Mathematics Teaching as Praxis

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In this paper we argue that mathematics teaching can be conceptualised as a form of *praxis*. Viewing mathematics teaching as praxis foregrounds the moral nature of teaching and the educational practices that are developed in response to the educational needs in particular sites. The case for praxis in mathematics education is then made by drawing on practice theory and, classroom observation and interview data. Finally the implications of a praxis perspective of mathematics teaching are presented.

We are currently in an era where the educational landscape is being dominated by a "performative audit culture" (Comber & Nixon, 2011, p. 168). Mathematics teaching needs to be responsive to a relatively new Australian curriculum, national standards for professional practice (Australian Institute for Teaching and School Leadership (AITSL), 2011) and national testing (NAPLAN). Following Kemmis et al. (2014) we see such accountability and performance mechanisms as forming a significant part of the practice architectures that enable and constrain mathematics teachers' practices. In this "era of accountability" (Comber & Nixon, 2011, p. 167) the pressure of the practice architectures of mathematics teaching seem to restrict and limit the capacity for quality education (Reid, 2009). We are concerned that the capacity for schools, and specifically mathematics teachers, to focus on the *double purpose of education*—to help people live well in a world worth living in (Kemmis et al., 2014) —is at stake, in that mathematics education practices may not sufficiently serve the needs of individuals or the mathematical requirements of societies (Grootenboer, 2013). To this end, Kemmis et al. (2014) stated that the double purpose of education, "must always be conducted as praxis" (p. 28). On this premise we discuss mathematics teaching as praxis. First we provide a discussion of praxis, before presenting a brief overview of the studies from which the data are drawn. Finally, we outline what we believe are compelling and urgent practical implications of a praxis perspective for mathematics teaching.

Praxis

The term *praxis* is not new, but it has been used widely with a range of meanings over many years. Here, we draw on two perspectives of praxis: (1) the classic Greek philosophical writing of Aristotle; and (2) the German ideological views of Hegel and Marx. Aristotle noted a plurality of forms of knowledges and dispositions with distinctive associated forms of activity which fundamentally can be viewed as three disposition-action couplings that have value and legitimacy in human practices: a theoretical, a technical and a practical perspective (outlined in Table 1 below).

In mathematics education each of these perspectives are visible in the everyday teaching and learning which happens in schools; each equally important. Teaching mathematics requires knowledge of mathematics and learning theory, mathematical and pedagogical skills, and practical wisdom and activity in the classroom. We acknowledge that each of these aspects are necessary, but here we want to emphasise the disposition of *phronesis*, and more specifically, the action of *praxis*. Our focus on praxis emerges firstly from a

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response to its under-representation in the literature and secondly, a belief that it specifically foregrounds the practical wisdom and activity of mathematics teaching in classrooms—the site where all the aspirations and intentions of education meet learners.

Table 1
Aristotle's Dispositions and Action Couplings

	Theoretical Perspective	Technical Perspective	Practical Perspective
Telos (Aim)	The attainment of knowledge or truth	The production of something	Wise and prudent judgement activity
Disposition	*Episteme*: to seek the truth for its own sake	*Techné*: to act in a reasoned way according to the rules of a craft	*Phronesis*: to act wisely, morally and justly
Action	*Theoria*: 'Contemplation', theoretical reasoning about the nature of things	*Poietike*: 'Making' action, involving means-ends or instrumental reasoning to achieve a known objective or outcome	*Praxis*: 'Doing' action, morally-informed action, involving practical reasoning about what it is wise, right and proper to do.

Hegel and Marx had a slightly different understanding of praxis, describing it as 'history-making action'. Like Aristotle, they included the action-nature of praxis, but they also emphasised that the activity has moral, social and political consequences for everyone involved in and affected by the action.

> Marx and Engels articulated their historical materialism, arguing that social formations, ideas, theories and consciousness emerge from human and collective social praxis, and that social action (praxis) makes history. In much Anglophone usage today, the term 'praxis' is used in the Aristotelian sense; in much of Europe …'praxis' is used in the post-Hegelian, post-Marxian sense. (Kemmis et al., 2014, p. 26)

By drawing on both of these praxis traditions, we take praxis in mathematics education as moral and ethical pedagogical activity in the classroom, and, action that will make and shape histories and can only be judged as effective or otherwise in hindsight. This perspective allows us to address the double purposes of mathematics education – for the benefit of individual students and the benefit of societies (Grootenboer, 2013).

In taking a praxis perspective of mathematics teaching, we are also theorising mathematics teaching as a practice. There is not scope to fully outline this here (see Kemmis, 2008), but we highlight two critical concepts: *practice architectures* that enable and constrain practices and the *ecological nature* of practices. Practices, including the practices of teaching and learning mathematics, are enabled and constrained by practice architectures that exist in any classroom. These include *cultural-discursive* arrangements such as the language which exists in mathematics lessons shaped by prescribed curricula and testing regimes, *material-economic* arrangements such as the activities, resources and material objects necessary for mathematics lessons to happen, and *social-political* arrangements such as how students relate to one another and the teacher as they participate—through interactions—in mathematics lessons (Kemmis, 2008). Further to this, mathematics teaching practices do not exist in isolation, but in any given site (e.g., a particular classroom in a particular school in a particular community) the practice of

teaching is ecologically related to other practices including student learning, educational assessment, professional learning and school and systemic leadership.

Empirical Foundations

The arguments developed here are supported by data from two similar studies: one that explored the practices and identity of highly regarded mathematics teachers (see Grootenboer, 2013) and another that investigated the practices and identity of mathematics and music teachers (although here we only look at the mathematics teachers). In these studies, data were collected through an initial semi-structured interview, classroom observation and a post-observation interview to review salient features of the lesson. The examples are not necessarily novel or innovative, but represent ordinary, everyday-type lessons, since these typify the very mathematics education that students experience in their day-to-day schooling. Photographs were taken during observations to provide stimulus for the post-observation interviews. In most instances a student group interview was conducted after the lesson with students selected by the teacher. Altogether, 19 highly regarded mathematics teachers participated from a range of schools (primary and secondary; state, Catholic and independent; a range of socio-economic backgrounds; regional and urban). These teachers were recommended as 'highly effective mathematics practitioners' by peers and leaders in the schools and district. Together, these two complementary studies provided a large data set that included 41 hours of interview transcripts. We draw on this broader data set to exemplify the discussion of mathematics teaching as praxis.

Mathematics Teaching as Praxis

As noted previously, we appreciate that effective mathematics teaching is complex and multi-faceted, and involves teacher knowledge and pedagogical skills—both dimensions prominent across our empirical data. In a very general and simplistic sense, teacher knowledge and pedagogical skills correspond to Aristotle's notions of *theoria* and *poietike*. Here, however, we move the analytic focus to the third perspective of *praxis*: practical action informed by moral and ethical consciousness (and the associated disposition of *phronesis*). This is crucial for mathematics education since a teacher's knowledge (of mathematics, pedagogy and content-specific pedagogy) and skills are brought to bear in the moment-by-moment interactions and practical actions with learners in classrooms.

Teaching mathematics is a morally dense practice because in the course of any lesson, teachers are always making decisions to act and respond in particular ways. Typically, in any given lesson, students are placed in situations replete with social interactions (with the teacher and with their peers). These interactions are charged with morally complex, intersecting and simultaneously influential factors, often tacit and imperceptible to participants (Edwards-Groves, Anstey & Bull, 2014). While this could be said for all learning situations, it seems to be particularly significant in mathematics learning, where students' mathematical identities can be fragile (Grootenboer, 2013). In this, teachers have to navigate the tension between creating some dis-ease or challenge to provoke mathematical growth while simultaneously supporting and protecting their emotions as they learn. And, of course, all this is seemingly undertaken 'on the run' within the complex interactions of classrooms (Edwards-Groves et al., 2014). Next we focus on the aspects of data that relate to the decision making and related actions of the mathematics classroom.

Critical Decision-Making within a Pedagogy of Care

As expected, data were saturated with examples of these exemplary teachers enacting what we describe as a pedagogy of care and thoughtfulness. This is important for teaching in any subject area, but particularly in mathematics where, for many students, learning mathematics is perceived as stressful and experienced with high levels of anxiousness (Grootenboer et al., 2008); and for some, the relative thoughtlessness of some mathematics teachers forms a significant factor in their bruised mathematical identities. In this study, participating teachers overtly demonstrated a pedagogy of care in mathematics lessons which were relationally warm and inviting, creating particular social-political conditions which enabled mathematics instruction to unfold in uniquely 'humanistic and civil' ways. Paul commented (Note: all names are pseudonyms):

> But I treat kids the way I want to be treated; respect is a big word in my classroom. I talk about values and I try to teach kids the way I bring up my own children … The other thing is connection, connecting with kids. You have to have that connection with kids; that care factor. I enjoy working with young people and I think it's important to show them that you care and show a genuine interest.

Creating this relationally grounded classroom atmosphere is important in mathematics teaching because students' perspective of mathematics and their relationship with it are significantly shaped by the broader context in which it is experienced. Unfortunately it seems that unenticing and sterile mathematics classrooms are too common and consequently many students have historically seen mathematics as cold and uninviting (Cotton, 1993). In short, the praxis of mathematics teaching demands a relationally warm and inviting classroom atmosphere that at the same time enables student learning; that is, a praxis-oriented disposition requires teachers to consciously create conditions which challenge learners within supportive, responsive relationships. We argue that this is not an optional extra to a mathematically sound and pedagogically well-organised lesson.

Nevertheless, learning mathematics and developing students' mathematical identities can often require students to feel confusion, frustration and uncertainty as they engage with new ideas and try to comprehend material for the first time; this can be make them ill-at-ease and uncomfortable (Carter, 2008). Further, there are inherent inner-tensions when teachers, like Paul, try to create conditions which enable students to feel welcome and at ease and to teach them difficult concepts at the same time. On the one hand, they are attempting to guard and preserve students' mathematical identities; on the other hand, is the need for creating disequilibrium and discomfort so learning can be facilitated. Managing this dilemma is a critical challenge for mathematics teaching because it is morally and ethically charged, and navigating the tension requires praxis.

In one Year 5 lesson, a boy was observed struggling with the mathematical ideas he was facing; apparent by his behaviours and increasing frustration, exacerbated by most other students quickly advancing to the next level with the manipulative task at hand. The teacher approached the student and spent approximately five minutes working with him individually; after a short time and with some excitement, the boy successfully completed the activity and displayed an understanding of the mathematical concept involved. During her time with this student, the teacher did not take the quickest option of simply showing the boy how to do the activity; she took the time to ask more dialogic questions about what he was doing (asking him to substantiate his reasoning and provide evidence for his thinking), praise him for his "persistence" (while simultaneously providing learning focused feedback) and encourage him to continue. This situation, although a very ordinary

instance, illustrates how one teacher, in the midst of the flow of a busy classroom lesson, showed both pedagogical responsivity and interpersonal concern and support for a student while at the same time not allowing him to avoid the mathematical demands of the activity. She created conditions which brought to his consciousness his own learning processes. This example illustrates how praxis is visible in what we describe as the 'support-challenge-relationship'. It suggests that although there is no certainty with the 'courses of action' involved in the moment-by-moment decision making required of teachers; educational hindsight would suggest this was the right thing to do in this case. Taking a praxis view of mathematics teaching and learning makes overt the conscious deliberate actions critical for the best learning outcomes for the diverse group of mathematical learners who 'live' in every classrooms. Further, the long-term consequences of these simple in-the-moment decisions can be significant both in the short and longer term.

It was apparent across the data that these teachers created a niche for learning through a range of principled dialogic practices (Edwards-Groves et al., 2014). These were demonstrated in the ways teachers constantly provided learning focused feedback, encouraged and affirmed students for their effort, perseverance, activity and mathematical thinking, and through sustained questioning supported students to exemplify, extend and rationalise mathematical thinking and behaviour. In post-observation interviews, teacher participants were asked to comment on this feature. Sandy typified their responses:

> I guess it is just part of who I am. I want the students to feel safe and valued so they can try new and difficult things, and I guess I just give them little reassuring words or a touch on the shoulder without really thinking about it.

When questioned about whether this was just good teaching in general or something specific to mathematics, participants suggested that it was more necessary in mathematics because students were often more "timid" or "fearful of failure". Important to note, is that the feedback, praise and encouragement was given in meaningful, learning-focused and sincere ways that directed students overtly to specific actions or characteristics, such as persistence and thoughtfulness. This concerted and deliberate attention to the personal and emotional aspects of learning mathematics was also evident in lessons where the teachers paid overt attention to the learner's affective involvement. For example, Alana, a Year 4 teacher, asked a particular student in the midst of an activity, "Does it worry you that it's not even?" In this, in what could seem as a mundane course of action, she acknowledged and attended to her "worry" without allowing the student to avoid the 'mathematical wrestling' she was undertaking in her attempts to understand the mathematical concept.

The development of mathematical knowledge and skills is not devoid of affective engagement by the students, particularly as they struggle with new or difficult concepts, and navigating the inherent tensions can be difficult for teachers (Carter, 2008). An integral part of developing sound student mathematical identities is to foster a sense of persistence and resilience as learner qualities which enable them to cope with significant mathematical problems and persevere in the face of new and challenging mathematical concepts. This is a difficult emotional and ethical practice, and it demands practical wisdom (phronesis) in order to manage the induced unease of a learning task so the students can develop healthy mathematical identities. Against this backdrop, the situation is exacerbated as mathematics teachers often deal with large and diverse student groups in the complex and multi-faceted environment of the classroom. They do this, while at the same time their pedagogical work is bounded by the often competing practice architectures evident in their sites (e.g.,

implementing new curricula or NAPLAN testing). For us, juggling these social-political demands requires praxis.

Enriching Learning through Differentiating Teaching

As highlighted above, the mathematics classroom is a site constituted by a diverse range of students who come together to encounter and engage with mathematical ideas and concepts. They enter with a variety of unique backgrounds, experiences and mathematical identities, and considering this the teacher has to make prudent decisions and take thoughtful action in the midst of a dynamic and complex social site. Implicit in this understanding is the idea that students require differentiated teaching. Whilst participating teachers were observed usually focusing on a single topic, they all differentiated pedagogy.

In a particular senior mathematics class, students were undertaking an extensive mathematical modelling task involving logarithms and they were working in small groups. After setting up the task for the students, the teacher expected them to engage with the task for an extended period of time as he moved around the room and interacted with groups as required. After about 15 minutes, one particular group asked the teacher for assistance with the activity, but after looking at what they had recorded, he said, "You guys need to have a look at what you have done then keep working on your model" and then he moved away. A short time later another pair of students also asked for some support with the task and he took quite an extended period of time to read their work. He then proceeded to engage in a substantive and sustained discussion with them (for about 8 minutes). During this conversation he appeared to give quite a lot of focussed individualised instruction along with sustained encouragement, learning focused feedback and words of affirmation, such as, "Your ideas are insightful here – very cool!" What was striking here was that in the same lesson where the students were working on the same mathematical concept with a common task, the teacher responded to different groups of students in completely different ways. Furthermore, it appeared that he made the decisions to do this almost instantly and without much thought, as he worked with about 25 students on a complex mathematical concept and task. After the lesson, Ray was firstly shown the photographs of these two interactions and asked about his differentiated pedagogical actions.

> I guess I've had them long enough to know where they're at with their mathematics and for some kids it's pointless giving them another question because they just can't access what you've got, so you've got to give them some sort of scaffold, whereas a more confident kid a question for them to think about is.. enough for them to move onto the next level … I do answer kids in different ways because I know where they're coming from … I want them to be thoughtful and I need to give them good and targeted feedback … to understand kids do things in different ways and that needs to be valued.

Foundational to Ray's teaching practice was knowing his students' broader and mathematical identities well. When asked about what he was thinking at these times, Ray commented, "I can't really remember. I probably wasn't thinking about anything, just reacting". From this it seems that these complex decisions and actions were enacted in ways which Ray took for granted and without conscious thought, but from our observations it was evident that there was a deliberateness and prudence about his practical actions that connected directly to what we are suggesting is a praxis orientation. But these are not simple decisions, and the actions (or inaction) cannot be undone. Furthermore, the real-time nature of teaching means these pedagogically sound decisions have to be made in the

momentary flow of instruction (almost on the spot) with little time for analytic reflection or extended consideration. This is why, we argue, that praxis is necessary.

Practical Implications

In this section we specifically comment on two key practical implications for viewing mathematics as praxis. The first implication relates to teaching; and the second, teacher professional learning, leading and teacher education. These dimensions of education are ecologically connected and directly contribute to the future development (and success) of mathematics in society. A praxis view of mathematics offers education a fresh view that accounts for phronesis (*practical wisdom*) and praxis (the *action* that comes from that disposition) that leads to a professional consciousness about the doubleness of education.

A focus on teaching. Our data showed a constellation of actions in everydayness and routineness of mathematics teaching we attributed to praxis. For example, we observed teachers working within what we describe as the 'support-challenge-relationship' learning model, overtly providing learning focused feedback, encouragement and praise, interacting with students in ways which are more dialogic (generating more substantive conversations with students which required sustained levels of mathematical reasoning). Our discussion has suggested that praxis is required in teaching mathematics because teachers have to constantly make significant pedagogically sound decisions and then act upon those decisions with actions that may have enduring affective, intellectual and social consequences (as history-making actions). A teacher can have a carefully planned lesson and a range of quality resources, but it is the 'in-the-moment' interacting, thinking, acting and reacting that is crucial to the success of the lesson (Edwards-Groves et al., 2014). This responsive pedagogy requires a teacher to have both a sound pedagogical knowledge and techniques along with a robust mathematical identity so they can perceptively identify the mathematical opportunities available in lessons.

From this, a praxis perspective for teaching mathematics foregrounds the ethical and moral dimensions of teaching which pursues the double purposes of education. Given that many students finish their schooling with a poor attitude towards mathematics and often avoid the subject altogether (Cotton, 1993; Grootenboer et al., 2008), there is a sense that mathematics education does not attend to either of its double purposes. As a consequence, there is long-term damage inflicted on the mathematical identities of individuals, which in turn impacts broader societal outcomes as the community develops a decreased capacity to cope with the mathematical demands of contemporary life (Australian Academy of Science, 2006). Therefore, we urge for mathematics teaching to be seen as a form of praxis where the ethical, moral and affective dimensions of pedagogy are fore-grounded and overtly considered (especially in teacher education and teacher professional learning).

A focus on teacher professional learning, leading and teacher education. Our observations of highly regarded teachers suggests that all teachers be afforded the *communicative spaces* (Habermas, 1996) to interact with each other about the nature and context of their teaching, mathematical ideas, and the practice architectures that enable and constrain their practice. These communicative spaces are afforded in school structures which tangibly prioritise the centrality of the classroom and the dual purposes of education. One way this can be achieved is for school leaders and teacher educators to quarantine time for focused professional learning conversations grounded in sharing and critical reflection centred on classroom interactions, practice architectures, and the ideas and practices of mathematics. In this way, mathematics teaching praxis can be accomplished, both

individually and collectively, as teachers consciously work towards develop the mathematical identities of their students contextualised in everyday mathematical experiences which stem from, for example, particular 'support-challenge-relationship' learning practices. According to Edwards-Groves (2008),

> *praxis* only develops as an on-going self-extending stance when an intrinsic value and understanding of the ideologies of schooling, the discourse of teaching and learning, self-regulation, focused reflection and inquiry are clearly understood, enacted and articulated. *Praxis*-oriented teachers … do what is right and prudent for the good of the students they teach. (p. xxx)

We see a need to reconceptualise mathematics teaching since *praxis* puts the spotlight on the dispositions required to enact quality mathematics pedagogies; dispositions which draw deliberately from theoretical (knowledge), technical (techniques) *and* practical perspectives. Apparent in each of these perspectives, but particularly for praxis, is a need to attend to both the mathematical identities of teachers (Palmer, 1998), and the social-political arrangements which underpin their practices. We contend that a key to improved mathematics education in the current era of accountability is to fore-ground mathematics teaching *as* praxis. To achieve this, mathematics teachers do not require greater prescription or regulation, but rather professional learning which embraces collective communicative action related specifically to the practice architectures and students in their sites. Mathematics teachers cannot simply decide to undertake this in a vacuum; their teaching practices are fundamentally ecologically arranged with other educational practices including the leading practice of administrators. It requires an orchestrated and concerted change in all the practices of education if change is to be realised and sustained.

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