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Turbulent flow into smooth streams: transferring research knowledge between academic environments and practitioner contexts.

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ABSTRACT

The use of research knowledge in schools and colleges remains limited (e.g. Hargreaves: 1998; 1999). Efforts to transfer research outcomes between academic environments and practitioner contexts have not always been successful (e.g. McIntyre, 1998; Ebbutt, 2001; Cordingley, 2000; Wilson, 2004). This paper considers the use of research knowledge in one secondary school, where it has been successfully applied to address a number of distinct issues. The particular areas of application have been: effective approaches to assessment, improved strategies for revision classes, informed responses to school transfer (from Primary to Secondary), computers as tools for learning, and effective implementation of staff development. These five examples appear to have some common characteristics: (i) each was initiated by a 'professional provocation', (ii) each occupies a domain where there is a significant knowledge base, (iii) each of these bodies of knowledge is readily susceptible to 'practical tweaking', and (iv) in each case there are real gains in workload and impact. Acknowledging the increasing use of 'chaos theory' to provide insights into educational management (e.g. Gunter, 1995; Mansfield, 2003; Fullan, 2001), a classic chaotic system – "turbulent water flow" – is used to provide a framework for these four characteristics, and is extended to provide further observations on the context in which the transfer of research knowledge has been successful.

EXPLAINING THE BACKGROUND TO THE PAPER

During the summer of 2005, I was invited by the University of Birmingham to prepare a short contribution for discussion at a seminar considering issues surrounding the transfer of research knowledge into schools and colleges. The seminar was hosted by the UK's Teaching and Learning Research Programme (TLRP) and was one of a series motivated by the ambition to see greater impact for research outcomes. Whilst the TLRP was clear about the desirability of research informing policy and practice, the participants were similarly clear that the mechanisms that achieve this are not necessarily direct and uncomplicated.

My own contribution was to be based on my job as Director of Research and Development – part of my Deputy Headteacher job description – within a thriving English secondary school. It is a school where, under the leadership of the Headteacher and with the benefit of Leading Edge funding, practitioner research and applications of academic research findings have both found an increasing role.

I was asked to consider the following questions in my contribution:

- What research-based knowledge do you use?
- How do you use it?

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- Why do you use it?

I had no difficulty in immediately identifying five substantial examples of research knowledge being used within our school: effective approaches to assessment, improved strategies for revision classes, informed responses to school transfer (from Primary to Secondary), computers as tools for learning, and effective implementation of staff development.

In this paper, I outline the details of these five examples of research knowledge in use within our school. The paper also includes reflections on the common characteristics of these examples, and explores a framework for these features derived from turbulent water flow. This framework is then cross-referenced to each of the examples, and additional comments are made on the context in which these examples have been successful. Some suggestions are made regarding possible implications for the transfer of research knowledge.

DESCRIBING THE FIVE EXAMPLE AREAS OF RESEARCH-KNOWLEDGE TRANSFER

When first asked to consider: "What research-based knowledge do you use?", it was very easy to identify five distinct areas of development within our school where research knowledge was being either directly or indirectly applied with practical consequences. These five examples are outlined here, with a preliminary indication of how the research knowledge was used. Later in this paper, each example is considered more fully with direct reference to the common characteristics that are identified in the 'hydrodynamic framework'.

1. Effective approaches to assessment: our work in this area has concerned practical initiatives in formative assessment, or 'assessment for learning' (Black and Wiliam, 1998). This has included the alteration of marking procedures, the increased use of peer and self-assessment, an associated change in task structure and format, and the incorporation of various techniques (e-marking, shared drafts, online coaching et c.) that have become possible with new technology. Although these various responses have not been uniform within the school, they have been adopted under the umbrella of a re-written school assessment policy, and an occasional research-based school 'assessment bulletin'.

2. Improved strategies for revision classes: working out how to maximise the retention of pupil learning is a challenge in itself. It becomes yet more complex when we acknowledge the number of pupils in each class, the variations in their prior learning, and the prescribed format for demonstrating competence in examinations (Bransford, Franks, Vye and Sherwood, 1989). Over the last four years, various colleagues have focussed on this challenge with particular reference to practical approaches for pre-examination revision classes.

3. Informed responses to school transfer (from Primary to Secondary): pupils entering our school come from as many as fifty different feeder schools in any one year. There are

significant variations in their experiences of Primary education. Even where the various national initiatives (such as the 'Numeracy Strategy') have made provision more uniform, the variations in pupils' actual learning appear to be substantial (Johnson and Millett, 1996; OFSTED, 1999). Moreover, the individual backgrounds of children leads them to have quite diverse expectations of secondary school (Galton, Gray and Rudduck, 1999). Over five years we have introduced revised approaches to teaching in Year 7, which take account of variations in prior learning. We have also examined pupils' views before, and experiences after, arrival at our school to inform our approaches to managing the transfer process.

4. Computers as tools for learning: computer education has always incorporated three elements – learning *about* computers, learning *to use* computers, and learning *from* computers (Jonassen, 1996). Over the past ten years, our school's intention to educate pupils about the physical components of computers has receded. In parallel, pupil proficiency in using computers has increased; and the inadequacy of much educational software has become apparent, as anticipated by Salomon (1985). In our school, we have elected to offer formal Information Technology tuition only in Year 7; and all other use of computing facilities occurs within other curriculum subjects. Our declared aim has been to find and adopt, or adapt, classroom approaches that utilise the unique 'affordances' of new technologies (Harlen and Deakin-Crick, 2003) to develop an effective e-pedagogy.

5. Effective implementation of staff development: professional development for teachers can be provided in many formats, with consent or coercion, with a narrow focus or broad scope, and may be implemented in equally many ways (Cordingley, Bell, Rundell and Evans, 2003). Within our school, we have sought to refine our approaches to staff development – with an eye on economic efficiency, but also with a very strong emphasis on professional efficacy in the classroom.

LOOKING FOR WAYS TO EXPLAIN THE SUCCESS OF THESE EXAMPLES

Having identified these five example areas, a series of questions naturally followed. Why had the transfer of research knowledge in these examples been so apparently successful? Why had other areas of research not had the same impact? What were the pre-conditions for research knowledge to be transferred to practitioner contexts? Although each of these questions could be potentially helpful, it is also apparent that the questions themselves carry implicit assumptions. To ask about pre-conditions is to imply a relatively uncomplicated model of causality: 'if only every school did *X*, and every piece of research had *Y*, then it would be *transferred* – hey presto!' It is clearly necessary to adopt an assumption that research knowledge transfer is considerably more complex than this. It is also true that any inferences from these examples would have to take into account the limitations of using only five instances in one case study school – any generalisations may themselves struggle on transfer to a new context.

It seemed inappropriate to adopt a rigid analytical framework in search of formulae, or recipes, for predictable research knowledge transfer. Nonetheless, research knowledge had

been transferred, and this wasn't happening in many other cases. The success of the transfer seemed to be dependent on aspects of the research, and aspects of the school environment; and this dependence seemed to be very sensitive to initial conditions. Small deviations into other areas of research, or slight changes in the school context, could readily inhibit or limit the research knowledge transfer. Systems exhibiting non-linear behaviour of this kind are often described in the physical sciences as 'chaotic', or when applied to natural or social systems as exhibiting 'complexity' (e.g. Bertuglia and Vaio, 2005). Although simple rules may govern such systems, the interactions between those rules when scaled across a social context such as a school give rise to unpredictable outcomes. The systems are simultaneously deterministic and unpredictable: fluid within a set of equations.

Fullan (2001), along with other authors who have examined the nature of educational leadership (see also Gunter, 1995; Mansfield, 2003), appealed to features of complexity science as the most appropriate vehicle for illuminating the dynamics of change in organisational cultures. In order to understand the cases he examined, he deployed the language of 'strange attractors' (Fullan, 2001, p. 114) – relatively stable regions within a fluid system that exert a 'pull' on the surrounding field.

The appropriate analytical tool for the five examples presented here seemed to require a similar 'fluid framework'. This would serve, by analogy with other chaotic systems, to help:

- the identification of common characteristics across the five examples; and
- an examination of how these areas of research knowledge came to have leverage, where others did not.

Chaotic systems are characterised by tipping points (or 'bifurcations'), where the possible outcomes may diverge very rapidly despite very similar starting points. Consider, for example, the vastly differing paths taken by two 'Pooh sticks' dropped side by side in a slow moving stream. Are there comparable 'tipping points' in the five examples of research knowledge transfer?

Chaotic systems – despite being governed by deterministic rules – are also characteristically susceptible to small external interventions. Consider, for example, the intriguing complexity within a column of cigarette smoke as it billows just a few centimetres above the lit end; and how easily the entire pattern is disturbed by the tiniest of drafts. Is such susceptibility a discernible feature of research knowledge transfer in these five examples?

ADOPTING A FLUID FRAMEWORK

Having decided to examine the five examples by analogy with a non-linear structure, I chose to consider similarities between the common features of our five examples and a suitable (i.e. typical or generic) chaotic system: turbulent water flow. This decision is consistent with observations that are made about the fluid and intuitive characteristics of 'mastery' amongst professional teachers (Genberg, 1992).

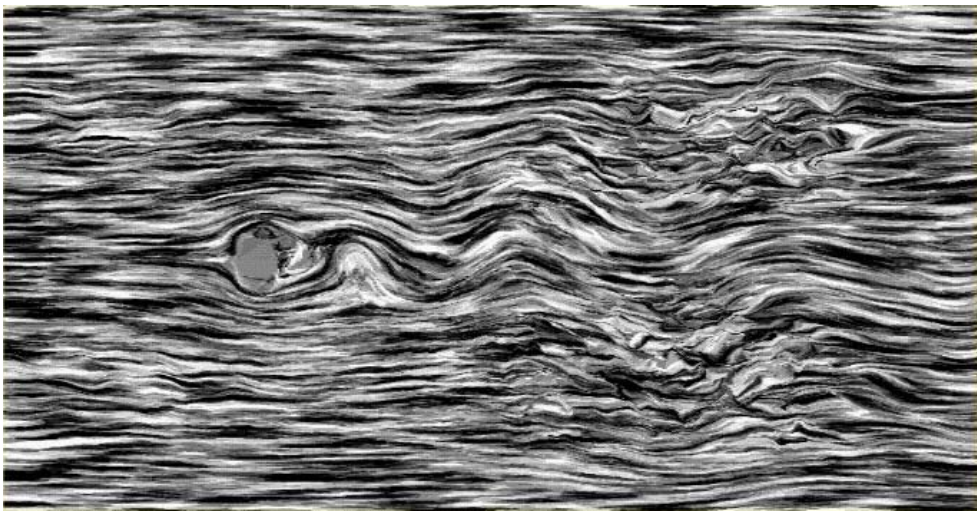

Figure 1: transition from laminar to turbulent flow. Image generated by W. de Leeuw, Centrum voor Wiskunde en Informatica, Netherlands (de Leeuw and van Liere, undated) – used with permission.

Figure 1 illustrates how uniform flow may be disrupted by an obstruction, which in turn generates turbulence. The resolution of that turbulence depends on the depth of the channel – 'still waters run deep'. In time the flow continues purposefully with a new pace.

DEVELOPING THE FLUID FRAMEWORK AS AN ANALOGY

In order to apply the analogy to the five examples, I developed a correspondence between features of the hydrodynamic flow and characteristics of the areas of research knowledge transfer. (The *bold italicised* phrases are those used later when applying the framework to the examples.)

The 'stone in the stream' represents the *tipping point* in the system, some small external influence that disrupts the otherwise uninterrupted flow of the professional teacher. Such perturbations occur, of course, with great frequency in the daily lives of teachers! However in the five successful examples of research knowledge transfer, the teachers appear to have countenanced the subsequent turbulence, as a pronounced 'professional provocation' caused them to disturb their normal flow. In each case the 'stone in the stream' was a small insight or observation about professional practice that carried profound implications.

The five examples are also characterised by '*channel depth*' – a feature that ensured that it was possible to be confident that the permitted turbulence would indeed be resolved. In each case there was a readily available, authoritative and substantial, body of research knowledge with easily accessible outcomes. Although in not one of the five examples did any teacher read more than the very smallest selection of the research papers available, the weight of their existence gave us the necessary confidence to permit changes to our established practices. Our understanding of the relevant bodies of research knowledge was

(and probably is) incomplete, simplistic, lacking in the subtleties of the original authors, and possibly even contrary to their intentions. This does not seem to have influenced our capacity to allow the research knowledge to generate impact.

In a previous paper (Bevan, 2004), I have put forward the view that the use of research knowledge by teachers varies over the course of their professional careers; but that it is always characterised by 'tweaking' research findings i.e. the small-scale modification and adaptation of published outcomes as they interplay with professional circumstances and identity. It is the fluidity of the analogy from hydrodynamics that illuminates this issue. The research knowledge, in each of the five examples, was readily *susceptible to 'filtering, fragmenting, or fiddling'*. As such, our model of knowledge transfer needs to emphasise the fluid property of the process: 'water not tarmac'.

The final aspect of the turbulent water flow that helps to understand our five examples is the sense of direction and purposeful motion. Each of the five examples exhibited, for our teachers, *real gains in workload and impact* – improved efficiency and efficacy. As such they feature a 'carrot and carrot' quality, rather than 'carrot and stick'. The application of the research did not demand greater effort, but redirected effort. The five examples illustrate that for the same level of effort, a genuine professional gain was secured.

It is worth emphasising that while these four features are illustrated here by use of the hydrodynamic analogy, they could equally have been identified as equivalent to those elements identified in other ways by researchers examining the nature of sustainable change in organisations. For example, Pascale, Milleman, and Gioja (2000) have described a necessary 'trinity' for the sustainability of any change. Their account demands an integrity and depth that informs any change (*channel depth*), a consistency with existing good practices that permits self-regulated change (*susceptible to "filtering, fragmenting, or fiddling*), and an 'economic viability' (*real gains in workload and impact*). "… If any of these three are weak or missing, the theory of sustainability says that the practice [what the organisation is doing] will not prove sustainable over time …" (p. 92).

These are, in summary, the four elements of flow that are to be used in our analogy:

- turbulence caused by the 'stone in the stream';
- resolved, in turn, through channel depth;
- the fluidity of the system: 'water not tarmac'; and
- the purposeful direction: 'it goes somewhere'.

CONSIDERING THE FIVE EXAMPLES IN THE FLUID FRAMEWORK

Having developed these four features of the analogy, I am able to illustrate how they apply across each of the five examples. In each, I describe a *tipping point* that initiated the research knowledge transfer. Reference is made to the *channel depth* – the extensive body of relevant research knowledge. There is some discussion of how this research knowledge is in each instance *susceptible to "filtering, fragmenting, or fiddling"* – not offering

prescriptive methods or fixed approaches. Finally, I review the *real gains in workload and impact* that arise from applying the transferred knowledge.

Effective approaches to assessment

tipping point: In 2000, I came across a Teacher Training Agency published summary of the practitioner research undertaken by Ronayne (1999). His work was centred around the usefulness of teachers' marking; and to that end he had devised a number of research methods that allowed him to interrogate this issue at a local level. In particular, one of his findings prompted a very clear question: "Thirty minutes after receiving marked work back from the teacher, what proportion of comments written in their books are pupils able to accurately recall?" As with many good research questions, the actual answer is relatively unimportant, as is the fact that the proportion would vary with pupils, topics and teachers. (Ronayne's figure is less than 50%.) The immediate corollaries of this question are powerful provocations:

- How much time is wasted marking?
- Why bother writing comments that pupils ignore?
- How can assessment be more effective?
- How can marking be more efficient?
- How do pupils learn best from their errors?
- What forms of advice are best for long-term retention of learning?

Our experience was that presenting the modified form of Ronayne's research question, in a staff 'assessment bulletin', acted as a powerful agent for change. The follow-on questions then arose logically, in discussion, or through professional reflection; and provided the turbulence that preceded change in school policy and individual practice.

channel depth: The unsettling nature of this 'tipping point' would probably have been disregarded, had there not been a significant basis for our subsequent action. Many colleagues were slowly becoming aware of the existence of an authoritative literature on 'assessment for learning', much of which had sought to synthesise findings from other places (see, for example: Black, Harrison, Lee, Marshall, and Wiliam, 2003; Black and Wiliam, 1998a; Black and Wiliam, 1998b). Various extracts of these documents were used in staff training, or were incorporated into the school 'assessment bulletin'; but this was rarely more than a single page. Teachers gradually incorporated more formative approaches. Some deployed peer-assessment activities, others focussed on pupils designing (rather than just answering) questions, and others concentrated on developing and using mark schemes. The practical activities had the characteristic hallmarks of 'assessment for learning' strategies (ARG, 2002).

susceptible to 'filtering, fragmenting, or fiddling': As our school's policy on assessment was adapted in light of the research evidence, it was clear that the new approach allowed teachers to modify their practice progressively and selectively. Some were reluctant to accommodate self-assessment, but were very comfortable with peer-marking as a 'moderation' exercise. Here was an area for professional development that could be progressed at different paces, with varying measures, and adapted to context.

real gains in workload and impact: As the research literature suggests (Black and Wiliam, 1998a), adopting formative assessment strategies generates gains in pupil performance, fosters an associated increase in pupil motivation, and does not increase the overall burden of teacher workload. Our teachers were predisposed to adopt such approaches knowing there was a workload gain and a pedagogic gain.

Improved strategies for revision classes

tipping point: During 2002, Stephen Ham (Head of Science) gave a presentation to the whole teaching staff, based on his small-scale study into the effectiveness of his revision lessons at Advanced Level. As with the previous example, the 'tipping point' was not achieved by examining his statistical report on the findings from the two groups he worked with. Instead the professional provocation came earlier in his presentation. An opening remark, by way of parody, seemed to resonate with colleagues and generated the turbulence that led to modified practice. Stephen described a typical pre-examination revision lesson along the following lines: 'You (as teacher) decide what they (the pupils) don't know, tell them what they don't know, demonstrate that you know what they don't know, and then discover that they still don't know what you told them they didn't know!'.

Once again, this stimulus is not sufficient in itself to generate the turbulence; but the parody carries with it implicit questions about the assessment of prior learning, about pupils identifying their own learning needs, and about the importance of active (rather than passive) approaches to learning.

channel depth: It was, once again, possible in considering this area of professional practice to draw on a substantial body of research evidence that had already been accumulated. The National Academy's report on 'How People Learn' (Bransford, Brown and Cocking, 1999) became a frequent source for a small number of colleagues, whilst others relied on less substantial texts. There was no codified attempt to distil the content of these publications into precise policy formulations, but certain central ideas became clear to teachers who were adapting their approaches to revision. It is not readily apparent that any of these ideas can be fully substantiated from the supporting research citation; but nonetheless, it seemed that 'learning for retention' would be enhanced by:

- more visual and participatory activities, rather than verbal and passive exchanges;
- requirements to adapt information provided in one form into a different form (e.g. from newspaper article to tables/graphs);
- increasing the opportunities for pupils to articulate their own learning – to each other, or to the teacher; and
- adopting strategies that increased emotional involvement with the learning (e.g. using competitive team approaches, or raising empathy through role play).

susceptible to 'filtering, fragmenting, or fiddling': Teachers were able to adapt their classroom approaches in light of these observations, without specific prescription, without risk of high-level failure (the existing approach to revision lessons was barely beneficial), and by selective implementation. Colleagues were able to filter out some of the

recommended activities, could put in place partial or mutant versions of other activities, and then could refine their approaches according to experience.

real gains in workload and impact: In this instance the immediate gain was professional efficacy, leading in turn to a reduced workload. Planning for a good revision lesson requires more preparatory thought and time, than maintaining the existing model. Such an investment in time 'up front', yields the benefits later as the need to engage in subsequent repeat sessions declines. Our experience suggests that with appropriately designed activities for revision, both the need for 'after-event' marking declines and also the pupils become progressively more independent in their own learning.

Informed responses to school transfer (from Primary to Secondary)

tipping point: My own Best Practice Research Scholarship-funded practitioner research in 1999 and 2000 (Bevan, 2002) had focussed on curriculum discontinuity in Mathematics on school transfer. In particular, I had used pupils' diagnostic pre-tests and teachers' lesson diaries to highlight that up to 40% of teaching time in Year 7, in our school, was spent working on topics pupils already knew.

This work was presented within the school's own development programme, and at staff training sessions organised with a cluster of local schools. Several colleagues were prompted to undertake similar explorations in their own subject areas; examining both the level of pupil understanding on certain topics, and also their perceptions of that subject before and after transfer from Primary school.

The suggestion emerging from my own small-scale research, coupled with the 'follow up' studies in other areas, accumulated to form a 'tipping point' in our consideration of transfer issues.

channel depth: Here also, there was a substantial and accessible body of research literature. In the two previous examples, syntheses of the research evidence were readily available. In this instance, the same ease of access to the literature was achieved as the research was dominated by a small number of researchers who had sustained their investigations over a long period (e.g. Galton et al., 1999; Rudduck, 1996), with practical reports from real classroom contexts (e.g. Suffolk LEA, 1997).

The 'channel' was deep enough to ensure the smooth running of our enquiries, into an area where our experience and enquiry had stimulated much turbulence.

susceptible to 'filtering, fragmenting, or fiddling': In the previous two examples, the practical implementation of the response to the research-knowledge was closely shaped by the recommendations of that research. In this example the recommendations in the published material were considerably more tentative, although they echoed – on a more significant scale – our concerns about continuity and progression.

It was possible, however, to take insights from the published research, and adapt these for our own investigations. Teachers have been able to trial their approaches to teaching in Year 7, by using pre-tests, and adapting their schemes of work in accordance with the outcomes. Some increased differentiation in classroom activities, according to prior learning, has also been developed. These changes have been gradual, even piecemeal, but clearly illustrate the importance of 'filtering, fragmenting and fiddling' with the research knowledge.

real gains in workload and impact: As with some of the other examples, our responses to issues following school transfer, have demanded an increase in both time and thought in lesson preparation. Some lesson time has also be 'lost' in assessing prior learning; but the gains emerged from a deeper insight into pupils' current knowledge, from a more motivated class of pupils, and from the substantial time-saving that arose from not dwelling excessively on material that was already well known by the pupils.

Computers as tools for learning

tipping point: The 'tipping point' for our work with computers as tools for learning, arose as a communal observation that can be aptly summarised by the phrase 'Power Pointless'! We had overcome the initial resistance, and technical anxieties, that had prevented many teachers from using computer technology in their lessons. Now that every teacher in the school was utilising information technology with pupils in the classroom, we looked at what was happening in those lessons. Many were very successful, but a significant number consisted of pupils producing 'presentations' or 'documents' with very limited content (less than could easily have been written by hand) and a disproportionate emphasis on clip-art, transition features, animated images and extensive web searches to find these gimmicks.

One particular instance involved a Science lesson on the function of the heart, where pupils (having produced quite striking animated web pages) were unable to cite anything new they had learned as a result of their extensive busy-ness. It is this sense of misuse of computers that has led Tufte (2003) to makes an even stronger claim that 'PowerPoint is evil'.

This cumulative concern signalled the need to begin modifying our approach to the use of computers in the classroom – specifically to focus on computers as mindtools, i.e. as tools for learning (Jonassen, 1996).

channel depth: Perhaps because so much computer-room time is taken with teaching 'ICT' as a discrete subject, there seems to be only a limited amount of material readily available that addresses the practical implications of using computers as learning tools across all subjects. However, Hyerle (2000), Jonassen (1996), Jonassen, Peck, and Wilson (1999), and Ruthven and Hennessy (2002) have all provided direct stimulus to several colleagues at our school. Their analyses of the issues echoed our own, and they offered practical insights into how different software tools could be used to promote effective learning. As such e-pedagogies develop, the extent of any measurable impact remains unclear. We have however been able to adopt strategies such as: WebQuests, annotated visual poetry, science

practical simulations, e-marking, collaborative concept-mapping, shared and co-edited draft essays, and on-line essay coaching.

susceptible to 'filtering, fragmenting, or fiddling': As is apparent from the list of practical approaches adopted by different teachers, this example again illustrates an area where academic research knowledge has been transferred into a school with teachers engaged in selective acceptance of the ideas, stepwise integration of new elements of practice, and modification of the ideas in light of classroom experiences.

real gains in workload and impact: This entire area of our school's development was, and still is, predominantly motivated by the desire to secure more effective approaches to teaching and learning – embracing, as appropriate, the affordances of new technology (Harlen and Deakin-Crick, 2003). By taking the best ideas from research knowledge, and adapting them to local context, we have been able to work directly towards more productive classrooms with the consequential workload benefits.

Effective implementation of staff development

tipping point: In discussion with colleagues during 1997, I proposed as a thought-experiment the 'W-test' as a mechanism for the evaluation of staff professional development. 'W' was a highly competent teaching colleague, with many years of experience, a good analytical mind, and a naturally conservative disposition. The nature of the 'W-test' was simply this: 'Would W do anything different as a result of today's staff development, than he would have done anyway?'. I was convinced that the answer was almost always 'No', and indeed that most colleagues who did modify their practice would have done so irrespective of the staff development provided.

Motivated by thoughts of the 'W-test', and having been promoted to be responsible for staff development in a different school, I collected teachers 'best and worst' experiences of INSET. The stories were frequently humorous, and when shared amongst the teaching staff there was much recognition of the tales that were related, in particular of the worst experiences. The humour was balanced, however, by a profound disquiet as we recognised the hundreds of teacher-days lost to this fruitless round of ineffective and highly expensive day courses.

This was the very clear 'tipping point' that initiated a significantly modified approach to staff development within our school: a change that probably could not have been accomplished with any less a sense of shared turbulence.

channel depth: Effective approaches to staff development have been researched and reported on widely (e.g. Guskey and Sparks, 1996; Guskey, 1999; Killion, 2001). Again, in this area the detailed outcomes of the research findings were of only limited importance in planning our revised approaches to teachers' professional development. The 'channel depth' offered by academic commentators in this area served to reinforce our resolve to act, as they coincided with our critique of the ineffective nature of much INSET provision. The

academic literature also hinted at the characteristics that we might need to incorporate into a more effective programme.

Evidence from the research knowledge seemed to suggest that professional development would be improved if:

- the focus of the INSET was identified/chosen by the participant teachers, and concerned their core function as teachers;
- the focus of the INSET was sustained over a period of several months;
- colleagues were expected to discuss progress in their development with their fellow practitioners;
- colleagues were expected to 'report back' to groups of practitioners on the impact of their development;
- teachers were granted a level of professional autonomy, that recognised their professional expertise, but acknowledged the need for improvement;
- external sources of advice and support were made available through access to literature, libraries, and Higher Education staff as mentors.

All these features were progressively introduced into a framework of professional development, which could be seen to withstand the 'W-test'.

susceptible to 'filtering, fragmenting, or fiddling': As the list of desirable features suggests, here once more, it was possible to 'filter, fragment and fiddle' with the research knowledge that was on offer. Not only did we look for an approach that recognised the inevitable local constraints on resources: time, money and expertise; but we were able to blend and select from our own sense of the practical implications of the research knowledge. The gradual transition, first with small groups of teaching staff, then with remodelled training days, eventually leading to a 'whole staff' programme, took three years.

real gains in workload and impact: If the 'W-test' has been met, then the gains in efficiency and efficacy are considerable. The resources devoted to professional development begin to have productive consequences, and there is also an allied pedagogic impact in the classroom.

PROVIDING ALTERNATIVE EXPLANATIONS

The previous section has demonstrated the usefulness of seeking an analogy with non-linear dynamic systems, in order to identify the features of examples where there has been successful research knowledge transfer. The five examples each exhibit a *tipping point* that initiated the research knowledge transfer. The flow is then sustained because of the relevant research knowledge: *channel depth.* In each instance the transfer of knowledge was *susceptible to "filtering, fragmenting, or fiddling"*, and it was possible to identify *real gains in workload and impact* from applying the transferred knowledge.

Although the choice of the analogy was explained earlier in the paper, it is worth commenting here on the limitations of seeking insights in this way. The analogy appears to

fit the examples that I have presented, and this was the motivation behind selecting the analogy. It is critical to avoid any inference that research knowledge transfer therefore exhibits other characteristics of hydrodynamic systems, or is somehow directly equivalent to a complex well-defined system of differential equations. (Sokal and Bricmont, 1998 provide examples of the misuse of scientific analogies in the social sciences.) Moreover, there is no reason to suppose that the chosen analogy would necessarily apply equally well to all situations where there has been a successful transfer of research knowledge into a practitioner context. However, it is self-evident that any process of research knowledge transfer, which leads to impact in a school, will have:

- a starting point, i.e. an expression of interest;
- some means of sustaining interest, in face of competing pressures;
- a capacity to adapt to local circumstances; and
- evidence, from evaluation, of benefits.

These alternative descriptors may withstand generalisation into new circumstances, and different experiences; but, unlike the four features chosen, lack the central emphasis on fluidity in the transfer: 'water not tarmac'.

The other limitation of the analogy lies in what it overlooks. Are there features that were present, before or during the research knowledge transfer, that are not adequately represented by the analogy. These might well be considered as the *banks of the stream*. The 'banks' may have less impact on the immediate form of the fluid flow, but certainly determine the overall direction of the stream. Given that my intention here is to highlight that we may not have recognised some of the necessary features in successful research knowledge transfer, it is inconsistent to attempt to identify them! However, it would be difficult to discount the following additional elements:

- the nature of leadership within our school: a distributed model based on professional expertise and competence;
- a solution-focussed school culture which invests time and effort where there are perceived gains in teaching and learning, rather than a pre-occupation with statutory direction;
- a high level of professional autonomy for individual teachers, working within productive and energetic departmental groups;
- flexible participation for all colleagues in school development (described by our Headteacher as a ‘loose-tight fit’), which recognises the critical role of peripheral participation (Lave and Wenger, 1991; Wenger, McDermott and Snyder, 2002);
- a practitioner-research culture, where individual enquiry is encouraged; and
- the availability of authoritative guidance from academic colleagues at the University of Cambridge.

It is only by looking at examples of successful research knowledge transfer in other schools, that we would be able to confirm the importance of some or all of these other features. Alternatively, some insights may be gained by examining those cases where research knowledge transfer has not been successful or sustained. It may of course, however, prove somewhat more difficult to tease common features out of such disrupted or abortive interventions.

Of the four features identified in the analogy, the *channel depth* is alone in being unsupported by a broader evidence base beyond the school. It may be readily possible to find examples of other schools that have initiated and sustained change with research knowledge that lacks a comparable supporting literature. As has already been discussed, it may be other features of our school that allowed these initiatives to be sustainable. It is nonetheless true that the accessibility, quantity and coherence of the relevant literature was a striking feature of our five successful examples where research knowledge transfer.

IDENTIFYING POSSIBLE IMPLICATIONS

This paper does not attempt to offer prescriptive solutions to the complex problem of increasing the impact of research knowledge in practitioner contexts. It does, however, highlight some possible considerations for those seeking success in this area. These considerations assume that the five examples I offer in this paper are typical (or proto-typical), and that I have identified their principal characteristics with some degree of validity.

tipping point: Is there a succinct professional provocation, perhaps in the form of a rhetorical question, which can readily stimulate interest in the research knowledge? Is there a compact research outcome, or a wry observation on existing practice, that might serve the same purpose?

channel depth: Is there a sufficiently accessible body of academic knowledge to provide practitioners with the confidence and authority to act? Is the research available in detail and in summary? Does it draw on a breadth of sources?

susceptible to 'filtering, fragmenting, or fiddling': Is there ample facility within the area of research knowledge for local adaptation, and arbitrary selection of elements of the research knowledge? Is the research knowledge offered on the understanding that it will be applied naively, crudely and without regard to the initial context of the findings?

real gains in workload and impact: Is there a genuine gain in impact available on application of the research knowledge in the classroom? Is that benefit adequate to offset any gains in workload, or are there other efficiency savings? Or, is there an expectation that practitioners will be willing to expend additional effort, in the face of competing priorities, to apply the new research knowledge?

If research knowledge transfer is to become more widespread, I suggest that some of these considerations would need to be addressed. The production and transfer of research knowledge has often been pre-occupied with the precise refinements and formulations of each output. While such attention to detail is imperative if the integrity of published papers is to be upheld, the five examples in this paper provide evidence to support a case for the substantial re-packaging of research outputs.

An authoritative body of academic knowledge is still needed, but anyone with an interest in the transfer of research knowledge will recognise: (i) the need to initiate interest in their work through some carefully designed stimulus – research reports and academic papers do not achieve this; (ii) the importance of marshalling a broad body of research knowledge into accessible summary form – isolated research studies and disputatious exchanges between scholars do not assist this; (iii) the reality of applying published findings in productive new contexts, with only partial regard for the original research – academic pedantry fails to recognise this; and (iv) only those recommendations that are sustainable within teachers' working lives, with clear gains in impact, will be adopted.

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