Mathematics Education as a Practice: A Theoretical Position

Peter Grootenboer
Griffith University
<p.grootenboer@griffith.edu.au>

Christine Edwards-Groves
Charles Sturt University
<cgroves@csu.edu.au>

In this paper we will examine mathematics education using practice theory. We outline the theoretical and philosophical ideas that have been developed, and in particular, we discuss the 'sayings', 'doings', and 'relatings' inherent in the teaching and learning practices of mathematics education. This theorising is drawn from an empirical study that focused on the broader practices of education in schools. We exemplify these ideas with a small excerpt of data. Understanding mathematics education as a practice highlights the site-based nature and also ecological arrangement of practices, and we conclude by outlining some implications that emerge from this perspective.

The idea that mathematics education could be conceptualised and understood as a practice was first introduced by Kemmis (2008) in his keynote address at the 2008 MERGA conference. In his lecture, he highlighted the moral and political nature of education, and drew a distinction between *education* and *schooling*. He saw education as serving a dual purpose – the formation of individuals and the development of "good societies". He suggested that this contrasted with "schooling which is the institutional formation of learners to attain (usually state-) approved learning outcomes which might or might not be in the interests of the students themselves or the good for humankind" (p. 17). In this context, mathematics education was conceptualised as a practice, and this enabled aspects of mathematics education to be considered, understood and examined from another perspective. In this paper we want to continue that pursuit by further elaborating our developing theoretical ideas about practice and considering these ideas in the light of some empirical data. We also want to consider more broadly the implications of considering mathematics education as a practice for the development of learning and teaching in mathematics classrooms. While we will specifically revisit this at the end of this paper, we note Kemmis' (2008) comment on the concept of mathematics education as a practice from the same keynote address:

> … changing professional practices like mathematics education is not just a matter of changing practitioners' own particular understandings and self-understandings (cf. sayings), skills and capabilities (cf. doings) or values and norms (cf. relatings), but also changing the practice architectures that enable and constrain what practitioners can do. (p. 21)

In this paper we begin by first briefly outlining our understandings of practice theory, including the concepts of practice architectures and praxis. Then, a few details are provided of the study that generated the empirical data reported here. After outlining a snippet of the data to illustrate the ideas of practice theory, we conclude with some implications and recommendations related to the development of mathematics education by drawing on the data from the larger study.

Practice Theory

Understanding mathematics practices in everyday classrooms requires conceptualising the sociality of practices as they happen in actuality when teachers and students encounter one another in everyday social situations; that is, how practices are found to exist and unfold in the temporally located 'happenings' of the site (Schatzki, 2010) or practice

In V. Steinle, L. Ball & C. Bardini (Eds.), Mathematics education: Yesterday, today and tomorrow (Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia). Melbourne, VIC: MERGA.

landscape (Kemmis, Wilkinson, Edwards-Groves, Hardy, Bristol & Grootenboer, 2012b). Practices also exist and evolve in history, in the practice traditions that inform and transform them - *as prefigurements* - as they adapt to changing times, participants and local circumstances. In one way:

> [People] make their own history, but they do not make it as they please; they do not make it under self-selected circumstances, but under circumstances existing already, given and transmitted from the past. The tradition of all dead generations weighs like a nightmare on the brains of the living. (Marx, 1852/1999, p. 1)

From this, we are interested in the sociality and the circumstances of these practices as they exist in physical space-time. To do this we take an ontological approach (Schatzki, 2002, 2010) which emphasises that practices occur in sites, and that they are sites of "human coexistence". To theorise practices in this way we turn to the theory of practice architectures (Kemmis & Grootenboer, 2008) which proposes that practices are composed of 'sayings', 'doings' and 'relatings', that take place amid particular arrangements of entities in three kinds of intersubjective spaces:

- *semantic space* (whereby a shared language in which meanings are shared and mutual understandings are constructed);
- *physical space-time* (whereby shared locations in space and time enable interactions in shared activities and work to be encountered); and,
- *social space* (whereby shared encounters afford different kinds of relationships and ways of relating to be possible).

These spaces are such that people encounter one another as interlocutors, in interaction, and in interrelationships (Kemmis, et.al. 2012b) in practices enmeshed in language games, activities and ways of relating. These practices are held in place or 'hang together' (Schatzki, 2010) amid three kinds of arrangements:

1. the *cultural-discursive* arrangements found in (or brought to) a site; for instance, the technical language of numeracy and mathematics which have particular meanings attributed to them in mathematics instruction and curriculum ;
2. the *material-economic* arrangements found in (or brought to) a site; for instance, how the set-ups of material objects such as desks, resources and computers are differently arranged in the mathematics lesson to enable particular activities to be 'done'; and,
3. the *social-political* arrangements found in (or brought to) a site; for instance, how teachers relate to their students would be different to how students would relate to their peers.

In other words, practices both constitute and are constituted by the particular words used, the particular things done and the particular relationships which exist in the interactions between the people and things involved. Together these constitute the particular or characteristic arrangements which form the practice architectures of a practice of one kind or another (Kemmis & Grootenboer, 2008). For example, the practice arrangements of a mathematics lesson (the language, the activities and the ways of relating) may be different from the practice arrangements of a language lesson in the same classroom (for instance different words are used, different student groups are used). Thus we draw on the definition of practice Kemmis, Edwards-Groves, Wilkinson and Hardy (2012a) who define practice as:

> a coherent and complex form of socially established cooperative human activity in which characteristic arrangements of actions and activities (doings) are comprehensible in terms of arrangements of relevant ideas in characteristic discourses (sayings), and when the people and

objects involved are distributed in characteristic arrangements of relationships (relatings), and when this complex of sayings, doings and relatings 'hangs together' in a distinctive project.

According to this view of practice, therefore, students become practitioners of mathematical practices by co-inhabiting these intersubjective spaces with their teachers and peers in classroom lessons (over historical time and in physical space-time), and by employing sayings, doings and relatings appropriate to the practice of mathematics. In their enactments they draw on the cultural-discursive, material-economic and social-political arrangements found in their classrooms, schools, homes and communities where the practice of mathematics teaching and learning occurs. This theory of practice architectures is depicted below in Figure 1.

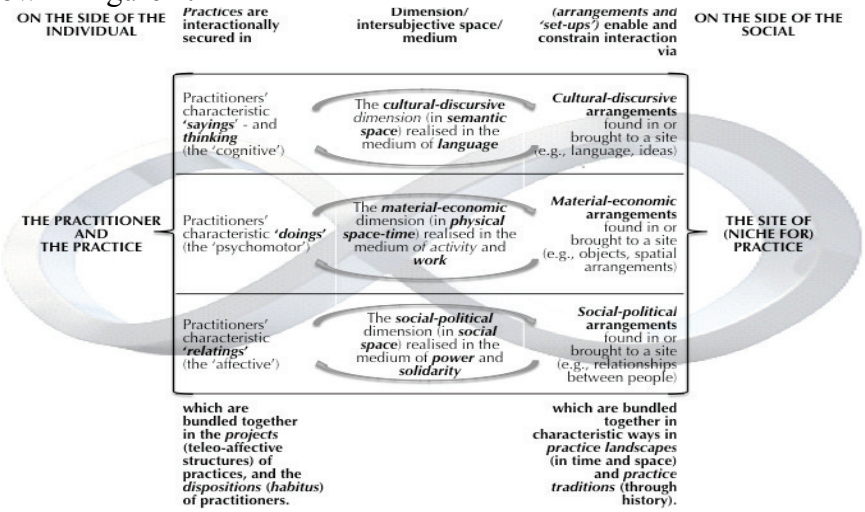

Figure 1. The theory of practice architectures (Kemmis, et.al 2012b; Kemmis & Grootenboer2008).

On the side of the individual (of Figure 1), we identify participants' sayings, doings and relatings as they occur in particular practices (like the practice of learning addition with concrete materials), and how they hang together in particular projects like teaching children about the properties of triangles, or deciding (in a professional learning meeting) how to use a constructivist approach to teaching algebraic functions. On the side of the social (of Figure 1), we identify the cultural-discursive arrangements – the language and specialist discourses – that make those sayings possible, the material-economic arrangements – the arrangements of people and material objects in physical space-time – that make the doings of the practice possible, and the social-political arrangements – the relationships of power and solidarity – that make the relatings of the practice possible, and we try to discover how those arrangements hang together in a particular kind of practice landscape. In this paper, we briefly illustrate this theory of practice architectures as a way to analyse a specific mathematics practice as it unfolded in an everyday lesson in a classroom.

We also understand practices as being ecologically related as they are derived from and within other educational practices which exist in ecological relationships with one another and in the whole complex of interrelated educational practices (Kemmis, et.al. 2012a).We use this theory because, for us, it provides a practical connection to the notions of *praxis* which allows us to reconnect with a lifeworld – human and humanistic – perspective on practice as a human and social activity with indissoluble moral, political and historical dimensions (Grootenboer, 2013; Kemmis, 2008). It offers the meta-awareness of a kind of action we take in educational circumstances which can only be evaluated only in the light

of their consequences – in terms of how things actually turn out. This kind of action educational 'praxis,' may be understood in two ways: first, as *educational* action that is morally committed and informed by traditions in a field ('right conduct'), and second, as 'history-making *educational* action'.

The Study

This paper draws on a four year philosophical-empirical enquiry which aimed to explore issues in practice philosophy and theory by interrogating practice as it happens (Schatzki, 2010) in the field – in particular classrooms in particular schools. The empirical work was conducted employing a multiple case study approach (Stake, 1995) with an explicitly ontological - or site-based - focus. In this, we differ from other approaches to case study that focus chiefly on people and their perspectives on organisations or issues. Instead, we focused on practices *as they happen* in sites. The specific aim was to conduct an in-depth exploration of practices in formal educational settings (schools, school district offices) as they happen in actuality over four years in the same sites. Furthermore we aimed to explore how practices are ecologically-dependent on other practices in what our research team has called the Education Complex of practices; i.e. leadership, teaching, professional development, student learning and research and evaluation (Kemmis, et.al, 2012b). The study focused chiefly on five schools and how various kinds of education practices in the schools were shaped by cultural-discursive, material-economic and social-political arrangements that existed within and beyond the schools.

Data were gathered in five different schools in two regions of Australia: one in the state of New South Wales and one in Queensland. The corpus of empirical data was gathered using a range of qualitative methods. In particular, we interviewed 15 district office staff (leaders, senior administrators and consultants), five school principals, 48 classroom teachers and 73 students (usually in focus groups of about six students), observed 23 classroom lessons, held debriefings after observations with teachers and students, and observed other activities like staff meetings and professional development sessions. Lesson observations, debriefs and semi-structured interviews were audio-recorded and transcribed for analysis. These transcripts represent the empirical material for this paper.

After an initial, independent examination of the corpus of data, a detailed examination of emerging categories to discern relevant themes using direct interpretation of the data was conducted; this involved looking at each case and drawing meaning from it using categorical aggregation (Stake, 1995). A collection of instances from across the corpus of data was sought with the view that issue-relevant meaning would emerge as they recurred in the data (Creswell, 1998). Furthermore, our analysis was guided by the theory of practice architectures (Kemmis, et al, 2012a, 2012b; Kemmis & Grootenboer, 2008). In this paper, we are especially interested in the practices teaching and learning of mathematics. Hence, we draw more specifically on classroom mathematics lessons and follow-up debriefs with students and teachers.

Findings and Discussion

In this section we are reporting on a small snippet of data that relates specifically to the learning and teaching of mathematics. In particular, we have focussed on a mathematics lesson in a Year 5 classroom which was taught by Brian, also a senior leader in his school. It should be noted that this was not necessarily an 'exemplary' lesson, but rather it was an everyday lesson that just happened to be on the program for that day. In this section we

will identify and exemplify some *sayings*, *doings*, and *relatings* evident in this small part of Brian's mathematics teaching practice, and we will also show how this practice is enabled and constrained by *practice architectures*.

The sayings, doings and relatings of mathematics teaching

In the classroom observations and in the interviews, there were several examples of the three components of the teaching practice, i.e., the *sayings*, *doings*, and *relatings*. Concomitantly, the analysis revealed some of the *cultural-discursive, material-economic* and *socio-political arrangements* that enabled and constrained the teaching practices.

The lesson observed was replete with mathematical terms and an integral part of the project of the lesson was to equip the students with appropriate mathematical language. The short excerpt below came fairly early in the lesson as Brian sought to revise and connect to prior learning.

> Brian: Place value, okay, so we're pretty good with the place value for whole numbers, Kimberly's just told us the place value to how many places?
>
> Student: 3.
>
> Brian: Which is all we've been covering okay, and the first place value is?
>
> Many students: Tenths.
>
> Brian: Tens or tenths?
>
> Student: Tenths.
>
> Brian: That's right, why is it called tenths and not tens?
>
> Student: Because it's part of a whole.
>
> Brian: Part of a whole, and if it's tenths what do we visualise what we're doing when we look at tenths? We're splitting the whole thing into?
>
> Student: Ten pieces.
>
> Brian: Ten pieces, so if you've got 3 tenths, how many of those pieces have you got?
>
> Student: 3.
>
> Brian: 3, okay. What's the next place value?
>
> Student: Hundreds.
>
> Brian: Hundreds. Isaac, what's another one?
>
> Isaac: Thousands.
>
> Brian: Thousands or thousandths?
>
> Student: Thousandths.

This small transcript of what seems a fairly normal classroom lesson shows the sort of mathematical language critical to the practices of teaching and learning mathematics. In particular, the teacher was concerned that the students understood and could grasp the finer nuances of particular mathematical terms - for instance, place value, tenths, thousands, parts of a whole, whole numbers. For him, his aim was to counter the possibility that slight inaccuracies can radically alter the meaning for the students as they practise mathematics.

What is also evident in this example of a fairly typical classroom interaction is one of the common *doings* of teaching – asking questions and managing a dialogue through the IRE structure. This pedagogical practice (teachers asking questions and students

complying by answering) is not unique to the mathematics classroom, but is ubiquitous, and its effectiveness is mediated by the teacher's relationships with his/her students – i.e., *relatings*. In the case exemplified above, the teacher's *doings* involved reviewing the previous learning on "place value" in order to prepare for the new material, and to manage and orchestrate the discussion. What is not evident in the transcript is the care and thoughtfulness that the teacher employed to ensure that all were involved. To undertake this sort of discussion, the teacher has to organise the turn-taking and to promote participation, and the relational foundation for this was evident in the students' enthusiasm and eagerness to be involved.

Practice Architectures

As has been noted, practices are enabled and constrained by *practice architectures*. Mathematics teaching practices are not only responsive to the students in the school and classroom, but also the *cultural-discursive*, *material-economic*, and *socio-political arrangements* in the classroom, school, community and system.

At a simple level, the *sayings* that characterised the lesson were directed, to a certain degree, by the prescribed and mandated curriculum documents. These are an imposing aspect of the *cultural-discursive arrangements* of the mathematics teaching practices. At a more localised level, Brian and his colleagues have employed the "First Steps in Maths" and the "GoMaths" programs in the school, and these also support certain mathematical pedagogical practices and restrict other practices. In terms of the *material-economic arrangements*, the lesson was facilitated and limited by the physical organisation of the room. In the extract outlined previously, the arrangement of the desks and chairs had to allow the teacher to effectively engage the students in a 'question and answer' dialogue where all were involved. The teacher stood at the front near the Smart Board and the students sat as a group on the floor facing the front. The conduct of the lesson, and in particular the question and answer dialogue, was enabled and constrained by the mostly tacit *socio-political arrangements* that define the teacher's role and the students' roles in this sort of interaction. The students (and the teacher) clearly knew and understood the rules of turn-taking, 'hands-up' to answer, etc.

Implications

In the previous section we used a small snippet of data to illustrate the theoretical ideas, but now in this final section we draw on the broader data set of the study. While there were a range of issues and points of interest that emerged from the data, here the focus is on two particular themes that seemed critical: (1) the ecological arrangement of mathematics education practices; and, (2) the site-based nature of mathematics education practices.

The ecological arrangement of mathematics education practices

It was noted previously, that since the inception of mass schooling there has been five core educational practices that emerged seemingly simultaneously, namely leading, teaching, professional development, student learning, and research and evaluation. These we called the *Education Complex of practices* (Kemmis, et.al, 2012b), and it was clear throughout the study that these were all evident in each site, and they were inter-related in an ecological manner. More specifically, while the practices of mathematics education could be identified and labelled, they were not discrete – they are ecologically arranged

and intimately inter-related. At the most obvious level, it is clear that the teaching practices of the teacher were intimately related to the learning practices of the students. Indeed, the teacher plays a major role in structuring the practice architectures that enable and constrain the learning practices of the students. But Brian's teaching practice was also related to the leading practices of the school leadership team, and his pedagogical approach was informed by professional develop he had experienced.

The ecological arrangement of the practices has implications, not the least being the need to consider the educational complex of practices when engaging mathematics education reform. If a mathematical innovation or reform program is to be promoted, it is inadequate to simply focus on one practice. For example, with the roll out of the Australian curriculum, attention needs to be given not only to the teaching of mathematics, but also to student learning, the pedagogical leadership, the research and evaluation, and importantly the teacher development. These practices are ecologically arranged and therefore, dependent upon one another, and so attention to one aspect without an associated and allied focus on the other related practices, will be less effective and sustainable.

The site-based nature of mathematics education practices

Given the ecological arrangement of mathematics education practices, and in particular the teaching and learning practices, it became clear that the site is critical. Mathematics practices occur in a site, and that site is a fundamental dimension of the practice architectures of those practices. Therefore, to be properly understood and developed, mathematics education practices need to be considered as situated. We contend that with the centralisation of education in Australia, it is important to emphasise the classroom and school as the critical sites of education – whatever happens at the international, national, state and district level, in the end mathematics education practices are realised in a particular classroom at a particular time. This ontological perspective has repercussions for the development of mathematics education.

First, mathematics education practices are enabled and constrained by the practice architectures of the site, and so development requires a simultaneous and related focus on the practices and the practice architectures. If attention is given to practices without giving a concomitted focus to the situated arrangements that facilitate or hinder the practice, then development is likely to be impoverished and unsustainable.

Second, mathematics education development needs to fundamentally be construed as a site-based process. This does not mean that there cannot be developmental programs that are conceived of at a national or regional level, but it does mean that these programs need to be based on facilitating development at a local level that is based on site-based data. In our view, forms of participatory action research can be effective in structuring and facilitating the site-based educational development in mathematics that will be responsive to the educational needs of the learners, teachers and the community.

Final comment

In viewing mathematics education through practice theories, it becomes evident that a teacher does not conduct their teaching practice in isolation, and considering the issues raised in the introduction, we are cognisant of the warning highlighted by Kemmis (2008):

> If [mathematics] teachers are obliged to follow all the available advice too slavishly, if they take their eyes off the students in front of them because they are obliged to listen too closely to the voices of the advisors and administrators behind them, they may find themselves working on what the state intends – schooling – rather than for the good of their students and the society. (p. 22)

This cautionary note seems particularly relevant today as, at least in Australia, teachers are implementing a national mathematics curriculum, and their performance is increasingly being measured by test scores like NAPLAN, and reported upon publically in forums like the My School website.

Acknowledgements

We would like to acknowledge the work of our research team for the 2010-2012 Australian Research Council-funded Discovery Project 'Leading and learning: Developing ecologies of educational practices' (DP1096275).

References

Creswell, J. (1998). *Qualitative inquiry and research designs: choosing among five traditions*. London: Sage

Grootenboer, P. (2013). Praxis and mathematics education. *Pedagogy, Culture and Society*. doi: 10.1080/14681366.2012.759131

Kemmis, S. (2008). Praxis and practice architectures in mathematics education. In M. Goos, R. Brown & K. Makar (Eds.), *Navigating currents and charting directions* (Proceedings of the 31st annual conference of the Mathematics Education Research Group of Australasia, pp. 17-28), Brisbane: MERGA

Kemmis, S., Edwards-Groves, C., Wilkinson, J., & Hardy, I. (2012a). Ecologies of Practices. In P. Hager, A. Lee and A. Reich (Eds.), *Practice, Learning and Change*. (pp. 33-49). London, UK: Springer

Kemmis, S., & Grootenboer, P. (2008). Situating practice. In S. Kemmis & T. J. Smith (Eds.), *Enabling praxis: Challenges for education*, (pp. 37-62), Amsterdam: SENSE Publishing.

Kemmis, S., Wilkinson, J., Edwards-Groves, C., Hardy, I., Bristol, L. & Grootenboer, P. (2012b). *Changing education, changing practices: Executive summary.* A synopsis of findings of the ARC Discovery Project 'Leading and Learning: Developing ecologies of educational practices' presented at the project's Dissemination Seminar, Canberra, October 17.

Marx, K. (1852/1999). *The eighteenth brumarie of Louis Napoleon*. http://www.marxists.org/archive/marx/works/1852/18th-brumaire/ch01.htm. Retrieved March 15, 2013.

Schatzki, T. (2002). *The site of the social: A philosophical account of the constitution of social life and change*. University Park, TX: University of Pennsylvania Press.

Schatzki, T. (2010). *The timespace of human activity: On performance, society, and history as indeterminate teleological events*. Lanham, MD: Lexington.

Stake, R. (1995). *The Art of Case Study*. California, US: Sage Publications, Inc.