Scripted Identities of the Mathematics Learner: Blurring Fiction and Fact in the Presentation of Research Data

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Research on mathematics learner identity often relies on interview data and presents case studies of individuals. This method allows an in-depth understanding of the person and their relationship with mathematics, but fails to generate a larger picture of identity with more breadth. In this paper we propose a method that blurs the boundaries of fiction and fact by creating fictional characters and a playscript derived from questionnaire response data of senior secondary mathematics students. We argue that this method allows for a wide representation of learner identity without sacrificing the individual voice that may resonate for various stakeholders within mathematics education.

Increasing student enrolment in tertiary mathematics (or STEM fields) remains a focus within mathematics education; requiring that senior secondary school students retain an interest in the subject and consider it to be something they might continue in the future. Mathematics learner identity is a conceptual lens that has often been applied to this retention problem, offering insights into why individual students may choose, or opt out of, continuing their mathematics study (Braathe & Solomon, 2015; Hernandez-Martinez & Williams, 2011; Solomon et al., 2016; Ward-Penny et al., 2011). These studies examine the stories students tell as they 'self-author' their relationship with mathematics (Braathe & Solomon, 2015). Identity provides the lens to consider aspects such as their experiences of transition to college/university (Hernandez-Martinez & Williams, 2011), reasons for leaving (Ward-Penny et al., 2011), or motivations for choosing further study (Black et al., 2010). Often the stories require some form of negotiation, e.g., the tension between liking and a fear of mathematics (Braathe & Solomon, 2015) or differing identities such as woman *and* mathematician (Solomon et al., 2016).

Research on mathematics learner identity seeking to understand students' decisions to engage with further mathematics, largely does so with individual cases. The studies mentioned above, for example, feature just one, two, or four participants in each case. Thus, whilst this body of research gives important and deep insights into how identity is implicated in students' affiliation with mathematics, it does not often gain a wider perspective from a broad range of students due to the methods typically employed in identity research (Darragh, 2016; Graven & Heyd-Metzuyanim, 2019). We consider it a worthwhile challenge to explore how we might create new methods for gaining the perspective of large groups of students without losing the richness of data that comes from looking at learner identity of individual cases.

Additionally, research exploring the reasons students may choose to (or not to) continue with further mathematics, may not reach beyond academic circles into practitioner groups. Careers advisors, mathematics teachers, and students may not have the interest nor access to read academic reports, especially those presented in a 'dry' manner. Developing innovative methods for the presentation of findings may go some way to extend the reach of the research.

In this paper we propose a method that aims to address such issues as described above. We draw from responses of a questionnaire sent to senior secondary students in schools across Aotearoa New Zealand. Following a more typical content analysis of the 641 respondents, we engaged in a methodological process that blurred the boundary between fiction and factual representation of data. Our aim was to present our data in a manner that *resonated* for the reader, yet also *represented* the broad range of responses, all the while maintaining a deeper sense of the person, as fitting a study on learner identity.

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Our main purpose in this paper is to present the method we employed to synthesise the data and generate a playscript which we believe captured the main themes, albeit using a non-traditional presentation method. In the sections to follow we review literature that has similarly played with fiction in data; we detail our method; and we present an excerpt of the resultant playscript, together with a discussion of what might be read from these findings.

Research Using Fiction and Narrative

Fiction- or narrative-based approaches to qualitative data analysis have been popular for some time (Ollerenshaw & Creswell, 2002). According to Ollerenshaw and Creswell (2002), the stories that emerge as a product of narrative-based research methods tend to involve "a first-person oral telling or retelling of events related to the personal or social experiences of an individual" (p. 332). There are advantages to these methods, including that they enable us to convey the richness of the data through storytelling (Nardi, 2016), and permit learning to occur through the sharing of individuals' stories and experiences (Ollerenshaw & Creswell, 2002).

Narrative re-storying involves qualitative data, such as that from interviews or surveys, being analysed to identify potential story elements among responses, before being rearranged to form a new story (Ollerenshaw & Creswell, 2002). There are numerous ways in which re-storied data can be presented, affording researchers the flexibility to choose the shape they want their narrative to take based on their audience or purpose. In mathematics education, some fictional narratives produced through re-storying have taken the form of dialogues (da Costa et al., 2019; Nardi, 2016), inner monologues (de Freitas, 2004; Hannula, 2003), and movie synopses (Darragh & Radovic, 2019).

It is noted that re-storied data is ultimately shaped by the shared relationships and experiences of the participants and researchers (da Costa Neto et al., 2019). Nardi (2016) re-storied interviews verbatim to create a dialogue between a mathematician and mathematics education researcher, expressing that fictionalising the data in this way "assimilates the multiplicity of voices (researchers' and research participants' …) without suppressing or eliminating this multiplicity" (p. 364). Narrative-based approaches' ability to capture numerous perspectives was also commented on by da Costa Neto et al. (2019) who, like Nardi (2016), presented their re-storied interview data as a fictional dialogue between a researcher and retired mathematics lecturers. They highlighted that the re-storying method enabled them to amalgamate quotes from the interview transcripts of four separate participants into a single, coherent debate, whilst still showcasing similarities and differences among the interviewees' perspectives (da Costa Neto et al., 2019). Hence, fiction-based methods provide "a possible version of this story, through the lens of its actors" (da Costa Neto et al., 2019, p. 4) due to qualitative data analysis being "by definition a form of re-storying" (Nardi, 2016, p. 364).

Narrative formats also provide the opportunity for data to be situated in a context or setting that is relevant to the participants and their experiences (Ollerenshaw & Creswell, 2002). Hannula (2003) and de Freitas (2004) re-storied their respective student and teacher interview data into interior narratives set in mathematics classrooms to reflect the typical context in which mathematics teaching and learning takes place. Similarly, Darragh and Radovic (2019) situated their re-storied movie synopsis in Chile as it permitted them to "examine common societal discourses" (p. 518) that emerged from their interviews with Chilean primary school teachers and explore the identity of Chilean teachers more broadly. Because fiction-based methods act as "bridges between the different worlds of subjective experiences" (Hannula, 2003, p. 32), they enable readers and researchers to access, interpret, and learn from others' experiences and settings (Ollerenshaw & Creswell, 2002; Hannula, 2003). Thus, re-storying may be "a potent communicative tool" (Nardi, 2016, p. 364) in mathematics education research.

Methods

The questionnaire forming the data set elaborated in this paper was just one part of a larger project that aimed to understand mathematics learner identity, with a specific focus on the context of online instructional platforms for learning mathematics. Ethics were obtained for all aspects of the study. A mathematics learner identity can broadly be defined as:

> A socially produced way of being, as enacted and recognized in relation to learning mathematics. It involves stories, discourses and actions, decisions, and affiliations that people use to construct who they are in relation to mathematics, but also in interaction with multiple other simultaneously lived identities. This incorporates how they are treated and seen by others, how the local practice is defined and what social discourses are drawn upon regarding mathematics and the self. (Darragh & Radovic, 2018, para. 1)

For the purpose of this paper, we also note that identity is temporal: Student responses to a questionnaire prompt may be seen as one small identity act in that one moment of time. Following the definition of identity we use, stories or recounts of experience may be read in terms of the wider societal discourses that are drawn from, the affiliations made with the subject of mathematics, how mathematics learning is constructed in practice, and the ways in which others recognise the learner of mathematics.

The questionnaire was designed for senior secondary school students, for whom we assumed their identity would be somewhat consolidated, in order to gain a broad picture of common discourses or narratives about the learning of mathematics, both in-class and online, and an understanding of the various "local practices" in these contexts. The questionnaire included four opened-ended prompts; the final two questions were, "*Thinking back over all your experiences learning mathematics, which would be the highlight? Please explain why."* and *"Thinking back over all your experiences learning mathematics, which would be the low point? Please explain why."* These prompts solicited stories from the respondents that could be read in terms of identity, albeit just one enactment of identity in a moment of time. Secondary schools around Aotearoa New Zealand were invited to participate, and seven schools agreed. The schools were diverse in terms of geographical location, demographic makeup, and socio-economic area. From these schools, 641 students responded to the questionnaire and most (98.3%) were taking a senior mathematics or statistics class.

First we completed a broad statistical analysis of closed questionnaire prompts, comparing differences in student ratings of their mathematics ability, their relationship with mathematics, and their perceived usefulness of mathematics by demographic groups and whether or not they planned a STEM career. Secondly, we conducted a content analysis of the open-ended responses. The first author worked with two research assistants to code every response following these steps: (1) The team read the first 50 responses together and identified codes; (2) Independently we coded the next 100 responses then met together to discuss and clarify any differences in our coding and decide if we needed to establish additional codes; (3) The remaining responses were divided amongst the three coders so that each response was coded by two people; and (4) We met a final time to discuss any conflicting codes and come to an agreement. This process was repeated with each of the four open ended responses.

The categories and counts we developed through these two analytical processes certainly summarised the data gained in the questionnaire, yet we felt the breadth of data came at a cost to depth. We had noted what we thought were heartfelt storied responses to the questionnaire prompts and we wanted to do better justice to the messages that were told and to bring this data to life in a way that might resonate for a broader audience.

Consequently, we completed a second wave analysis of the students' responses to the final two open-ended questions, using them to create characters and to form the basis of a play, as described below. Five researchers took part in the character development process. We formed a diverse group by ethnicity (Pākehā, Māori, and Korean), by gender, and by age (from recent

high-school graduates to those with high-school aged children). From the whole data set of responses to these two questions, we independently each chose one or two quotes that *resonated* with us. We then imagined *who* the person who wrote that response might be, imagining them as a mathematics learner. Next, we found other excerpts from the corpus of responses that we felt fit with the character we had created. Finally, we returned to the questionnaire data and found the corresponding demographic information for each participant for whom we had identified a 'resonating quote'. We looked at their self-identified ethnicity, gender, age, current mathematics education status and career aspirations, and we gave each character a name.

After creating the characters, we reviewed the dataset again to identify other responses that we felt matched each character and 'assigned' to them further quotes. At this point we also identified any types of response that we felt could not connect to one of the characters we had created. We concluded that there was scope for three additional characters: one who had no strong feelings about mathematics, one who had disengaged with mathematics, and one who expressed feelings of anxiety toward mathematics. Again we began with the quote that expressed the character before looking to their demographic information. Finally, during the coding process, we also decided to merge characters together due to similarities in the types of responses we were allocating to their character description. This left us with eight student characters altogether. This cast was a little larger than desirable from a playwriting perspective, but we felt it was the minimum necessary to be able to allocate the full data set of 641 individual responses to the various characters in a coherent manner.

Before re-storying our responses (Nardi, 2016), we decided that the play's setting should be a school careers expo as we could imagine conversations about mathematics experiences taking place in this environment. Using the selected responses for each character, we arranged whole or part quotes to create a fictional dialogue between our characters derived from the student survey responses. It is important to note that while the dialogue was fictional, the content of each utterance in the play was directly derived from the real data collected in the questionnaire. Modifications were made to some responses, including tense corrections, spelling corrections, and adding words or linking phrases for clarity and flow. These changes are denoted in the play by square brackets. For example, two responses to the questionnaire prompt about highlights were, "A positive learning environment" and "Class, I have a very strong bong with them." These were re-presented in the play as "A positive learning environment [is a highlight in maths]. I have a very strong [bond] with [my class.]" The question context, a typo correction, and a grammatical change are shown in square brackets, but it can be seen the meaning of the two responses are retained. Finally, we also decided to include an additional student advisor character to guide the students' conversation. This character is entirely fictional—although it represents the university voice, such as the authors of this paper.

The draft playscript was given to a few mathematics educators to read and we asked them for feedback on the play. This feedback process allowed us to make informed adjustments to the play based on the educators' uncertainties, improving the study's trustworthiness (Stahl & King, 2020) and credibility (Shenton, 2004). One main adjustment we made was to give the advisor more of an agenda to match the rationale of the paper.

Findings: A Playscript of Mathematics Learner Identity

Whilst most respondents (97.7%) rated themselves as average or above average ability in mathematics, much fewer (64.1%) saw mathematics and statistics as useful for their future. Those who planned to go into a STEM career saw mathematics as more useful than those who did not, but these students accounted for only 35% of the respondents.

The content analysis of the open-ended prompts revealed 140 responses that mentioned achievement as a highlight, 116 mentioned understanding the content, 96 were coded as related to affect, and 79 mentioned assessments or end-of-year exams. Seventy-five responses

described pedagogy as a highlight of learning mathematics, and 64 said the teacher had been the highlight. Similar themes were also prominent in the responses to the prompt asking for a description of the low point of mathematics learning experiences. Of these, 175 mentioned lacking understanding as a low point, 98 mentioned affect, 92 mentioned assessment, and 89 mentioned achievement. The low point pertained to pedagogy in 83 responses and the teacher in 69. As mentioned earlier, we felt a lot was lost in this categorisation and counting of the dataset. Whilst example quotes could be presented in a list format, we suggest that the playscript may help the responses to come alive for the reader.

The final play script on mathematics learner identity is lengthy and contains nine characters: eight students and one student advisor who is entirely fictitious. The length enabled us to incorporate a range of student responses from the original survey and weave several prominent themes from the survey responses into the discussion between our fictional characters. The student advisor character enabled our setting to reflect the rationale. The themes included in the playscript reflect those themes found in the content analysis of the questionnaire data set, yet also included statements about affiliating with mathematics.

The playscript length meant that we could not feature it here in its entirety. Instead, we present one excerpt during which the characters are mostly discussing the topics of competitions and peer support. To access the full play script, see Darragh and Smith (2024). When reading the playscript it is useful to remember that every comment by one of the characters, excluding the advisor, was in fact a written response to one of the two open-response prompts from the questionnaire. Topics of conversation in the full playscript include: affiliation with mathematics (or not), assessment, algebra and statistics learning, the usefulness of mathematics, teachers, competitions, peer support, and the classroom environment. Woven throughout the play are also a number of affective comments related to confidence, stress, and anxiety as well as a tension between struggle and understanding of mathematics content. Taken together, the play content gives some insight into societal discourses and local practices of learning mathematics that were drawn on in the students' responses to the questionnaire.

A group of students are at their school's careers evening. The students walk around the school hall together, surveying their potential career options as they wander. A student advisor from a nearby university waits at his stall for students to talk to him about STEM career pathways at his university

[The play begins with the students talking about their own feelings of mathematics learning, ability grouping, experiences learning algebra and statistics, before moving on to various teachers they have had]

Bao: Bad teachers don't really inspire me to try…

Advisor: *Sympathetically* [That's understandable.]

Manawa: Or they're mean and I just don't want to bother with their negativity.

Riley places the engineering pamphlet back on the table

Aisha: *Sounding frustrated* [Me neither! My] teachers forced me to do mathematics competitions.

Margaret: *Sounding surprised* [Oh…] I enjoyed participating in the Mathex competitions in years 7–10.

Riley: *Nodding* [So did I].

Aisha: *Looking at Advisor* The competitions slowly made me hate mathematics…

Advisor: *Sounding intrigued* [Oh…]

Aisha: And since they weren't optional, I would be punished if I hadn't participated in the 'personally paid' exams.

Advisor: *Sounding confused* [I thought competitions like that were meant to be fun?]

Riley: *Looking at Advisor* [Yeah! I always thought competitions] were a fun way to learn and compete with friends, classmates, and people from other schools [and] figure out where you are in terms of understanding maths.

Margaret: *Nodding* [Yeah,] the sense of accomplishment and the team relationships were very rewarding.

Aisha shrugs and starts having a conversation with Bao in the background about the neighbouring psychology careers stall.

Advisor: *Looking at Riley and Margaret* [Supportive environments like that must be beneficial for your learning.]

Margaret: *Looking at Advisor* Having a positive learning environment [is a highlight in maths]. I have a very strong [bond] with [my class.]

Manawa: *Nodding* [Me too!]

Aisha and Bao drift away from the group slightly to get a better look at the psychology stall.

Margaret: Discussing questions with peers throughout the year strengthened our relationships and [deepened] our understanding of math at the same time.

Manawa: *Looking at Margaret* [Absolutely! I've been] helping some of my friends that weren't fully interested in math to succeed and get good grades.

Margaret: *Looking at Manawa* [Same here! I was] able to help my peers in my class who were also struggling just like I was.

Manawa: Getting to help other people either with others struggling in class, tutoring younger years, or teaching younger siblings [is really cool.]

Riley: *Enthusiastically* [Being] able to explain [complex concepts] to other people gives [me] a feeling of achieving.

Manawa: I just think it's such a nice feeling being able to pass someone a set of information you know [and] help them with things they struggle with.

Margaret: *Nodding* [Totally! I could be] there for them when they felt like they were going to give up.

Advisor: *Looking at Margaret* [How awesome!] *Turns to Aisha and Bao who are still chatting in the background* [Do you agree that supportive class environments are important when you're learning maths?]

Aisha and Bao see the Advisor talking to them and stop their conversation. Margaret and Manawa continue chatting to each other in the background.

Aisha: *Nodding* [Definitely!] Not having a supportive teacher [can be] a big struggle.

Bao: *Looking at Aisha* [I agree.] When I am in a situation where I am unable to receive the assistance I need, I just [feel] lost and clueless [and] worse about my maths ability.

Sefo: *Sympathetically* It doesn't make you feel great [when you can't understand something].

Aisha: [Especially when there's an embedded] stereotype from an early age that [maths is] really hard.

Advisor: [That's very true!]

Aisha: *Looking at Advisor* [I like supportive classrooms because] it [often] takes me longer to understand things than others in my class…

Sefo: [Me too!]

Margaret and Manawa's conversation ends and they turn back to the group.

Aisha: [But] after assistance [from my teacher and friends, I'm] able to be back on track.

Jackson: *Shrugging* I [don't] care enough to ask for help.

Sefo: *Sounding surprised* [Really?]

Jackson: Yeah, I don't want to learn.

Manawa: *Looking at Advisor* [Well, I think it's nice having] good support in terms of friends who [can] help.

Sefo: [Yeah totally, and] after two years of consecutive not so great maths teaching and learning, [having a supportive teacher has made me] aware of how important maths is for my future.

Jackson nudges Margaret and suggests they go look at some of the other stalls.

Advisor: *Looking at Sefo* [That's great to hear.]

Margaret and Jackson slowly start walking away from the group. The Advisor spots them leaving and panics slightly.

Advisor: *Addressing the whole group but sounding slightly flustered* [It's been great chatting to you guys but before you go, would any of you be interested in signing up for one the STEM courses at our university next year?]

Margaret and Jackson continue walking away in the direction of the police stall.

Riley: *Enthusiastically* [Absolutely!]

The Advisor smiles with relief and hands Riley a sign-up sheet. Riley writes her name down and takes the engineering pamphlet she was looking at earlier as she leaves.

Advisor: *Looking optimistically at the remaining students* Anyone else?

[…]

Discussion

Our main purpose in writing this paper was to explore the potential of this fictional format for presentation of data, particularly the affordances and limitations. To that end, we wish to draw attention to a few noteworthy aspects we believe the method has demonstrated. Firstly, the play excerpt presented above explores the themes of competition and peer support/classroom environment, and in a more subtle manner we may also see the characters' planned careers coming through in their actions of picking up a pamphlet from the advisor's stall, versus their wandering off to other stalls, such as psychology or policing (these were desired careers stated in the demographic information for Bao, Aisha and Margaret's characters). The advisor's panic that very few people were signing up for STEM reflects the rationale mentioned at the beginning of this paper and highlights the affordance of creating a fictional setting that is relevant to this problem (Ollerenshaw & Creswell, 2002). In this manner the questionnaire data may be explicitly tied to the research purposes through its being pitched at an audience, beyond other researchers, who are stakeholders in the issue.

Secondly, the character development process (also described in Darragh et al., 2023), enabled a 'face' given to the anonymous data obtained in the questionnaire, perhaps lending it a certain authenticity. By choosing a *resonating* quote, we allowed student voice to surface after the content analysis reduced the data to categories and numbers. It could be suggested that choosing a quote in this way generated subjectivity in the data, however, we argue that this kind of subjectivity is always generated when selecting quotes to represent themes. We recognise the risks involved in giving our characters names that indicate ethnicity and gender. We did not randomly select the character demographics, these were responses connected to the initial 'resonating' quotes we picked to begin the process. We wish to emphasise that our characters are not intended to represent others in their ethnic or gender groups, however they do demonstrate the fact the questionnaire reached a diverse range of respondents. We wonder if the tension between resonating and representing data is worthy of further discussion—this is something likely present, yet hidden, in any data presentation that includes illustrative quotes. We also wonder if in assigning other quotes to the character 'type' we diminished the complexity one might see in a real person. These questions are worthy of further discussion.

In many ways, the presentation of data here differs little from typical qualitative research. Themes were found and quotes were selected to present those themes. However, we hope that the playscript presentation brings the questionnaire data 'to life' so that the implications of findings might be more apparent than otherwise, and may be more engaging for a wider audience. We suggest that issues of retention and students' choice to continue studying mathematics (or not) might be unpacked with senior mathematics teachers using a playscript such as ours. The success of this strategy would certainly be an area for future research.

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