

# How mathematical identity informed collaborative learning opportunities for a first-year international student from China

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*For international students who transition to university mathematics in a foreign social context, adjusting to unfamiliar customs within the mathematics classroom presents many challenges. To support these students as they adjust to their new social context, it is important for universities to understand their transitional experiences. In this study we explore the actions of an international student from mainland China as she interacts with her peers in a collaborative first-year mathematics tutorial at a host university. We see how her mathematical identity informs her access to learning opportunities in this collaborative context.*

*Keywords: International student, identity, undergraduate, positioning theory, language*

## Introduction

Mathematics has been often viewed as a springboard to prestigious careers. It is also considered by many to be language- and culture-neutral (Wagner, 2021). These perceptions may contribute to the choice of many international students to enrol in mathematics-related programmes when studying abroad. For example, in 2021 there were some 200 000 international students studying mathematics or computer science programmes at tertiary level in the US (Institute of International Education Project Atlas, n.d.). Di Martino et al. (2022) highlight the potential for different cultural contexts to shape student experiences of the transition from school to tertiary mathematics (hereafter *STT*). In their recent systematic review of the *STT* literature, Di Martino et al. point to a paucity of research in this area. To support international students as they transition to universities across the globe, it is important to understand their experiences of learning mathematics. Accordingly, we aim to explore how international students might experience collaborative learning contexts in their first year of mathematics at a host university.

This paper focuses on a single international student from mainland China, enrolled in a first-year mathematics course at a large New Zealand university. Using mathematical identity as a lens, we analyse her interactions with peers in a collaborative tutorial to understand how these interactions inform access to learning opportunities.

## Theorising mathematical identity

In mathematics education literature, there are wide variations in how mathematical identity is conceptualised and operationalised. Marks and O'mahoney (2014) adopt a critical realist perspective on identity that views the social and subjective elements of identity as being distinct, but related to one another. They characterise social identity as being the embodiment of roles generated by social structures, and personal identity as emerging from the reflexive self. Gardee and Brodie (2023) define

*mathematical identity* as being a social phenomenon that emerges from a relationship between personal identity, social identity and agency. We adopt this definition, proposing that students enact *social mathematics identities* when they position themselves relative to roles commonly recognised in the social structure of their mathematics learning context. *Personal mathematics identities* come into play when individuals relate to internal structures, such as how they feel, or what they care about in relation to learning mathematics. Personal mathematics identities may emerge from the internalised social structures of prior experiences. Students reproduce or transform both social and personal mathematics identities through agentic actions.

We rely on positioning theory (Harré & Van Langenhove, 1999) to operationalize our concept of mathematical identity, which we view as being enacted, within a specific context, by a multitude of *positioning acts*. Positioning refers to the way that people ascribe rights and duties to themselves or others in interactions. By inviting others to conform to a *storyline*, which offers positions with incumbent rights and duties, people clarify who they are and how they see others. For example, a student who offers help to a peer positions their peer as a struggling student. The subject of positioning may accept or comply with the offered storyline, or reject it in favour of their own.

In the context of this paper, students in a collaborative tutorial classroom enact social mathematics identities as they strive to fulfil classroom obligations or norms. Personal mathematics identity stems, on the other hand, from actions related to individual goals such as avoiding embarrassment. We use a two part view of mathematical identity to consider how international students might position themselves relative to both society-generated opportunities, and their own reflexive understandings of themselves as learners of mathematics. For example, if a participant in an interview describes her first priority as completing her work, she contributes to her social mathematics identity by aligning with classroom norms. However a claim to shyness is a reflexive understanding of self that contributes to personal mathematics identity. We might similarly recognise social and personal identities being enacted in classroom observations.

## **Research background**

To be recognised as an effective learner of mathematics in a classroom, Cobb et al. (2009) suggest that students must identify with an accepted set of classroom obligations or norms. They further suggest that students develop their own understandings of these norms. For international students in the STT, understanding classroom norms requires cultural adjustment. For example, differing beliefs about the association between talking and thinking engenders variations in the discursive practices of school classrooms in China, Korea and Australia (Xu & Clarke, 2019). Oates et al. (2005) outline the unique character of collaborative tutorials at a New Zealand university, where the tutor circulates amongst students to guide and facilitate group discussions around a given set of tutorial problems. For many students studying mathematics at a foreign host university, cultural differences can add an extra layer to the raft of challenges associated with the STT (Di Martino et al., 2022).

For international students, whose home language is different to the medium of instruction, language proficiency plays an important role in the transitional experience. Barton et al. (2005) showed that first-year students at a New Zealand university, whose home language was not English, suffered a notable disadvantage when answering text-based mathematics questions. For these students,

following the academic language used in lectures, and participating in groupwork, may also be difficult. Hwang et al. (2022) report that the discomfort experienced by a Chinese-speaking student, when unable to successfully communicate her ideas to her English-speaking peers, inclined her to silence in a groupwork task. These findings raise questions about how differences in both the cultural understandings and the language proficiency of international students might shape collaborative learning experiences in the STT.

## **Research aim and question**

Our aim, in this study, is to explore how international students experience collaborative classroom settings during their first year of university mathematics. We focus on Peggy (pseudonym), an international student from mainland China, as she participates in a collaborative, first-year, mathematics tutorial at an English-medium university. Our choice of an English sounding pseudonym reflects Peggy's choice to adopt an English name while studying in New Zealand. When analysing the data, we ask *how Peggy positions herself in a tutorial classroom, and how this positioning informs her access to learning opportunities.*

## **Method**

The study took place at a large New Zealand university where around a third of the students in first-year mathematics are international students. In addition to lectures, students in Peggy's course attended bi-weekly tutorials comprising around thirty students and overseen by a postgraduate student tutor. During tutorials, students worked on pre-assigned questions related to content from recent lectures. They earned assessment credits for participation and were not required to submit work from the tutorial session. In mandating small-group tutorials, the university hoped to facilitate learning communities in which students supported one another through collaborative problem solving (Oates et al., 2005). In the language of Cobb et al. (2009), the obligations of an effective student in this setting would centre on cooperative efforts to make sense of problems by working with other group members. Tutorial rooms were informally arranged to facilitate collaborative work, and whiteboards covered the surrounding walls. The tutor's role was to circulate freely, supporting individuals and groups as they worked on problems. Students were encouraged to access course texts or other resources and to discuss problems freely with one another, or the tutor, during tutorials.

Peggy was one of ten students who took part in the first author's (ongoing) doctoral research study to explore the experiences of international students in first-year mathematics. Three of these participants (including Peggy) took part in a series of semi-structured interviews with the first author, and two tutorial observations in the early and latter part of the semester respectively. The first interview sought to gather storied identities from participants about learning mathematics in different contexts, whereas post-observation interviews clarified participant actions during a tutorial. In the final interview some questions from the first interview (e.g., view of success, description of self as a learner) were repeated to understand how these might have evolved over the semester. Interviews and observations were video-recorded and transcribed by the first author.

The focus of this paper is on Peggy's positioning relative to her peers in the first tutorial observation, and uses interview data to understand storylines. At the time of her first interview, Peggy had studied in New Zealand for two and a half years. She had previously attended school in mainland China,

where experiences of group learning were limited to lectures and homework sessions (during which students worked independently in a classroom and could ask one-on-one questions of the supervising teacher). She then completed a foundation (or bridging) course at a college for international students in New Zealand. This was followed by her first year of a BSc programme in New Zealand, before enrolling in a university mathematics course for the first time. Peggy volunteered to participate in the research study at the beginning of her second semester of mathematics.

In examining her interview data, we found two storylines constructed by Peggy in which she spoke about herself in the setting of a tutorial. In one of these storylines she positioned herself relative to her perception of a prototypical student, as based on her understanding of classroom norms. For ease of reference we named this position, afforded by an institutionally generated role, the *ideal student*. We viewed Peggy's positioning relative to her ideal student as contributing to her social mathematics identity. A second storyline constructed by Peggy in her interviews related to her individual experiences of communicating with peers and the tutor in tutorials. In this storyline Peggy's positioning, relative to her idea of a *proficient English-speaker*, contributes to her personal mathematics identity. We finally considered Peggy's in-the-moment positioning actions while interacting with others in the tutorial classroom. One would not expect a storied identity enacted in interview to be replicated in the complex social setting of a tutorial classroom. However, we believe that juxtaposing Peggy's positioning acts in both settings is insightful.

## Findings

### Two storylines: Enacting a social and a personal mathematics identity in interviews

By examining social and personal identities through the stories told by Peggy in interviews, we understand how Peggy perceives her rights and duties as a student in tutorials. In her first interview, Peggy shared a story in which she positioned herself as a student of a certain type:

- Peggy: Oh, most of the students .. is focused on the answer, answer the question and do the question, and ask the question to tutors if they don't know how to solve it.
- KL: So they mostly work by themselves?
- Peggy: Yeah and a few students will .. uh .. the brain is go here, go there, just uh .. how do you say that? A few students they not focused on the questions. They may thinking another thing, thinking something, I don't know. So for me, I will, at the beginning I will answer the question. After I answer all the question, my classmates will ask me something he don't know. Yeah, then I will solve for him.
- KL: Right, okay. And if there's something that you don't know?
- Peggy: I will ask the tutor, or just close to me – the students.

From this interview transcript we see the storyline pertaining to Peggy's perception of classroom norms. Peggy perceived the ideal student as being focused on answering questions independently and asking the tutor only when stuck. Her ideal student would also help other students when their work was done, and could ask peers for help as well. We notice that Peggy's storyline, in which students work independently before exchanging help, differs somewhat from the university's storyline of tutorials being a setting for collaborative problem solving. While Peggy initially positioned herself as her ideal student, in later interviews we also see other positioning. For example, on one occasion she admitted that to "ask the tutor maybe more helpful for me [than to ask peers]." Here she positioned herself as not receiving much help from her peers. She also mentioned that "I'm not very frequently

to ask the question to tutors.” All of these positioning acts layer one upon another and contribute to Peggy’s social mathematics identity as a not quite ideal student.

A second storyline about communicating in English is also evident in Peggy’s interviews. Although other Chinese-speaking students attended the tutorial group, Peggy repeatedly reiterated her preference for speaking English when in the tutorial room “because it can practice my English.” However, Peggy claimed, “I prefer speak English to discuss the mathematics with who speaks English. But uh, I’m a little shy. I’m not sure they will each discuss with me.” This storyline, constructed by Peggy from her individual experiences, suggests that proficient English-speakers have a right to discuss mathematics together, but that Peggy may not enjoy this right. In her final interview, she positioned herself as a less than proficient speaker of English, explaining how she often preferred to work independently because “I know my English is not good, so I’m kind of afraid to speak English. So I’m rather to study by myself at the first.”

In the following transcript we see how Peggy’s limited proficiency in English informs, not only those situations in which she must express herself in English, but also those in which she must understand the discourse of others in the tutorial room:

- Peggy            Sometimes, maybe because the accent, because they have accent or they speak too fast, so maybe sometimes I cannot hear correctly. But sometimes I can understand, yeah.
- KL                Okay, so if there's a conversation happening over there, and you think, ‘Ah, that's what I'm working on,’ you can link into it?
- Peggy            Yeah, but I think as long as one person speaking English clearly so I can understand very well yeah.

Peggy’s positioning entailed limited rights to learn from the mathematical discussions of proficient English-speakers around her. However, accents and conversational speed sometimes excluded her from these learning opportunities.

### **Interpreting in-the-moment classroom positioning through the stories told in interview**

During the first observation of Peggy in her tutorial, we noted that, for most of the time, her gaze focused largely on her tablet where she both wrote solutions to tutorial questions using an electronic pen, and could access an electronic version of the course book. When approached by the tutor, Leigh, to find out if she needed help, Peggy responded in a strongly patterned manner. She repeatedly offered one or more of her answers for confirmation, sometimes by merely pointing at her answer as she spoke the number of the question aloud. Incorrect answers exposed specific learning needs and enabled Leigh to offer help in these areas. By checking answers Peggy was able to communicate her problem (or lack of one) with limited recourse to language, a position contributing to her personal mathematics identity. She simultaneously reproduced her social identity of an ideal student who first attempts questions and asks for help only when stuck.

In the second half of the tutorial, her peers, Nina and Jared, in separate instances, sought Peggy’s input on specific questions. Peggy willingly offered what she was able, using a mix of words, symbols and gestures to explain her work. The following extract evidences the final moments of a seven minute interaction in which Peggy determinedly tries to help Nina:

- Peggy            So you just, from question ‘a’ you can get a point, it’s the minimum point, value.

Nina Mmmmm  
 Peggy But  
 Nina /[interrupts] I don't really know how to explain that with words.  
 Peggy Ohhh  
 Nina It doesn't make sense, maybe he [tutor] can help me.  
 Peggy Yeah okay [sits back]

Despite Peggy's efforts, Nina finds her mathematical difficulty unresolved, and declares that she will turn instead to the tutor for help. The outcome of Peggy's attempt to help Jared was the same and he too turned to Leigh for assistance. Here we see Peggy positioning as her ideal student by helping others once her own work neared completion. The actions of her peers, however, suggest that her efforts may have been hindered by communicational difficulties, and they turned to the tutor instead. Peggy readily accepted her ejection from the discussion in both cases, reproducing her identity as a less than proficient speaker of English who is excluded from mathematical discussions.

When Nina and Jared, discussed tutorial questions with one another, we noted that Peggy did not appear to engage with them in any way. She remained focused on her tablet, even when they discussed a question on which she too was working. However artefacts from the tutorial evidenced Peggy's engagement with the early part of a protracted discussion between Nina and Jared, but stopped well short of their solution. When questioned about this incomplete working on her tutorial sheet after the observation, Peggy responded that she "just heard from classmates and think about what they actually talk about." Peggy's limited engagement in the collaborative discussions of her peers, reproduced her storied identity as being somewhat excluded from collaborative learning. However we notice also that the duties of Peggy's ideal student involved an exchange of help rather than collaborative sense making. Reproducing her ideal student may also have contributed to Peggy's reticence to participate in mathematical discussions of this sort.

We look finally at Peggy's actions when offered help by her peers. The following extract occurred within minutes of the start of the tutorial when Peggy checked her answer to the first question with her peers. The question asked students to find the limit to the sequence  $\left\{\frac{n-1}{2n+1}\right\}_{n=1}^{\infty}$  :

Peggy So it's the limit to one, the first one?  
 Nina The limit? Should be one over two.  
 Peggy One over two? Oh.  
 Nina Yeah, you divide it by ..  
 Jared [interrupts] Because that's just 'a' 'n' to the 'k' and that's 'b' 'n' to the 'l', and they're both to one so 'a' over 'b.' [As Jared speaks, he tracks with his finger in course book, which he turns to show Peggy. Then he passes the book across to her and places it on table to her left. Peggy looks at book and Nina leans across from her seat to look as well]  
 Nina What formula are you using? That doesn't make sense.  
 Jared I just read the book.  
 Nina Oh, there's something like that, okay. I don't remember that.  
 Peggy Yeah [returns gaze to own work but doesn't write anything].  
 Nina If it's a polynomial, I usually just divide that by the highest factor.  
 [Peggy turns to look at Nina, concentrating on what she is saying. Then returns to look at own work.]  
 Nina Like if the highest is 'n' squared then I divide everything by 'n' squared.  
 Peggy Yeah yeah, I'm also same.

When a comparison of answers to the first question elicited a surprised response from Peggy, Nina and Jared positioned her as being in need of help. Nina explained her own approach, while Jared offered his course book showing Peggy the section on l'Hopital's rule. However Peggy, after listening for about thirty seconds, returned her focus to her own work saying, "Yeah, yeah, I'm also same," effectively refuting their positioning of her and closing down her peers' attempt to help. Peggy also rejected two subsequent offers of help from Nina later in the tutorial saying, "No, I'm okay." These efforts to reject the help of her English-speaking peers may be partly explained by Peggy's positioning, in interviews, where she repeatedly described her fear of speaking English in mathematics tutorials. Peggy's mathematics identity as ideal student was overshadowed, in tutorials, by anxiety about communication. This restricted her ability to learn from English-speaking peers in a tutorial context.

However holding Peggy's repeated rejections of help from her peers against her storied ideal student also illuminates some tacit understandings. Firstly, in her storied enactment, Peggy acknowledged her right to ask nearby peers for help when needed. In the tutorial setting, however, Peggy did not ask for help. While her visible uncertainty sparked offers of help from her peers, Peggy had not expressly verbalised such a request. A second item of note, when comparing classroom and storied identities, is the timing of these offers of help. While Peggy's storied enactment of student did not specify when she could request help from her peers, an interpretation compatible with the timing of when she could help others, is that peers help one another only when all questions have been attempted alone. Again Peggy's ideal student may differ from her peers' in terms of giving and receiving help. Her repeated rejection of help from peers may be Peggy's attempts to reposition herself as her ideal student.

## **Discussion**

This study contributes to literature on affective and sociocultural issues in the STT by showing how cultural understandings, along with language difficulties, might restrict access to learning resources in collaborative learning contexts. It answers Di Martino et al.'s (2022) call for studies that compare student experiences across cultural contexts by addressing the collaborative mathematical learning experiences of international students in transition. The conceptualisation of mathematical identity as having distinct social and personal aspects takes the novel approach, introduced to mathematics education research by Gardee and Brodie (2023), into a different context. Our methodological move to juxtapose Peggy's positioning in interviews and observations also afforded a richer understanding of her interpretation of classroom norms that would not otherwise have been visible.

Peggy's case provides evidence of how students from different cultural backgrounds might be barred from collaborative work in university mathematics classrooms. The significance of this finding to mathematics education research becomes clear when one considers the large number of international students in tertiary mathematics programmes (Institute of International Education Project Atlas, n.d.). Our findings support, and move beyond, Hwang et al.'s (2022) study of students in multilingual classrooms by showing how not only language, but also cultural understandings, might lead to an inequitable distribution of learning opportunities in collaborative settings. While Peggy's case showcases a specific combination of cognitive, social and affective circumstances, we suggest that

the findings may hold relevance to other situations. For international students, differences in language and classroom norms (Xu & Clarke, 2019) raise many opportunities for inequity.

By showcasing an example of an inequitable distribution of resource in collaborative work, we hope to illuminate challenges that international students might face in these settings. Tutor sensitivity to cultural and language differences amongst students in a group is essential. Tutors may find they need to offer more of their own time to those barred from collaborative discussions due to language or cultural differences. Even more important is awareness of how students in collaborative groups manage language and cultural differences, suggesting a need for further research in this area.

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