished, the participant periodically checked whether I understood their words or whether they had answered my question. This emphasises the co-constructive nature of the interview setting, i.e. that the participant endeavoured to craft responses that were relevant to the interviewer and topic of the interview. Some details of the interview and stories have been omitted to preserve the confidentiality of the participant.

It is notable that although the story is the unit of analysis, narrative inquirers do not confine themselves to gathering stories alone (Clandinin & Connelly, 2000, p. 78). Rather, the stories facilitate the co-construction of meaning from the participant's words through an *interpretive story*. The next step in the analysis is to construct an interpretive story for this interview (McCormack, 2000b) after the story titles are presented to the participant for review. This step allows the participant to amend or augment their stories and allows them the opportunity to discuss how their privacy can be ensured in the analysis that I publish (using pseudonyms for people and places, using analogies, selecting which [if any] elements of the interview they would prefer not to reveal in writing).



In conclusion, the storying stories framework is applicable to interview data concerning mathematical identity and was effective in distilling meaning from the participant's mathematical life story.

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