

WRITING THE THESIS IN MATHEMATICS EDUCATION

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In this paper, I share some reflections on the recent experience of writing a doctoral thesis. Readers who anticipate the task with as much apprehension as I did, may find encouragement, and even some assistance, in my account. At the same time, it is evident that their experience may not be the same as mine.

INTRODUCTION

Sooner or later, every student pursuing a higher degree by research must confront the prospect of having to produce a thesis of some 80 000 words or more. The purpose and audience for a thesis is different from that for a book, but the size of the product is much the same. In this respect, mathematics education has more in common with social science than with mathematics - the author of a thesis has to be a determined and competent writer of prose English. Indeed, the elegance of the prose style of certain writers in the field of mathematics education is an inspiration in itself. Whilst most researchers in our discipline are content to report their findings with clarity and good form, it is evident that others set out to meet the same demands of scholarship within a work of some literary merit. Whilst I toiled in the foothills of research for a higher degree, I anticipated the distant intention of actually writing a thesis with a mixture of dread and disbelief. It was this awesome combination - the sheer scale of the task, and desire for an outcome that might give me some lasting sense of satisfaction - which made the undertaking appear so daunting in prospect.

I neither wish nor intend to say anything, in this paper, about approaching and structuring a thesis as a research report. Every research student would expect and almost certainly get guidance on such matters from their department or supervisor. My aim is to consider what they may not tell you about - the physical and emotional aspects of assembling a thesis, and how the actual act of writing it may affect and change you. Whilst doing so last year, I found that I was very aware of how I had organised the project, of my patterns of working, of my progress towards the goal of completion. I claim no generality whatsoever for the account which follows, but invite

others to look for similarities or contrasts with their own experience. I am conscious that many co-workers will not identify with my way of working; this was brought home to me at a recent seminar at which other higher degree students talked about their routines and habits for writing. It is tempting to draw on their accounts to give greater breadth to this paper, but in the end I have chosen to risk a personal narrative which may be singular and possibly controversial. For a more balanced overview, see Phillips and Pugh (1987, pp. 58-62).

LITTLE ACORNS

It is generally regarded as good advice to tackle a thesis as though it were a large number of small tasks rather than one huge one; to make your target the next staging post rather than the end of the journey. In fact, I had been engaged in this process throughout most of my period of registration for a higher degree in mathematics education. Almost from the beginning, I was encouraged to talk and write about what I was doing. My first attempts at doing so were excruciating experiences for me, like walking on thin ice. What I had done, what I had to offer, seemed so tenuous, so insubstantial. For me, the only way to ward off total collapse was to hold a script in my hand. I had written for publication before, but nearly always self-contained articles which marked the conclusion of a few months' work. I had enjoyed the sense of completion on seeing something 'written up', but rarely sustained anything beyond a short burst of energy and enthusiasm. In part, it was the feeling that I would like to do so that motivated my registration for a research degree. I realise that, for others, the necessity of somewhat blinkered, sustained involvement with a single theme for a significant slice of one's life may be a sufficient deterrent against beginning. Whilst I still made time for brief detours into other professional study and writing, it was a novelty for me to develop a coherent line of work and written output, to know and to show that one strand of my thinking was building up in a direct and observable way.

As I began to contemplate writing the thesis I could speculate where much of my previous writing for talks and publications might belong in a framework of chapters eight, in my case. In the event, four of my chapters contained elaborated versions of

earlier pieces of writing. I had anticipated one problem (but not how severe it would be) to do with re-working earlier material in this way; as your understanding of your topic matures and grows, so does your dissatisfaction with much - not all - of what you had earlier set in tablets of stone. A computer file that, at one time, looked like most of a ready-made chapter, can become a vehicle for seemingly never-ending selfcriticism and revision. At one stage in writing up my thesis, I encountered a schizophrenic situation; as I was completing one chapter - my 'improvement' of an article that I had submitted to a journal a year earlier - the proofs for the original article arrived in the post. As I read it, I knew that it was not the same as the article that I would want to submit now - although that did not invalidate the original. On balance, however, there was something entirely positive about being able to start at least *some* chapters with a few thousand words to criticise and work on, rather than an empty space. I realise that others have a real aversion to returning to 'old' material.

ENERGY AND STAMINA

The bulk of my writing-up took place between April and August 1995. Anticipating readiness for a period of intensive writing, I had applied a year earlier for study leave in the summer of 1995. I was successful, subject to ongoing College duties amounting to just a few hours a week, on average. I fully realise that few part-time research students are able to entertain such an opportunity. Conversely, full-time research students may be able to allow themselves longer than five months. As my leave approached, I devised a plan of campaign. The final structure of the thesis was agreed with my supervisors, but my time schedule was entirely self-imposed. Essentially, I had to aim to write 5000 words a week, for 20 weeks; that should result in the completion of the first draft by the end of my study leave. I reckoned I would be able to cope with subsequent revisions in the Autumn, on the usual evenings and weekends basis. I knew that I was capable of writing a thousand words on a good day, but fewer on average. By working five or six days a week, and re-working some of my earlier writing, I judged that my schedule was achievable. I treated it very much like an office job - starting just before 9 am and finishing at 6 pm, with breaks for coffee and lunch. It was the only way I could keep my nerve. At times, of course, I was

way behind schedule (my worst full working day resulted in 50 words!) and wanted to continue working into the evening and the night. One friend told me that she compiled her thesis by writing between 10 pm and 5 am every day. I rapidly discovered that this is not for me; when I did work late, I was exhausted the next day and achieved very little. It seemed to me that there is a clear dimension here to do with physical stamina and fitness. My usual day-to-day work routine is less intensive in terms of writing, more varied and broken up by conversations, interruptions, administrative tasks and so on. During my leave, I entertained very few 'displacement' activities, simply because of a burning ambition to get the first draft finished. I honestly had no confidence that I would reach that goal until I had nearly finished the last chapter. Such hopeless pessimism seems almost incredible, but arises from a renewed sense of self-doubt and disbelief as one labours over the first few pages of each new chapter.

For the first two or three weeks of almost non-stop writing I felt quite drained at the end of each day, like an out-of-condition athlete at the end of a training session. After a month or so, I became aware that I had acquired fitness for writing, and now had some energy left (for other things) at the end of the day. It seemed strange that nobody had told me that this might happen, although I had sought advice in advance from a number of experienced academic writers.

ON WRITING

The process of writing created the conditions under which I could think most lucidly and most freely. A conventional perception is that one 'has' the idea before committing it to 'paper'. This has often been the case; the ideas 'come' as I travel alone in the car, or when I lie awake at night. But the very act of writing seems to channel the energy, to focus the concentration. Thus, a great deal of synthetic sensemaking occurs whilst one is actually sitting to write. The word-processor allows the notion that these ideas are provisional, that the commitment (to RAM and disc) is not irrevocable. Indeed, that the products of one's sense-making are modifiable *con jectu res*.

Others have commented on their awareness of the interaction between thought and writing. Describing his earliest experiences as a researcher, Jean Piaget wrote:

But for lack of a laboratory and guidance [...] the only thing I could do was to theorize and write. I wrote even if it was only for myself, for I could not think without writing - but it had to be in a systematic fashion as if it were to be an article for publication. (1952, p. 241)

The "as if it were" is something of a luxury in the 1990s. Nevertheless, I found the incentive to publish parts of my research in advance of the assembly of the thesis entirely beneficial in a formative sense. As Dave Hewitt so succinctly puts it,

I write in order to learn. (1988, p. 61)

Reflecting in her doctoral thesis on 'the researcher as writer', Rita Nolder wrote:

Writing went hand-in-hand with analysis - my own perception is that the physical act of writing [...] actually stimulates the process of analysis. (1992, p. 136)

It is clear that the act of 'writing up' a thesis, or 'writing down' ideas, is not purely a communicative act, for the benefit of some supposed audience. It may also be a creative act, for the enlightenment of the writer. A strange phenomenon which commonly results from intense writing is heightened sensitivity to the issue under consideration. At times, it seemed that whatever I read in books and newspapers, things that I heard on the radio, things that people said - almost everything seemed to confirm, to illuminate, to link in with the matter that I was working on. On the whole, this is a good thing, but not necessarily so. It can be overwhelming, and confuse the task of selecting and editing. It is, I suppose, a kind of 'high', with the dual possibilities of fresh insight and poor judgement. Who shall discern the difference?

At times, the process of selection seems to highlight that of omission. But it is not always possible to make the choice in advance of writing. What I discovered, or re-discovered, is the function of writing as a filter, assisting the process of omission by clarifying the benefits of retention. Sometimes I wrote all day, suspecting but not yet knowing that very little that I was producing would survive the tests of quality and

relevance, to make it to the final document. But I could not make that decision until it had been written. This was particularly and painfully true of my third chapter, the final version of which has little in common with the first draft. My thesis examines the use of vague language in mathematical conversation. In preparing Chapter 3, I became preoccupied with some philosophical aspects of vagueness. This was all very fascinating, but it really had no place in the thesis. At one point, sensing my dismay at the prospect of 'wasted' effort, one of my supervisors reassured me that it's quite in order to know some things that aren't in your thesis!

Writing performed for me another, therapeutic function. For many years I was reluctant to register for a higher degree, because I doubted my ability to complete it. One result of this, after I'd begun, was a sense of frustration that I might have done so earlier. The 'right' time is relative to one's circumstances. In any case, all kinds of life experiences are potentially of value for research. In the time between first considering that I might submit myself to the discipline of being a 'research student' and eventually grasping the nettle, my head became filled to capacity with the debris of things that might have been part of a thesis - not the one I eventually wrote, but a thesis from a different time. One of the functions of writing was to purge myself of many ideas left over from all the unwritten theses; wondering whether I might find a place for some of these ideas; to see them written down, and then to let most of them go.

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