



# “I’m on My Own and I’m Not Trained”: A Cultural-Historical Activity Theory Analysis of Teaching Mathematics Out-of-Field in a Small School

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## Abstract

This paper employs Cultural Historical Activity Theory (CHAT) as an analytical heuristic in exploring the internationally prevalent situation of teaching out-of-field. Drawing on interview transcripts, we use CHAT to frame the activity of a young teacher teaching mathematics out-of-field in a small rural K-12 school in Australia. We identify and map some important elements and tensions of out-of-field mathematics teaching, how these tensions change over time and how this activity interacts with in-field teaching. Finally, we consider emotions and identity in relation to the structural elements of CHAT mediational triangles to more fully explore and represent some of the complexities of teaching mathematics out-of-field in a small rural school and implications for responding to the out-of-field phenomenon.

**Keywords** Cultural Historical Activity Theory (CHAT) · Mathematics · Rurality · Teacher identity · Teaching out-of-field

## Introduction

Shortages of mathematics teachers in Australia, especially in rural and regional hard-to-staff schools, have resulted in the subject being taught by some teachers without the usual appropriate tertiary qualifications, that is, by teachers who are teaching out-of-field (Australian Institute for Teaching and School Leadership [AITSL], 2021; Hobbs, Du Plessis, Oates, Caldis, McKnight, Vale, O’Connor et al.,

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2022; Prince & O'Connor, 2018). The definition of teaching out-of-field is complex (Hobbs, Delaney, Campbell, Speldewinde & Lai, 2021) because of differences across jurisdictions in regulations around university entry requirements and how teachers are registered. Weldon (2016) defined teachers as out-of-field where they teach a subject that they have not studied in the second year at university and for which they have not taken the associated teaching method courses. According to this definition, the incidence of out-of-field teaching in Australia has been significant for many years, especially outside metropolitan areas. For example, Weldon (2016) reported that about 21% of Year 7–10 mathematics teachers were teaching out-of-field. Recent data from the Australian Institute for Teaching and School Leadership (AITSL, 2021, p. 8) indicated that in Australia, 40% of the time mathematics was taught by teachers who were out-of-field. Rural and remote locations are particularly susceptible to high unmet demand for teachers qualified in mathematics and other STEM subjects, while teachers in these contexts can face significant personal and professional challenges (Fraser, Beswick & Crowley, 2019; Prince & O'Connor, 2018). Teachers in rural schools are most at risk of negative impacts of out-of-field teaching (Hobbs et al., 2022), including teacher attrition (Handal, Watson, Petocz & Maher, 2013), and the phenomenon has been identified as a potential impediment to Australia's economic prosperity (Productivity Commission, 2017). Similar issues of teacher shortages and out-of-field teaching have been experienced across many international contexts (Donitsa-Schmidt & Zuzovsky, 2016; Hobbs & Törner, 2019a).

Teachers routinely negotiate a range of opposing forces leading to ambiguity and conflicting purposes (Andra, Liljedahl, Di Martino & Rouleau, 2016). Tensions exist between what teachers think is important and what they are “pushed” to do (e.g. by the syllabus); between conforming to school norms and adhering to personal convictions; between utilising familiar safe practices and risking innovating (Andra et al., 2016) and between their obligations to various stakeholders (Herbst & Chazan, 2020). These tensions are likely to be exacerbated for out-of-field mathematic teachers, many of whom are grappling with limited pedagogical content knowledge in mathematics and challenges to their self-efficacy, confidence, work-life balance and identity (Hobbs et al., 2022). In addition, teachers may neither feel the same passion for their out-of-field subject as for their in-field subject (Hobbs, 2013), nor have a normative commitment to their out-of-field subject, which impacts their willingness to undertake professional learning and development in that subject (Ní Ríordáin, Goos, Faulkner, Quirke, Lane & O'Meara, 2022).

Growing interest and public discourse (e.g. Hobbs et al., 2022; Productivity Commission, 2017) around how to respond to the widespread reality of teaching out-of-field includes calls for upskilling out-of-field teachers through professional learning and development (e.g. Lünne, Schnell & Biehler, 2021; Prince & O'Connor, 2018; Vale, 2010). It is critical that teachers in an out-of-field context can develop the content knowledge and associated teaching practices specific to their out-of-field area (Ní Ríordáin, Paolucci & Lyons, 2019), but professional learning also needs to attend to teachers' “subject-related identity” (Bosse & Törner, 2015, p. 8).

While we recognise the complexities in defining teacher identity (Graven & Heyd-Metzuyanim, 2019), we define teacher identity as “being recognized by self or

others as a certain kind of teacher" (Luehmann, 2007, as cited in Hobbs, 2012a, p. 720) and identity learning as a process that occurs as the teacher reflects on their professional and personal experiences. Teachers' developing identities are influenced by contextual factors (Hobbs, 2013) and teachers' emotions (Geijssel & Meijers, 2005) and are tightly linked with their ethical aims (Roth, 2007) and passion and commitment for teaching (Hobbs, 2012b). Teaching a subject out-of-field can disrupt a teachers' identity as a competent teacher, leading to feelings of incompetence and lack of belonging (Du Plessis & McDonagh, 2021). It may also lead to identity expansion, "arising from positive historical interactions with the subject" (Hobbs, 2012b, p. 27), feelings of satisfaction and expanded knowledge and appreciations of what other teachers do (Hobbs, 2020). Teachers' identities can influence their belief in their capacity to learn and their willingness to undertake professional development in their out-of-field area (Faulkner, Kenny, Campbell & Crisan, 2019). The identity learning of teachers has been described as "the core process of educational change" (Geijssel & Meijers, 2005, p. 426) and a crucial focus in understanding and responding to teaching out-of-field (Hobbs, 2020). For example, a national summit on out-of-field teaching in Australia recommended to "explore the role of teacher identity and capabilities for managing the experience of teaching out-of-field" (Hobbs et al., 2022, p. 29). Identity has been acknowledged as a necessary focus of professional development of out-of-field mathematics teachers (Goos, Benison, Quirke, O'Meara & Vale, 2019).

## Rationale and Study Aims

Responding to the out-of-field phenomenon requires a sophisticated response from school leaders and teacher educators "that is informed by data that captures the various nuances of this phenomenon" (Hobbs & Törner, 2019b, p. 321). It therefore requires an understanding of the interrelationships between the elements of a teachers' out-of-field activity, cultural effects on teachers' motivations (Hobbs & Porsch, 2022) and their identity and ethical aims within the real world context of their day to day work. The school context plays a critical role in enabling teachers as they cross the boundaries (Hobbs, 2013) between different teaching activities, including recognition of difficulties associated with teaching a new subject and provision of emotional and educational support (Hobbs, du Plessis, Quinn & Rochette, 2019). Engaging with such complexity foregrounds the utility of using cultural historical activity theory (CHAT) to systematically interrelate the different aspects of the activity of teaching out-of-field. By enabling an integrated view of the out-of-field phenomenon grounded in well-developed theoretical considerations of human activity, CHAT can aid the conceptualisation of context-embedded difficulties associated with teaching out-of-field and thereby help to frame discussions with teachers and leaders dealing with the realities of this issue. CHAT facilitates explicit description of context, which has been identified as an important future direction for research into studies of mathematics teacher identities (Lutovac & Kaasila, 2014).

In this paper, we aim to use CHAT to explore the teaching activities of a single teacher in a small rural Australian school, who was teaching mathematics

out-of-field, as well as “personal development, health and physical education” (PDHPE) in-field. We address the following three research questions:

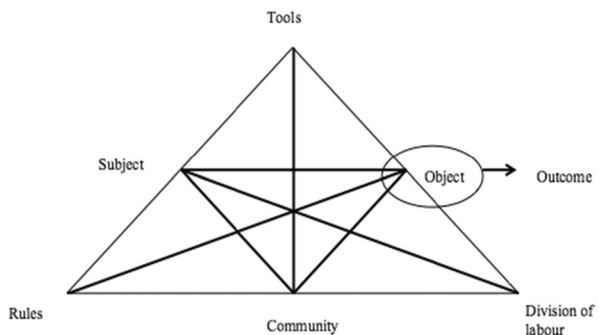
1. How does a teacher’s activity of teaching mathematics out-of-field interact with the activity of teaching in-field?
2. What are some of the tensions involved in teaching mathematics out-of-field and to what extent are these resolved?
3. How are the emotions, ethics and identity of a teacher mediated by and/or how do they mediate participation in the activity of teaching mathematics out-of-field?

### Conceptual Framework: Cultural Historical Activity Theory

CHAT originated in the 1920s and 30 s from Vygotsky’s contention that human actions comprise a dialectical relationship between a subject (an individual), the object or goal of the individual’s activity and mediating cultural artifacts (Engeström, 2015). The elements of this triad are potentially transformed by the activity, for example, the outcome of an action depends on how the subject uses mediating tools to perform it, while conversely, mediating tools may be reshaped by the way they are used. Vygotsky’s original focus on individual actions was subsequently extended to include the social contexts of collective object-oriented human activity and has been popularised by the research of Engeström and colleagues (e.g. Cole & Engeström, 1993; Engeström, 2001, 2015; Engeström, Mietinen & Punamäki, 1999). In this second generation of CHAT the culturally and historically located rules, division of labour and community that mediate collective activity are represented as points on interlinked triangles (see Fig. 1). These points represent interlinked perspectives from which the structure and interactions of the activity system can be viewed and analysed (Engeström, 1987, p. 63).

The *subject* was conceptualised by Engeström (1987) as the individual person or group of people motivated towards achieving the object of the activity, from whose perspective the analysis is viewed. The subject (in this case the teacher) constructs the *object*, “which refers to the ‘raw material’ or ‘problem area’ to which the activity is directed” and also encapsulates the goal or motive of the activity (Karkkainen, 1999, p. 16). Following Engeström and Sannino (2010, pp. 4–6), the circle around

**Fig. 1** Dimensions of the CHAT mediational triangle



the object in Fig. 1 emphasises the ambiguous nature of objects as well as their focal role in the system as “the future-oriented purpose of an activity... the true carrier of the motive of the activity...[and] always internally contradictory”. As discussed by Kaptelinin (2005), conceptualisations of the object and motive of activity have been close to synonymous, hence activity can respond simultaneously to multiple motives, while Karkkainen (1999, p. 108) described the narrowing, widening and switching between objects in her study of activity of teacher teams. The subject acts to transform the object towards the desired outcome of the activity, through the use of *tools*.

Physical *tools* in a teaching context include items such as computers, syllabuses or textbooks. Symbolic/conceptual/psychological tools include: language (e.g. mathematical notation) and image (e.g. graphs) (Vygotsky, as cited in Engeström, 2015, pp. 48–50; Miettinen, 1999, p. 173); a teacher’s knowledge (Engeström, 2015, p. 201; Yamagata-Lynch & Haudenschild, 2009, p. 508) including teaching and learning theories, strategies and pedagogical content knowledge (Shulman, 1987); norms and procedures (e.g. use and role of data) (Miettinen R, Paavola & Pohjola, 2012); and analogies, concepts and models (Engeström, 2015). These tools (e.g. the syllabus, the equation for the area of a circle and a protractor) in many ways characterise and differentiate between school subject areas. Moreover, ‘beliefs’ in the form of conceptions of a subject, the nature of knowledge or of good teaching are also tools that teachers draw on in their practice. Teachers’ beliefs may also potentially be transformed by that practice. For example, a teacher’s belief about how students learn to think mathematically may change after observing the impact of a given strategy. Self-reflection on action has been shown to transform and align teaching beliefs and practices for out-of-field mathematics teachers (Lane & Ní Ríordáin, 2020).

*Rules* of behaviour, including implicit norms and conventions as well as explicit school practices and policies mediate the relationship between the subject and their community (Engeström, 2001). The *Division of labour* delineates the distribution of responsibilities, roles and rewards among the participants of the activity system (Cole & Engeström, 1993, p. 7), while the *Community* includes other participants involved in the same activity and object as the subject and may include associated communities of practice (Wenger, 1998).

The third generation of CHAT recognised that an activity system interacts in networks with other related systems with a partially shared object and shifts the analytic focus to these interacting systems (Engeström, 2001). The way the tasks are distributed can reflect power relationships in activity systems. This is perhaps evident in the large proportion of out-of-field teachers in Australia who are early in their teaching career (Weldon, 2016) and therefore often in relatively power-less positions.

Contradictions, that is, “historically accumulating structural tensions” (Engeström, 2001, p. 137) can occur within and between elements of activity systems. Using second generation CHAT as a heuristic to identify contradictions within a bounded activity can facilitate understanding of the multi-dimensional nature of difficulties in complex activities such as teaching. Although contradictions can be a source of conflict and discomfort, they can also provoke learning and change as

participants in the activity attempt to find solutions to them (Cole & Engeström, 1993; Engeström et al., 1999; Miettinen et al., 2012).

While CHAT theorises structural elements of activity, it has been argued that needs, emotions and feelings need also to be considered in order to “capture the activity system as a whole” (Roth, 2009, p. 70). More specifically, ethical aims that are “motivated by concerns for society” and moral principles, are integral to the object and motive of activity and enacted through participation in the activity (Roth, 2007, p. 92). Roth further theorised that identity is linked to ongoing participation in collective activity (2007, p. 92) and that understanding an individual’s identity requires consideration of the elements of the activity systems with which they have been involved (Roth, 2004, p. 68). Hence, in exploring our research questions related to a teacher’s out-of-field and in-field teaching activities, we have integrated the structural elements of CHAT to highlight tensions within and between those activities, together with considerations of the emotions, ethics and identity aspects of those activities.

## Method

This paper draws on data collected from an existing *Australian Research Council*-funded 3-year longitudinal project investigating the experiences of secondary teachers teaching out-of-field in regional and rural Australian schools across three states (Victoria, NSW and Queensland). The project is guided by standard research ethics, including voluntary informed consent, approval number HE15-046. We are attempting to understand the contributions of elements of the wider school context to supporting out-of-field teachers in these often demanding roles.

While we interviewed 23 case teachers and associated leadership teams for the broader project, this paper focusses on a single particularly rich longitudinal case study from NSW, as this case. A case study approach, as argued by Yamagata-Lynch (2010), is congruent with both the context-embedded nature of the out-of-field phenomenon and the theoretical considerations of CHAT and allows us to report thick, rich data to enhance trustworthiness of the findings. Single case study methodology has been generative in understanding changing mathematics teacher identity (e.g. Skott, 2019). We therefore focus on the object-oriented activities of Bobby (pseudonym), a young teacher in a very small rural K-12 school with an enrolment of around 160 students. Bobby was selected along with other participants in the study through a process of canvassing rural schools in the wider local area by phone/email and personal contacts. Following initial discussions, the school principal, Bobby, and his mentor Joan, volunteered to participate in the research.

We interviewed Bobby at his school several times over a 3-year period with all interviews audiorecorded and transcribed verbatim. Interviews were semi-structured (Merriam, 1998) and questions changed over the course of the research, focusing on changes and developments in Bobby’s situation, thoughts and practice over time and being informed by his responses to previous interviews. More specifically, the interviews drawn on for this paper comprised:

- Three one-to-one, hour-long interviews (one per year) posing questions relating to: Bobby's background; teaching qualifications and experience, roles and teaching allocation; perceptions of his teaching situation and practices in both in-field and out-of-field areas; professional goals and learning and support needed and provided.
- Three interviews (one per year) with Bobby and the person he identified as his mentor (Joan), who was a member of the school executive. Questions probed how mentoring supported Bobby's out-of-field teaching, including its impact on Bobby's understanding of himself, his role and his teaching practice as well as changes in Bobby's enjoyment of and capacity for teaching.
- Two interviews with the school principal and other executive staff. Questions explored school context, goals and available support.

### Analysis of Interview Data

As argued by Rogoff (2008), personal, interpersonal and community processes of activity are interdependent, but any of these elements can be foregrounded as a focus or plane of analysis of sociocultural activity. In this study, we adopted the personal plane of sociocultural analysis (Rogoff, 2008) in foregrounding a single person, to identify Bobby's different school-related object-oriented activities over 3 years of the project. Reflecting the research questions, detailed analysis focused primarily on Bobby's out-of-field teaching activity in mathematics. In order to address research question one, structural elements of Bobby's in-field and out-of-field teaching activities were identified and mapped, while research questions two and three were explored by identifying and mapping contradictions within and between the poles of Bobby's out-of-field mathematics teaching activity.

Data were coded using NVIVO 11 and 12, using a combination of both inductive and deductive content analyses (Elo & Kyngäs, 2008). Deductive analysis made use of a priori codes corresponding to each of the poles of the CHAT triangles, as well as codes representing other key concepts drawn from the literature such as identity, mentoring and professional learning. Interview transcripts were read and reread to locate instances of these codes in the data. In inductive analysis, constant comparison was used (Boeije, 2002) to detect, define, delineate, compare and categorise other codes, for example, relating to emotions (adopting the labels used by participants), relationships and manifestations of contradictions.

Two kinds of linguistic cues were used to identify the discursive manifestations of contradictions (Engeström & Sannino, 2011). These were words indicating potential tensions, such as 'problem', 'frustrating', 'hard' or 'difficult' used by Bobby or his mentor during the interviews, as well as other less explicit phrases or questions, such as "I don't know...", "am I doing the right thing?" These cues were scrutinised to identify possible dilemmas, conflicts, critical conflicts or double binds (Engeström & Sannino, 2011) or other manifestations of contradiction (here, collectively referred to as tensions). We also coded instances where participants referred to attempts to resolve these tensions.

Emerging results were tracked and represented via traditional CHAT triangles. In addition, we adopted Roth’s (2007, p. 89) theorisation that participation in an activity “mediates the nature of who a person is”. Hence, to reveal further subject-related complexities of teaching out-of-field we noted changes in the emotive and identity-related dimensions of Bobby’s actions and activities, which we discuss in relation to the structural elements of the CHAT mediational triangles.

### Results and Discussion

In this section, we describe and discuss structural elements and tensions of Bobby’s mathematics teaching in relation to his sociocultural background, associated emotive and identity related elements and efforts by Bobby to resolve the tensions he experienced. In accordance with our area of primary interest and research questions, we focus primarily on Bobby’s out-of-field activity system of mathematics teaching.

In Fig. 2, we have represented key elements of Bobby’s out-of-field (Activity System A, left hand triangle) and in-field teaching (Activity System B, right hand triangle) activities over 3 years. Any changes to structural elements of Bobby’s activities over the 3 years are indicated by the suffixes Year 1, 2 and/or 3 next to the relevant elements at each pole. Tensions relating to Bobby’s out-of-field mathematics teaching are indicated by labelled dashed lines (a, b etc.) that are subsequently explicated in the text.

As can be seen in Fig. 2, in Years 1 and 2 of our study (in Bobby’s fifth and sixth years of teaching), Bobby taught mathematics out-of-field and PDHPE in-field. In

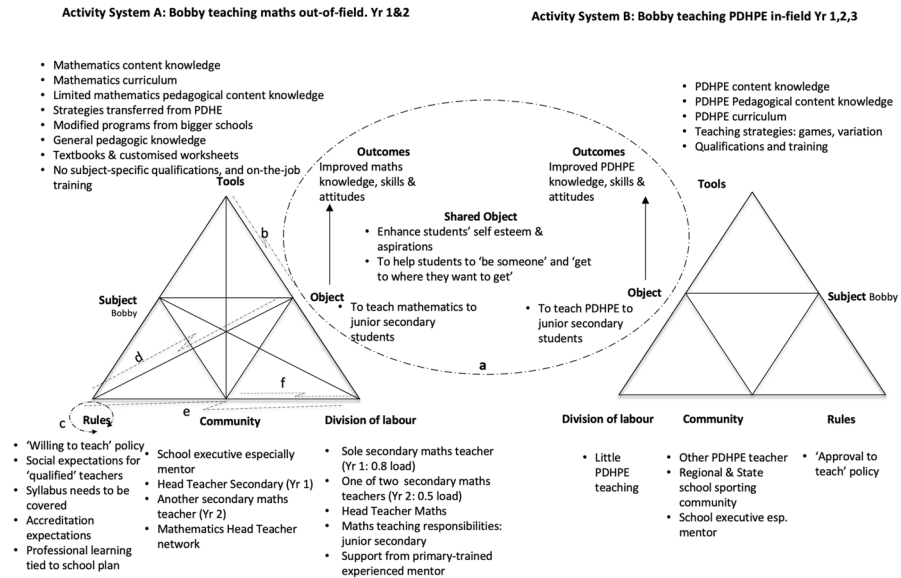


Fig. 2 Two of Bobby’s teaching-related activities over 3 years, focusing on his out-of-field mathematics teaching



the final and third year of data collection, Bobby was still teaching PDHPE, but he was no longer teaching mathematics out-of-field, and (not shown in Fig. 2) had taken on a different activity of teaching another subject area out-of-field.

### **Bobby as the Subject**

As background to interpreting these results, Bobby came from a rural area and a family background of considerable disadvantage. He was a national sporting representative, identified as an Indigenous Australian and was first in his family to gain university qualifications, which were a Human Movement degree and then a Graduate Diploma of Education. Bobby's teaching qualifications and in-field area of teaching were the subject area of PDHPE, (more colloquially PDH). He agreed to take some of his teaching allotment as mathematics to make up his first full-time ongoing position and took on more mathematics over the years.

### **Objects of Bobby's Activity Systems**

Bobby's two activity systems, outlined in Fig. 2, are defined by the two separate *objects* and associated *outcomes* at which Bobby's teaching was directed. These were:

Activity system A: defined by the *object* of the students in Bobby's mathematics classes who he was trying to teach, in order to achieve the *outcome* of enhanced mathematics knowledge, skills and attitudes. Although Bobby was not passionate about mathematics, he aimed to teach mathematics "*as best I can*", because of his pedagogical commitment to student learning. As argued by Hobbs (2012b), such pedagogical commitment to learning is necessary for teachers to put in the additional effort required to teach in out-of-field contexts.

Activity system B: defined by the *object* of the students in Bobby's PDHPE classes that he was trying to teach, in order to achieve the *outcome* of enhanced PDHPE knowledge, skills and attitudes. Bobby was very passionate about PDHPE.

Bobby also had a broader *object* shared by both activity systems (indicated by the oval in Fig. 2) of enhancing students' self-esteem and life aspirations. Many students were from Indigenous and/or low socio-economic backgrounds and/or were achieving several years behind the relevant curriculum stage expectations. Spanning both his in-field and out-of-field teaching activities, Bobby's overarching object was a motivating passion in his teaching, in part as a consequence of his own life experiences and background.

I: What are you passionate about in your teaching?

BOBBY: Seeing kids learn and really achieving goals. From my background I was the only one in my family for a couple of generations that went to Uni. I think being able to challenge kids to say, 'well, we can beat that and get to where we want to get on our own if we put our self to trying'... I can get them to look beyond the rural setting, beyond [the nearby town], and it's a big wide world out there ... If we can teach them through the education system or through experiences, something from outside the school system, or what

you've got from your own experiences. They go, 'wow, if I put my head down I can beat this and I can be someone'. Very inspirational sorts of things.

Bobby's goal to help students to 'be someone' reflects ethical principles relating to the role of education in social justice that informed his actions and goals.

### **Tensions Between Objects of Activity/ies**

Bobby's two activity systems of teaching mathematics and teaching PDHPE were to some extent in tension (a) caused by contradictions in the various objects of his teaching. Teaching mathematics had taken Bobby away from his preferred object of teaching PDHPE. This was manifest as conflict associated with ongoing self-questioning about his priorities:

I'd rather be teaching the PDHPE, and would like to get back to that so you don't lose touch with that. If, say, you got transferred out or you decided to move on, and you've been teaching five or ten years of maths, you lost ten years of development or experience as a PDH teacher...am I going to be teaching maths for the rest of my career, or am I going to get back to what I was trained to do and what I'm passionate about, and should I be spending more time on keeping those [maths] programs up to date? ...

The tension Bobby experienced between the two objects of his teaching impacted his emotions. He began his mathematics teaching activity with excitement: "I was excited to teach maths. I thought well, you know, maths was one of my favourite subjects at school, so, yeah why not give it a go", but over time his enjoyment declined, in part because of the conflict between his different objects "I was getting a bit cranky too, because I wasn't teaching PDH..." "So, I guess that enjoyment just went, because I wasn't getting what I was trained to teach, or what I thought, what I had in my head, was trained to teach."

These contradictions between the objects of Bobby's teaching were tenacious, relating to Bobby's cultural-historical background and identity. Over several conversations, Bobby's mentor Joan (part of the school executive) reported actively trying to expand Bobby's identity to encompass becoming a mathematics teacher:

And we talked about seeing yourself as a maths teacher ...he doesn't see himself as a maths teacher, even though he is a maths teacher—because he said 'I'm not really the maths teacher'. That's the first thing he said to me, 'I'm the PE teacher doing maths'. I said, 'no, you're a teacher who can do PE and maths ...'

Despite Bobby's commitment to mathematics teaching, and these identity conversations with his mentor, Bobby's identity as a PHDPE teacher was not easily displaced.

I guess it's something I just try and hide. I think I can come to terms with it. I do a really good job with it and probably yes, I am a maths teacher, but you

don't want to admit you are in case they go, 'cool, you're the maths teacher now' then I lose that [PDHPE].

In addition to the tensions between the object of teaching maths and Bobby's preferred object of teaching PDHPE, as indicated in Fig. 2, there were contradictions within the narrower and broader objects of Bobby's mathematics teaching. Bobby never indicated that he saw teaching mathematics as leading to the overarching object of enhancing students' aspirations, self esteem and life-chances. This contrasted with many expressions of the role of PDHPE in this broader object, for example:

That's why I go about the PDH and health and those sorts of things, because there's keys in that stuff that's really, really important for not only our indigenous kids but low socio-economic kids. And this is what we're teaching in 90%, probably 100% of our kids, who are low socio-economic here. They really need that encouragement and that belief in themselves to say 'I can really do that. I can become the teacher, I can become the doctor'.

This dilemma was sometimes manifested physically when Bobby switched to PDHPE-related actions within his timetabled 'mathematics' activity, while recognising the different purposes of the two subjects:

...sometimes I'll be halfway through a maths lesson, and will turn it into a PDH talk because of something that happened in the playground at recess, or the kids are unsettled and you start talking about behaviours and bullying in your maths lesson. Sometimes you're on for fifteen minutes and you go, 'hang on, we'd better get back to that maths work'.

## Tools

The tools Bobby referred to in teaching mathematics included mathematics content knowledge from secondary school, "I smashed algebra", and courses from his degree. He drew on strategies from PDHPE such as games, mathematics-specific strategies, including primary level strategies as well as the textbook and worksheets.

Bobby referred to a number of tensions between the tools and object of his mathematics activity (b). He experienced a dilemma between achieving his object of teaching mathematics with his limited training:

BOBBY: I often think that a qualified teacher could do a better job than I can.

I: Why?

BOBBY: I don't know. Because they're trained in it. ...

More specifically, Bobby found it difficult to achieve his object using the textbook as a tool, particularly early in his mathematics teaching:

So not knowing how to teach maths—and that was how I was taught maths at school, through the textbook. So you look around the maths room here, there's

textbooks everywhere—so that’s what I thought, ‘here’s the textbook, lesson one is write out the information on simplifying fractions’.

I: So what do you think now?

BOBBY: Throw the textbooks in the bin.

Bobby resolved this tension by creating his own worksheets based on the textbooks, but developing these tools became a time consuming further challenge:

You think all that work I did last year, I could pull out those sheets again and we can do this little task again and do this activity but—oh no. You’re back to teaching stage two instead of stage four, because the kids just aren’t at that level, and I think teaching out of area, that’s the biggest challenge.

Bobby became quite frustrated with trying to come up with tools to differentiate his teaching in order to achieve his mathematics teaching objective: “they’re counting on fingers, and you go ‘I know I’m not a maths teacher, but I’ve got to find something to get this kid to where they need to get. That’s real frustrating’.”

Bobby worked with his mentor to resolve the dilemma between his limited tools and his desired outcome of student learning in mathematics by exploring strategies from PDHPE.

I didn’t have the kit bag so to say—to pull out a different tool ... And she taught me to take on my experience of the PDH and background and challenging yourself and small gains, and to get better we need to train. And so to go back and rethink the way I was teaching maths, and to try and incorporate the PDH stuff made maths fun again—made maths fun for the kids.

These strategies are examples of boundary crossing objects (Akkerman & Bakker, 2011; Hobbs, 2013; Rahayu & Osman, 2020), facilitating Bobby’s transition to his out-of-field teaching context. The expanding array of tools that Bobby developed in working to resolve the dilemma and resolve his frustration also led to increased enjoyment in his mathematics teaching: “I’m learning what works, I’m trying some new stuff, and it’s fun”... “if you can increase the toolkit, then you’ve got an enjoyment of teaching.”

## Rules

In relation to the rules of his out-of-field activity, Bobby was able to teach mathematics, despite lacking the relevant tertiary qualifications to do so. This was because, in his educational jurisdiction, the formal ‘Approval to teach’ (which is based on tertiary qualifications in the subject area) may be waived at the discretion of a principal under certain conditions. Other rules relate to availability of and access to professional learning in mathematics, which had to be tied to a school strategic plan.

Several tensions were evident within the rules of Bobby’s mathematics teaching (c).

The rule that his formal professional development be undertaken in relation only to mathematics was also in tension with Bobby’s wish to undertake professional development in PDHPE.

BOBBY: I've, in previous years, expressed interest in wanting to get into professional development for PDH, and it's always been 'maths is a priority', and it's been said that 'maths is pretty much your core business and you teach maths here and that's where you need to go.'

Bobby also experienced a dilemma of being required to engage in professional development in mathematics while not yet having formal 'Approval to teach' in that area. He feared this professional development would not be formally recognised if he wanted to move schools.

We tie it into the school plan and when you do your professional learning stuff, it's got to tie into your school plan and if you're the maths teacher ...

I'm falling behind, because I can't go and transfer to another high school as a maths teacher because I'm not trained. ...it makes it difficult when you spend four years of doing all the maths stuff or even five years now I guess of teaching maths, and all your professional training is in mathematics, but you still don't have your accreditation or qualification as a maths teacher ...

Bobby's mentor and school principal, Joan, attempted to help resolve this dilemma by helping Bobby to gain his formal 'Approval to teach' for mathematics:

JOAN: We're working on it. You've got your two hundred hours ...Our aim is to get Bobby accredited for all the work he's done so that he can have the maths.

A further dilemma was apparent between the rules of covering the syllabus and Bobby's object of teaching mathematics (d):

If I'm pulling teeth teaching algebra, how important is the algebra? Do we hit the bases, tick off the minor outcomes and then move them on? Do I waste four weeks with them when they're quite happy to be engaged doing measurement, because they know they need that for their construction or their wood-work? It's those balances to make sure they're still engaged in learning ...

This problem is not unique to out-of-field teachers, as teachers and students commonly have contexts and goals that conflict with mathematics curriculum requirements (Dietiker & Riling, 2018). Here, Bobby was expressing a Platonist/instrumentalist belief about the nature of mathematics and how it should be taught (Vale, Campbell, Speldewinde & White, 2020). In Year 2, Bobby was finding it easier to reconcile meeting syllabus outcomes while achieving his object, but this remained a dilemma:

I'm finding it easier to modify and try and make it more enjoyable still meeting our outcomes and making it curriculum related. That's the challenge.

### **Division of Labour**

In the division of labour in this very small school, Bobby was the only mathematics teacher in Year 1 and therefore assumed the mathematics head teacher role, which

he maintained in Year 2 when another out-of-field mathematics teacher joined the staff. His isolation exacerbated many of the tensions experienced in his activity: “because I’m on my own and I’m not trained.” Bobby was conscious of a dilemma (e) in being simultaneously ‘qualified’ and ‘not qualified’: “It seems like a lot of time where I’m not the qualified person, but I am the qualified person at this school.”

Bobby found it difficult to assess his professional competence as a mathematics teacher when the division of labour had him teaching all the secondary mathematics by himself. This led to frequent expressions of self-doubt and lack of confidence, for example:

...me being the only maths teacher in this school, at the moment it’s hard to gauge where you’re at as a teacher, or to get that confidence from elsewhere to say you’re really doing a good job, or I love your programs. It’s always ‘I don’t know’, because there’s no one to compare that off or run it by ...

## Community

Given this division of labour, Bobby was only a peripheral participant (Wenger, 1998) in a mathematics teachers’ community of practice, which for him consisted predominantly of teachers in other schools that he met through occasional regional head teacher meetings. Although the Head Teacher of Mathematics, Bobby found it challenging (f) to fully participate in the community of Head Mathematics teachers and considered that the focus of this community was different from his agenda of gaining the tools that he needed. Nonetheless, Bobby used these meetings to try to resolve the tension (b) between his lack of tools and the object of mathematics teaching by trying to enhance his mathematics ‘toolkit’:

...there’s these head teachers that have been teaching for 21,22 years, and they’re flying things off each other and they’re saying ‘bring these to share’, and I’m like, ‘But it’s just me!’. And you’re wanting to pull in all these resources and soak it up like a sponge, and everything’s going over your head... and the other head teachers ask ‘what are you doing with your faculty?’ and it’s ‘I’m it and I want stuff from you guys. I’m not giving you guys anything because I’m not a trained maths teacher. I want you guys to give me the information and show me your programs and show me the things that you’re doing.’

Bobby’s mentor Joan, although not a mathematics specialist, was a very experienced educator with extensive primary teaching background, and was part of Bobby’s community in both his in-field and out-of-field activities. Joan assisted Bobby by helping him to develop and apply both generic and mathematics-related teaching strategies, and through her support and advice acted as a boundary-crossing object. Bobby’s increased enjoyment in teaching mathematics owed a lot to the interactions with his mentor:

...learning the skills from Joan [on] how to run an interactive, exciting maths class, because I just got, I suppose lost that joy of teaching for one, which we’d

said before, but not really knowing how to make maths really fun. And Joan sort of did that for me.

Bobby credited Joan for keeping him in teaching:

And I felt like giving up too. Without that support of Joan just popping her head in... once I sort of, I suppose had fully taken Joan's ideas on board and we were able to make a good connection, and I guess had full confidence in who Joan was in the school, and valuing, I guess what she had to offer, which is probably one of the better things I've done...[laughing] it has been great for my teaching ...

Joan also had explicit conversations with Bobby in relation to his identity as a teacher, which exemplifies organisations socialising people as they take on new roles and cross boundaries, through moulding their beliefs, values, behaviour and knowledge—in other words “negotiat[ing] and interlock[ing] with the fabric of their identity” (Nair, 2010, p. 11). These interactions seemed to have some influence on the way Bobby positioned himself in relation to mathematics teaching. Towards the end of Year 2, Bobby was expressing a more expansive identity as an educator, rather than specifically a PDHPE teacher:

BOBBY: I think that's the biggest change since Joan's come on, as before I was very reluctant to say I was a mathematics teacher, and now I'm pretty reluctant to say I'm just a PDH teacher. I'm an educator, or like when we went to uni they would say I'm a long life learner, but I think I've really changed that.

However, in the third year of our study by which time Bobby was also part of the school executive, he helped to locate and facilitate the appointment of a dedicated mathematics teacher, relinquished his mathematics teaching and reverted to teaching more PDHPE as well as another out-of-field subject. This suggests that despite Joan's explicit comments framing Bobby as a mathematics teacher, and despite Bobby's apparent expansion of identity to encompass being a mathematics teacher, Bobby ultimately did not relinquish his identity as a PDHPE teacher. Joan's interactions with Bobby did not modify the strongly held beliefs and ethical aims woven into the “fabric” (Nair, 2010, p. 11) of Bobby's identity.

## Implications for Supporting Out-of-Field Teachers

Bobby explained very clearly how overcoming his cultural-historical background of disadvantage through education had influenced his identification as a PDHPE teacher. This identity was interlinked to strong ethical principles relating to educating for social justice, which were integral to who he was, why he taught and the overarching object of his teaching. This case study of Bobby's experiences, goals, tensions, emotions and identity during his out-of-field activity of teaching mathematics demonstrates how tightly these multiple elements of out-of-field teaching are interlinked. While the case study is located in Australia, the findings align

with much existing literature in the area and point to a number of implications for responding to the problem of out-of-field teaching that apply internationally.

Bobby's enjoyment of and commitment to his mathematics teaching was impacted by the conflict between the objects of his mathematics and PDHPE teaching. This is also not an uncommon issue for out-of-field teachers, who are passionate about their own in-field subjects but also have a wider commitment to education as an individual and social good (Hobbs, 2012a). Responses by his mentor or the school executive to this kind of tension might involve professional discussions around the relationship between teachers' narrower and broader objects of teaching, such as (in this case) the contribution that mathematics learning might make to students' self-esteem and life chances.

Bobby's dilemma (d) relating to the rules of covering the syllabus and his object of teaching mathematics ("how important is the algebra? ...") is a good example of conflicting obligations to organisational and individual needs identified by Herbst and Chazan (2020). Bobby was pulled in different directions by the syllabus and his perception of the needs of the individuals in his classes — a tension to which he had found no resolution. Supporting out-of-field teachers could beneficially surface these tensions in relation to the rules and objects of activity, fostering discussions about the affordances, constraints and consequences of teaching decisions in response to conflicting obligations.

The difficulties Bobby faced in differentiating his mathematics teaching because so many of the students were working so far below their stage is not restricted to teachers teaching out-of-field. Literacy and numeracy are strongly associated with students' socio-economic status internationally (Boman, 2023), and the gap between Indigenous and non-Indigenous students' literacy and numeracy levels continues to be a national educational issue in Australia (Australian Institute of Health and Welfare, 2023). Hence, differentiation is core business for all teachers. For example, providing personalised learning and support according to individual student needs is required in many international contexts including, for example, Bobby's educational jurisdiction (NSW Department of Education, 2023). However, responding to such diversity can be exacerbated for out-of-field teachers in mathematics, who may not have the relevant 'horizon knowledge', that is, explicit and relational understanding of the ways of knowing, working and thinking in mathematics, its core ideas and the curriculum prior to and beyond the stage at which the students are working (Zazkis & Mamolo, 2011). This reflects a need for enhanced pedagogical content knowledge and mathematics knowledge for teaching which is common to many out-of-field mathematics teachers (Vale, 2010). PDHPE teachers are often asked to teach mathematics and can often benefit from 'subject matter enhancement' (Vale & Drake, 2019), including specialist knowledge relating to common difficulties students experience in learning mathematics concepts and how to make those concepts accessible to students (Ball, Thames & Phelps, 2008).

Bobby's lack of ongoing professional learning embedded in the day-to-day practice of teaching mathematics, given the lack of a community of mathematics teachers, is a common situation in small rural schools. In these situations, virtual communities of practice or professional learning networks within small trusted groups can be important sources of ongoing professional learning for isolated out-of-field



teachers, through discussing useful teaching strategies, observing and providing feedback on each others' teaching in the out-of-field area (Ní Ríordáin et al., 2017). Another potential avenue for resolving this issue for Bobby and other isolated out-of-field mathematics teachers could include strategic and targeted leveraging from head teacher network meetings or effective school cluster arrangements in rural areas, as outlined by Fraser et al. (2019). Time and resources could be explicitly incorporated at these meetings to support mathematics teaching, together with tailored professional learning support for teachers who may occupy leadership positions in a subject area as non-specialists.

Bobby did exhibit normative commitment to his role as a mathematics teacher (Ní Ríordáin et al., 2022), trying to do his job 'the best he can'. However, he was still ambivalent about taking professional learning and development in mathematics because of tension about the direction of his career away from PDHPE. So, while professional development in mathematics could beneficially attend to developing teachers' normative commitment to the mathematics teaching profession (Ní Ríordáin et al., 2022), out-of-field teachers' personal interests and career aspirations also need to be taken into account (Lünne et al., 2021). Bobby's strong personal commitment to PDHPE and its role in furthering the life chances of his students — the overarching and strongly expressed object and motivation of his teaching — indicates that normative commitment to an out-of-field area may not be enough to keep teachers there.

The interactions between the elements of Bobby's out-of-field teaching activity and his emotions also support the view of Geijsel and Meijers (2005) that teacher identity is a learning process, within which the critical role of emotions needs to be acknowledged and supported. Emotions and perceived capacity of out-of-field teachers traverse troughs and peaks over time and in response to key events (Hobbs et al., 2021; Hobbs & Quinn, 2021). Responding to these sometimes tumultuous changes requires professional learning that enables teachers to make personal sense of their new experiences (Vale & Drake, 2019), attends to teachers' wellbeing (Du Plessis & McDonagh, 2021) and takes account of elements of cultural historical background interacting with identity and emotions.

One of the strongest themes emerging from this case study was the value of Joan as a mentor in resolving of some of the tensions in Bobby's activity. Subject-specific support provided by mentors (Hobbs & Porsch, 2022) can enable teachers to reflect on their practice. Despite the limitations to the support Joan could provide in terms of specialist mathematics content and pedagogical content knowledge at the secondary level, through deep and authentic discussions that attended to Bobby's identity, she was instrumental in keeping Bobby in the teaching profession and teaching mathematics, at least for a while.

The professional relationship between Bobby and Joan illustrates the mutual trust that is critical for authentic and meaningful professional discussions and learning to occur in mentor relationships (Harris, Caldwell & Longmuir, 2013). The issue of trust therefore requires a place in professional development of mentor teachers. This underscores the potential value of formal professional development programs that help prepare experienced teachers to mentor their out-of-field colleagues (Ní Ríordáin et al., 2019).

Though Joan did appear to influence Bobby's expanded subject-related identity, and Bobby did try out this provisional identity (Hobbs, 2013; Ibarra, 1999) as a mathematics teacher, his choice not to continue with mathematics teaching by the end of the study suggests that this provisional expanded identity was both tentative and fragile. The unstable nature of teacher identity in relation to a range of personal, interpersonal and structural factors, including life history, experiences, emotions, narratives and a sense of belonging to a community has been well established (e.g. Beauchamp & Thomas, 2009; Bosse & Törner, 2015; Feser & Haak, 2023). In Bobby's case, several aspects of his activity may have mediated this change away from a provisional subject-related identity as a mathematics teacher. These included his lack of "belonging" to an accessible community of mathematics teachers and his very powerfully expressed motivation and object to help Indigenous students "to be someone", which was connected to his own emotions, experiences and ethical aims. In the longer term, Joan's, and then Bobby's own narrative of Bobby as a mathematics teacher did not outweigh these other influences on Bobby's identity development. This finding underscores the relational nature of teacher sub-identities described by Bosse and Törner (2015) and suggests that supporting teachers to expand their identities needs to take account of these relational complexities.

Although identity learning has been viewed as a necessary part of professional learning for teachers in general (Geijsel & Meijers, 2005) and out-of-field mathematics teachers in particular (Bosse & Törner, 2015; Goos et al., 2019; Hobbs et al., 2022; Vale, 2010), Bobby's ultimate resistance to Joan's efforts to shape his identity highlight some limitations to this approach. In an analysis of identity regulation in organisations as a form of control, Nair (2010, p. 17) argued that resistance to the regulation or manipulation of identity is not uncommon, that attempts at identity regulation can be stressful and are 'undesirable' for those concerned. Moreover, ethical questions relating to if and how far organisations should go in trying to influence individuals' identity remain unanswered (Nair, 2010). This suggests value in further research interrogating the ethics, form and impact of identity-related work in attending to professional learning and development of out-of-field teachers.

## Conclusion

The process of representing Bobby's in-field and out-of-field teaching activity using the elements of CHAT mediational triangles was a useful analytic framework that assisted in making sense of the complexity of the phenomenon of teaching out-of-field. By spanning important elements of the activity, viewing the out-of-field phenomenon through a CHAT lens facilitates a system perspective by bringing into focus the elements of the context of the teaching activity. This process can help to map and resolve the structural impediments to out-of-field teachers' access to necessary supports, noted by Vale (2010) as important to responding to out-of-field mathematics teaching. It also transcends a deficit focus on teachers' subject specific content knowledge, which is often characteristic of reporting on out-of-field teaching, for example to highlight the inequities in the education system (e.g. Van Overschelde, 2022). The different aspects of activity indicated by the points on the CHAT

triangles and identification of tensions between them could be used in discussions with policy makers to convey potential limitations to simplistic responses to the out-of-field phenomenon. They are also of value in professional learning conversations about ways of responding to the issue of out-of-field in a given activity network. For example, depending on the context, it may be that attention to policy frameworks comprising the activity rules, relationships between the members of the communities involved in the activity, modifying the division of labour, targeted professional development focusing on content knowledge and so forth, may afford options for change for individual teachers.

In addition, using CHAT as a lens may help those engaged in teaching activity to better identify the processes relating to teachers' 'learning' to teach out-of-field as they respond to emerging tensions and contradictions (Hobbs et al., 2019). It is important to understand how these processes change, how they are related to their context, the tools and supports teachers have available, and how teachers' ethics, emotions, dispositions and capacities influence teachers' commitment to their own learning when out-of-field. These discussions, though, need to be conducted within trusting relationships in order to genuinely encompass important elements of teachers' out-of-field activity, bearing in mind that attempts to shape the identity of out-of-field teachers may be resisted. Unsupportive environments where teachers are left on their own to learn unfamiliar content and teaching practices can lead to poor development of teacher competence and confidence (Hobbs & Quinn, 2021). This research has shown that subject-specific mentors or coaches or teacher support in the out-of-field subject make a difference to teacher confidence and enjoyment. Sustaining teaching quality in the face of out-of-field teaching means minimising risk to teachers' confidence and commitment in relation to their out-of-field activity (Hobbs, 2013) and maximising teacher capacity by building teacher capability. Nonetheless, when attempting to ascertain and meet the needs of out-of-field teachers, it is important to attend to the ethical aims which are associated with a teachers' concern for their students and their subject and tied to the objects of activity (the teaching of the subject and wider goals). Moreover, supporting these teachers requires attending to their emotions and identity that, as shown by Bobby, both mediate and are mediated by out-of-field teaching.

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