11

Concepts and Commodities in Mathematical Learning

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Educational thought is undoubtedly ideological, but its application to mathematical ideas can seemingly anchor more radical ambitions. It is often thought that you are either right or wrong in mathematics, with little space between. Educational research either informs improvement or it does not. The advance of mathematics as an academic field more generally, however, is defined by the production of new ideas, or concepts, which adjust progressively to new ways of being. That is, mathematical concepts are created to meet the diverse demands of everyday life, and this very diversity can unsettle more standardised accounts. For example, the expansion of mathematics as a field often relies on research grants selected to support economic priorities. In schools, economic factors influence the topics chosen for a curriculum. Our evolving understandings of who we are and of what we do shape our use of mathematical concepts and thus our understandings of what they are. Moreover, public images of mathematics pull in a number of directions that produce alternative conceptions of the field of mathematics. These disparities of vision result in much variety in how mathematical concepts are materialised in everyday activity. They also point more fundamentally to the uncertain ontology of mathematics as a supposed field itself and its evolution according to the demands made of it. Yet more typically, mathematics as a field is thought to exist as a consequence of rationality or even as a matter of belief. Ideology, however, can shape notions of utility, rationality and belief. School mathematics, this chapter argues, has been reduced according to ideological schema to produce its conceptual apparatus, pedagogical forms and supposed practical applications (Lundin, 2012). It has been transformed as a result of ever more pervasive formal assessment demands in schools linked to the regulation of citizens, as part of what Althusser calls the *ideological state apparatus*. The chapter offers some important insights into how Žižek's work extends Althusser's model

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of ideology as applied to revising our understanding of mathematics itself. It asks how we think about mathematics through ideological lenses, and contemplates the forms that it takes in the hundreds of hours that it occupies in most people's school education. The subjective experience of those hundreds of hours may exceed the ideological parameters whilst remaining in the service of those ideologies by making us believe them through the sheer force of habitual action.

For many people, mathematics stands apart from everyday life. It is other (slightly odd) people who do the more complicated versions of mathematics. Žižek's multiple references to Stephen Hawking point to a widely held attitude to mathematics and provide a somewhat unsympathetic reading of Hawking's popularity:

> Would his ruminations about the fate of the universe, his endeavour to "read the mind of God", remain so attractive to the public if it were not for the fact that they emanate from the crippled, paralysed body, communicating with the world only through the feeble movement of one finger and speaking with a machine generated impersonal voice? (Žižek, 1997, p. 173).

Žižek contends that Hawking's iconic status "tells us something about the general state of subjectivity today" (ibid), encapsulated, perhaps, in e-connected individuals expressing themselves, or accessing the world, through technological apparatus. Specifically, Žižek sees Hawking's mode of performance positioning mathematics and physics beyond the reach of a broader public through Hawking being a "new type of public intellectual … who, in the eyes of the wider public, stands more and more for the one 'supposed to know'[1], trusted to reveal the keys to the great secrets which concern us all" (Žižek, 2001, p. 212). Here mathematics resides in a parallel universe available only to those able or prepared to temporarily sacrifice everyday life to pursue the beauties of more abstract thought, and in so doing downplay analytical opportunities that could be more widely available through mathematical thought understood in a more inclusive way.

For various reasons, however, many people decline the benefits of a mathematical education. A recent report in Britain claimed that only 50% of adults function above the level of an average eleven-year-old, and very

[1] "[A] displacement of our most intimate feelings and attitudes onto some figure of the Other is at the very core of Lacan's notion of the big Other; it can affect not only feelings but also beliefs and knowledge – the Other can also believe and know for me. In order to designate this displacement of the subject's knowledge onto another, Lacan coined the notion of the *subject supposed to know.*" (Žižek, 2006, pp. 27-29)

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often members of the other 50% were quite proud of their limitation (Paton, 2012). The report's author was rather concerned: "Now that's a scary figure because it means they often can't understand their pay slip, they often can't calculate or give change, they have problems with timetables, they certainly can have problems with tax and even with interpreting graphs, charts and meters that are necessary for their jobs" (ibid, para 9). In addressing this problem the wonder of mathematics takes on a very different style in many school contexts that are shaped by teachers' accountability to examination regimes designed to support the many and various mechanical processes or economic structures that govern our lives. The pedagogical or practical mediation pertaining to such regimes reshapes and *commodifies* mathematical concepts into objects that can be more readily tested or applied within these regimes. That is, for many students in schools the space of mathematics is marked out by mechanical skills and procedures supportive of an ideological agenda. These aspects are privileged over developing more intuitive powers or other aspects of mathematics. The pedagogical objects of school mathematics (multiplication tables, Pythagoras theorem, decomposition method of subtraction), however, still mark concepts that retain their structural place within mathematical thought that exceeds these ideological parameters, ways of mathematical thinking that are suggested beyond the bare symbols (e.g. conceptualising iteration to infinity, the sense of a rotation in an angle measure). These latter aspects of mathematics are "exempted from the effects of wear and tear [where the supposed field of mathematics itself] is always sustained by the guarantee of some symbolic authority" (Žižek, 1989, p. 18). We forgive mathematics all of its awkwardness in everyday life as we sustain a faith in something more pristine.

So, although the very existence of mathematics is linked to our practical applications, there is also some implied claim to an underlying truth in a more abstract sense. Recent research in mathematics education has pointed to how the existence of mathematics is underwritten by its materialisation in structures and processes (Palmer, 2011). Karen Barad (2007) has shown us that it is never entirely clear where the human stops and where the operation of cultural machinery begins. For instance, is the mathematics that Hawking generates in his mind or in his computer? It is this sort of dilemma that has fuelled mathematics education research in recent decades. Research in the area had often in the past been governed by Piagetian conceptions of the mind (Piaget, 1952). Children were seen as passing through successive developmental stages where it was the teacher's job to enable the children to reconstruct ideas as they followed the inevitable or "natural" route to maturity. Mathematics and the mind were seen

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as two separate entities that got to know each other in the classroom. The international conference on the Psychology of Mathematics Education has provided a long-term centre of gravity for international researchers in the more generic field of mathematics education. In the last couple of decades, however, discursive constructions have become more familiar. In these later models the focus is not so much on minds developing as on changing the story or structure that individuals follow. On the one hand in this scenario students can construct their own accounts of mathematics, bringing new sorts of mathematics into being to meet the needs of their personal circumstances. In some contemporary understandings of mathematical learning pupils are seen as investigating mathematics towards introducing their own individualised structuring of the landscape being encountered, further blurring the line between the individual human and the mathematical concepts that she produces (e.g. Brown, 2011). Conversely, on the other hand, policy makers can legislate particular versions of mathematics, a more centralised script as it were, and police their implementation towards greater conformity (Brown & McNamara, 2011).

The next section provides an account of how mathematical concepts are produced. This formation is then considered in the context of school mathematics centred on the generation of ideological constructs that come to house these objects. Examples are provided of how we might understand policy makers, teachers and students variously identifying with or being alienated from mathematical phenomena. The chapter concludes by theorising how individuals begin to believe the ideologies that govern their actions.

THE PRODUCTION OF MATHEMATICS

Žižek's associate, Alain Badiou, follows philosophers such as Bachelard, Lakatos, and Althusser in seeing science as a *practice* marked by the production of *new* objects of knowledge (Feltham, 2008, pp. 20–21), in much the same manner as Deleuze and Guattari see philosophy as "the art of forming, inventing, and fabricating concepts" (Deleuze & Guattari, 1996, p. 2). Mathematics as a field can be seen as evolving through reaching new generalisations in newly encountered conditions. Over a longer term, the absorption of mathematics into life results in the field of mathematics itself changing. Certain elements of mathematics have been touched more frequently by the need to support applications (e.g. statistical analysis of demographic trends). The field of mathematics itself has been marked out according to how it has been seen as supporting practical agenda. Some aspects are much more popular than others for this reason and tend to be more likely used in everyday life, or secure research grants, etc. In a recent BBC radio feature, a professor of mathematics challenged a director of a government research grants agency by claiming that one could only get research grants for statistics in the current climate, such is the drive of supposed applications. Accordingly, mathematics itself has been reconstituted to meet evolving social priorities and criteria. The historical circumstances that originally generated mathematical objects are often lost. The objects may have become a part of who we are such that we are no longer able to see them. Geometrical constructions, for example, are routinely built into our physical landscape such that we do not notice them any more. We become accustomed to moving around such landscapes and those ways of moving become part of who we are. For instance, circles are common entities and they have been featured in many of the stories that we have told about our world. We may feel that we have gotten to know circles from a lot of perspectives, which results in them acquiring a broad set of qualitative features. We use *circle* as a concept in building our world, and as a result circles become materialised or absorbed in the very fabric of our physical and conceptual world. Stellated octahedrons, in contrast, have been denied that level of intimacy and familiarity with humans (Figure 11.1). Geometrically speaking, there is no reason as to why one might be privileged over the other. Circles have been reified not because of any essential difference between them and, say, stellated octahedrons, but because of merely historical and political reasons. It is actually quite difficult to sort mathematical concepts according to which ones are empirically referenced like circles and those that are not so common in appearance or utility, such as stellated octahedrons.

Mathematics exists as models of knowledge that sometimes support empirical enterprises, but ultimately, as empirical support, the models always reach their limits. We can never use words to precisely specify what mathematics is as such. Yet this realisation does not assist us much with understanding the predictive capabilities of mathematics, which have real psychic effects in more abstract mathematical analysis, and material effects in practical enterprises such as building bridges, the effective analysis of economic models, everyday finance, etc. There is something more significant to mathematical conceptualisation that *needs* to be accounted for. It has a precision and produces results unlike other languages. Mathematics can guide us or structure our thinking, but it does not fix our ways of making sense. Mathematics introduces polarities around which discourse can flow and which result in actual impacts on the physical and social world. Yet the

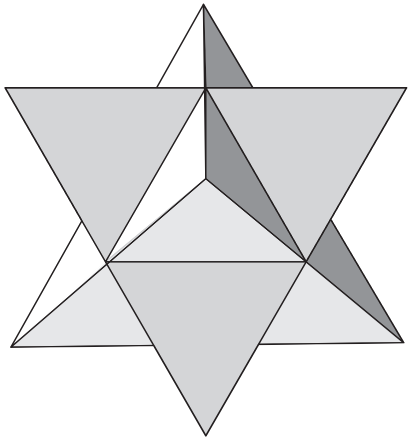

FIGURE 11.1 Stellated Octahedron.

possibility of mathematics as a complete system that supposes grounding in some empirical reference always slips away.

THE PRODUCTION OF SCHOOL MATHEMATICAL CONCEPTS

In the mundane of everyday life, children in schools learn or create mathematical procedures or pedagogical forms for handling different problems, such as those found in teaching schemes, textbooks or curriculums (e.g. how to teach the multiplication of fractions). The mathematics curriculum defines the forms through which school mathematical concepts are understood. For example, concepts of spatial awareness are learned through constructing triangles, reflecting shapes on graph paper, etc. Fashions change, learning theories move on, teaching schemes get replaced, resulting in school mathematics receiving regular makeovers whether or not these effect substantive changes (Brown, 2012). School mathematics has a tendency to reify particular objects (e.g. circles, the first ten integers, the formula for factorising quadratics) or procedures (e.g. the decomposition method of subtraction) for greater scrutiny. It is often applied mathematics shaped around recognisable situations. Particular configurations are repeatedly used resulting in the landscape of mathematics being viewed through perspectives that begin to characterise our engagement with mathematics. Questions are asked in familiar ways. Particular areas of mathematics are favoured, such as the concepts that are more easily tested (finding the

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difference between two integers, finding the area of a triangle) rather than exploring a mathematical terrain. Further, mathematical language used in schools points to styles of social interpretation, social practices and ways of understanding the teacher-pupil relationship.

In Žižek's (1989, pp. 11–48) notion of commodity-fetish, commodities (or specific forms) become the supposed objects of desire. In our case in question, *commodified* versions of mathematics have become the institutionalised markers, or concepts, of school mathematics (Brown & McNamara, 2011). The commodified objects, or mathematics' greatest hits, orientate our understanding of the subject. In Badiouian terms (Badiou, 2005), the objects of school mathematics result from certain sets of elements being "counted as one". For example, if mathematics is seen as needing to include learning multiplication tables, the emphasis on mathematical tables becomes part of the commodification of mathematics and the way it is understood more broadly. That is, the table compiling multiplication results becomes an object, a counting as one of a certain class of results that provide points of reference orienting the pupils' wider engagement with mathematics. The addition of elements to the school curriculum (e.g. tables and graphs) and the reduction of other areas (e.g. geometry) marks the ongoing historical formation of mathematics in the context of social practices. But the statements or concepts that locate mathematical phenomena so often become the statements that police its boundaries. Pupils must then know their tables if they are to advance in mathematics as it is understood within the particular regime.

Whilst university mathematics provides a system against which the correctness of school mathematics is judged, the latter is more often locally defined around social practices, such as calculating supermarket bills, estimating the number of bricks needed for a wall, predicting economic trends, etc. But why have classroom activities assumed the social forms that they have? That is, why have they become commodities with a given form? Commodification suggests a form of packaging designed for presentation in a particular way of life where worlds have been conceptualised around them. For Badiou (2009), the assertion of any object "counted as one" is linked to the assertion of a transcendental world. This conceptualisation of alternative worlds built around commodities mediates the production of mathematical concepts and proliferates or typifies the senses in which they can be understood. The core mathematical idea may be linked to a way of life, but in so doing it normalises particular forms of life as though they were a transparent layer free of ideology.

For example, the English mathematics curriculum has formatted mathematics for consumption in schools (Skovsmose, 1994). The government has exercised its control over teachers and students by specifying specific skills, conceptual awareness and competencies, which stand in for the government's supposed obligation to promote a numerate population with consequent benefits to our society, technology and the economy. Mathematics is characterised by the identification of a particular set of elements, which in turn imply a specific understanding of the world and how it might be changed. The route through which this can be achieved, however, may be difficult to specify in advance or interpret in retrospect. We may ask: what was in successive government ministers' minds in introducing such policy instruments into English schools (cf. Žižek, 2001, pp. 61–62)?

- The minister wanted to improve mathematics by whatever means as part of his quest to provide an education as a basic human right – any rationalisation of how he achieves this is secondary to that basic desire.
- The minister saw pursuit of the improvement of mathematics as a good ploy for re-election – his only real concern.
- The minister sincerely believed that the implementation of his policies will bring about improvement in mathematics in the way he suggests.
- The minister was himself aware that policy setting is not an exact science but instinctively believes that a simple and insistent presentation of his policies will achieve for him the best possible outcomes in some way or other. This might be through good participation among teachers, quantifiable improvements in test scores, an image of a government taking charge or, more negatively, the demotion of mathematics as a political issue in the public's eye.

Which account best describes the minister's perspective? Perhaps all of them do. It seems impossible to attain a "real" version of events governed by straightforward causal relationships. The options above merely provide alternative fantasies through which reality might be structured. To personify the implementation of policies with a clear association between one person's rational action and its effect risks oversimplifying the broader concern. The effects of policy implementation are probably too complex to be encapsulated instrumentally.

From a teacher's point of view one might contemplate reducing the emphasis on singular *metaphorical* associations between mathematical activities and mathematical concepts, in favour of a *metonymic* association between mathematical activity and social activity more generally. This entails linking the mathematical activities (seen as activities governed by certain procedures, rules, performance criteria, etc.) with other social discourses, including others specifically related to mathematics. The meaning of the mathematical discourses thus becomes a function of their relationship with the other discourses with which they are entwined, interpretive links that can always be revisited or renewed. This softens any assumption that the activities are anchored in specific mathematical concepts. Rather, we need to attend to the reification of such supposed concepts as they unfold in specific discursive environments. This would move us away from any supposed universal conceptions of what mathematics should be about; instead, it alerts us to the historical and social processes that generated classroom mathematics in the forms it now takes.

From a student's perspective, mathematics can often be presented as though it comprises singular answers to any given question, as if there is always a right and a wrong answer. This view of mathematics promotes a pedagogical attitude governed by the commodification of objects characterised by *this procedure getting that result*, verifiable rather than true. Yet it is possible to produce mathematics as a conceptually defined space in different ways. In some of my own teaching I designed some activities towards enabling the students to develop their spatial awareness as a prelude to a more formalised approach to geometry. They were invited to explore various body movement activities. In one such activity a student was asked to position herself between two fixed points on the ground that were about four metres apart such that she was positioned twice as far from one point as she was from the other. She was challenged to walk so that she was always twice as far from one point as she was from the other. A group of students observing this provided alternative interpretations of what was going on. A number of students produced drawings (Figure 11.2). Others provided algebra. Another reported on the emotional stress she experienced from being asked to do mathematics in this group situation.

The issues became more complicated as the problem shifted to remaining twice as far from one dot as from the other in three-dimensional space. The challenge provoked much gesturing alluding to points beyond immediate grasp. One student documented the different ways in which she saw her colleagues making sense of the problem:

> [P]eople do not visualise the same problem in the same way. When we were describing the same visualisation (e.g. the shape of the curve in 3D) each individual gave very different, but equally valid, explanations. For example, the explanations for seeing a circle in 3D were given as: a penny being spun around at the end of a piece of string; modelling the shape with your hands; imagining being the origin of the circle (therefore being inside the shape) and what it would look like looking in each direction; imagining the shape being built up from the established points which were on the ground.

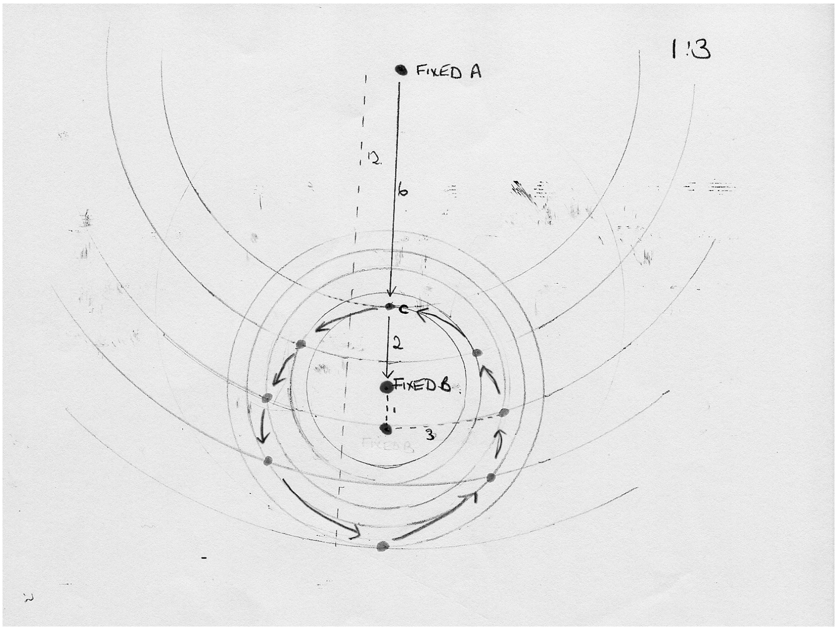

FIGURE 11.2 Circle.

Through such participation the activity became centred on documenting connections to alternative discursive formations of self: a physical self moving in space; a pedagogical self reflecting on the learning of others; a geometric self creating drawings; an algebraic self solving formulae; an emotional self on how it felt relating to other students. But in understanding oneself one is alerted to territory that one can grasp within the terminologies available and also spaces beyond reach that can only be pointed to or imagined from different perspectives. What had been movements of the body became materialisations of one's comprehension of reality itself. The experience of the configurations became linked to how one felt at the time, a narrative of participation formalised for posterity, for the time being.

THE INCOMPLETE PRODUCTION OF MATHEMATICAL REALITY THROUGH COMMODIFICATION

Can we then be more precise in depicting how mathematical concepts intervene in more ideological constructions of reality, where forms of

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practice motivate specific understandings of mathematical concepts? In a famous debate Richard Dawkins represented a rationalist camp that "raged against any kind of mystery in the cosmos, preferring instead to settle for a cold universe driven by the machine of pessimistic reason" (Žižek & Millbank, 2009, p. 6). He was countering Alister McGrath, a professor of theology, who had posited a religious thinker governed by faith. A second debate, however, between the theologian John Millbank and Žižek led to an assertion that faith and reason are not simply opposed to each other (ibid). They each argued in different ways that the work of Hegel undermined any dichotomy between the mythical and the rational. For Hegel, "the object [or concept] is always-already bound up in the complex mediating process of the subject's thinking it, and conversely, the subject's thinking the object is itself bound up in the object's very existence" (op cit., p. 14). "What we experience as reality is not the thing itself, it is always-already symbolised, constituted, structured by way of symbolic mechanisms" (Žižek, 2011, p. 240). Its very constitution is ideological. Žižek (2011, p. 144) identifies three positions in Hegel's formulation:

> In the first, reality is simply perceived as existing out there, and the task of philosophy is to analyze its basic structure. In the second, the philosopher investigates the subjective conditions of the possibility of objective reality … [we ask where are we coming from in seeing it that way]. In the third, subjectivity is re-inscribed into reality … [our ideological assumptions as to where we are coming from become part of reality].

He provides the example of art: "Reality is not just 'out there', reflected or imitated by art, it is something constructed, something contingent, historically conditioned" (op cit., p. 254). In postmodern art for example, "the transgressive excess loses its shock value and is fully integrated into the established art market" (op cit., p. 256). Similarly, mathematics describes realities that are consequential to past human endeavours or conceptualisations or commodifications.

Mathematics as a field is built in the human's own self-image through its expansion according to a social agenda. Humans, however, are a function of the worlds that they have produced. The mathematical concepts that they have constructed are then built *into* the human self-image. These self-producing and self-validating relationships trap us into thinking that there are universal realities as to what it is to be mathematical. As seen in the last section, mathematics can provide a structuring or formalisation of one's connections to the world. Commodified versions of mathematics have created

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the illusion that there is something more tangible in mathematical thought that assumes the quality of reality, supporting thoughts directed towards particular arrangements of the world. In Badiou's terms, by counting the elements of a commodity as one, the commodity is brought into existence in the world of school mathematics. This Badiouian approach is discussed in relation to mathematics education by Brown, Heywood, Solomon and Zagorianakos (2012). These constructions become the currency used to measure and classify mathematical thinking. The need for accountability in mathematical learning results in specific transformations of mathematical teaching and learning around commodified concepts.

How then do these concepts provoke our willingness to be governed by them? According to Žižek (1989, p. 43), Althusser "never succeeded in thinking out the link between *ideological state apparatus* and ideological interpellation":

> Althusser speaks only of the process of ideological interpellation through which the symbolic machine of ideology is 'internalised' into the ideological experience of Meaning and Truth. (Žižek, 1989, pp. 43–44)

In our case, the link would be between the assessment structures that govern our practice and our belief in those structures. Whilst we may criticise the structures in theory, our practice is largely compliant. As indicated, mathematics in universities and in schools interpellate individuals, but why? Althusser offers no explanation. Žižek contrasts Althusser with Lacan, who posits some subjective space that exceeds ideological interpellation. In a Lacanian framework, the subjective experience of mathematics can exceed these ideological parameters as a result of individuals *practically* participating in the rituals of schooling. In subjecting oneself to the ritual of institutionalised mathematics one is inadvertently materialising one's belief in it and this belief creates a successful link between *ideological state apparatus* and interpellation. Meanwhile, mathematical thought will always exceed its specific commodified manifestations such as the concepts that are constructed for school and elsewhere. After Kripke, Žižek posits a notion of a " 'rigid designator' – of a pure signifier that designates, and at the same time constitutes the identity of a given object beyond the variable cluster of its descriptive properties" (Žižek, 1989, pp. 43–44). The name "mathematics" locates something that is more than the sum of its descriptions, thwarting any consistent account of what mathematics "is". Rather, mathematics is only accessed indirectly through descriptions of the activities taking place in its name. And the sum of those activities is not the whole.

CONCLUDING COMMENTS

The production of mathematical concepts may be helpfully understood mathematics coming into being, or participating in the becoming of mathematics, making it come into being. The learner may experience mathematics as part of herself, a self that is also evolving in the process. Mathematical concepts and the ways in which we relate to them would never finally settle in relation to each other. Their final form always stays out of reach. The building of mathematics then reflects the image we have of ourselves and becomes part of those selves that it reflects. Yet, we may not experience our immersion in mathematical changes in this way. We understand ourselves as operating in a rather more restrictive space decided upon by legislation, by teachers or by expectations beyond our active control. If the world is built in our own image, our children may encounter that world as an external demand out of line with their own perceived needs. Following Hegel, Malabou (2011, p. 24) suggests that the individual "does not recognise itself in the community that it is nevertheless supposed to have wanted …. The individual is 'alienated from itself'". The "self is already implicated in a social temporality that exceeds its own capacities for narration" (op cit., p. 28). These fractures in our self-image can result in adjustments to our tangible reality and to how we encounter it. Mathematics is a function of how we organise its supposed content (concepts, patterns, formulae, procedures) at any point in time. Yet it is also a function of the narratives that report on how we experience it through time, and of the hermeneutic working through of those narratives that generate new dimensions of mathematics (Doxiadis & Mazur, 2012). These narratives may be productive, misguided, manipulative, or functions of particular administrative or ideological perspectives (Lundin, 2012). For example, ideal accounts of mathematics can readily become policing structures in the service of compliant behaviour transforming how subsequent students experience mathematics. Curriculum innovation and associated testing can activate new, perhaps unexpected, modes of mathematical engagement or educative encounters across a community. People or communities more or less identify with these new conceptions of mathematics and shape their practices accordingly. School mathematics does not generally reach for the stars, and often prefers to make do with some rather rusty scaffolding in the name of corrosive metrics. There is a recurrent sense that there should have been more to it than has been allowed. Whilst the Truth of mathematics can sometimes be used to underwrite its ideologically motivated manifestations, we need to trouble the "truths" that are presented to us, towards encountering the spaces beyond and the hold they have on us.

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