Characterising the Knowledge Base in Education

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Foray has offered an analytical framework and a set of indicators designed to illuminate the measurement and application of knowledge in a number of sectors. This paper offers a response from the particular perspective of the education sector. Other responses cover engineering, health and biotechnology.

Following initial comments on Foray's approach to model building, it sets out four characteristics of the education sector which have particular relevance to knowledge measurement and application issues. It then addresses the two main elements of Foray's account: basic attributes of a knowledge base; and systems and mechanisms for transferring knowledge. His generic, cross-sector indicators are critiqued and some specific alternatives proposed for the education sector. The extent to which a single, linear approach can model the knowledge measurement requirements of such diverse sectors remains to be established.

Introduction

When models encompassing diverse phenomena or sectors are being constructed it is natural for those concerned with a particular sector to highlight ways in which it is different and not readily incorporated by the model. 'Yes, a fine model but it doesn't apply to us.' Taken too far, this is defensive obscurantism. Differences must not be ignored, however; disregarding essential characteristics equally leads to a lack of clarity. Everybody fitted into Procrustes' bed, but at a price …

Foray's paper seeks to provide a model of knowledge bases, their measurement and transformation, that applies to engineering, health, biotechnology, education and possibly beyond. This is an ambitious undertaking and he acknowledges the

difficulty in achieving it. In particular, he refers to the extreme differences between the sectors and the problem as a consequence of finding a framework that applies to each. His solution to this problem is to add descriptors to cover all possible situations in each sector. For a given sector the model is constructed from a subset of the universe of descriptors, with those not used treated as redundant.

If this works, it will yield a powerful tool that is both parsimonious and conducive to analysis and exchange across sectors. There are some questions to be asked about it, however. First, the accretion of elements in a linear way is a limitation on model construction, and one has to ask how well the result can represent the structure of complex knowledge bases. Then the approach is predicated on certain assumptions regarding the inter-relationships between knowledge actors in the different sectors and the relationships between these actors and their knowledge bases. What if these relationships were radically different in the different sectors? A more robust challenge still comes from Gibbons et al (1994) account of developments in the production of knowledge and their key distinction between Mode 1 and Mode 2 knowledge. Foray's proposal is a bold hypothesis and should not be seen as more than that pending detailed empirical testing.

The education sector has a number of distinctive characteristics so far as knowledge generation and use are concerned, one of which probably renders it unique and several others which require particular consideration.

The outstanding feature of education is that it is geared toward learning and knowledge creation. Its product is developed learners. (A broad formulation is necessary since the aims of education are contested and are prioritised in different ways. In all cases, however, the goals are defined in terms of knowledge - as well as skills and values - and knowledge increments on the part of learners.) This establishes a sharp divide between education and other sectors such as engineering and health, a divide that has implications for the respective sectors' relationships to their knowledge bases.

A second, associated characteristic is that education does not have just one knowledge base. There are at least two sets of knowledge bases, and arguably more depending on the level of abstraction employed. The relationship of the knowledge actors to the base is quite different in each case, as are the measurement and application issues. Where teachers are concerned, there is a basic distinction between subject knowledge and professional knowledge. A science teacher must be immersed in the science knowledge base or appropriate subsets of it. Initial training for science teachers is in principle indistinguishable from the training received by others seeking a science-based career, and it is necessary for them to absorb the canons of scientific method as well as specific bodies of knowledge associated with physics, chemistry and so on. Similar expectations will be held of the history teacher, the music teacher and so forth; each must learn the knowledge generation and verification procedures of their discipline and must master subsets of disciplinary knowledge and skills appropriate to their teaching context. *Teaching* science, however, requires very much more than immersion in the science knowledge base. Matters of pedagogy, knowledge of learners and so forth, as developed later, loom large. These entail not only different knowledge bases but different relationships between teacher and knowledge base. In particular, measuring the knowledge stock may need to be approached quite differently.

A third challenging characteristic of education is the diversity of knowledge actors and the multiplicity of their relationships to the various knowledge bases. Consider the young child with cerebral palsy as a focus of knowledge-based interventions. A psychologist will conduct assessments that draw on cognitive, affective and attainment-related metrics. A doctor will advise on medical aetiology and prognosis and how these interact with cognitive development. Speech and physiotherapists will contribute to assessment and programming on the basis of their specific disciplines. An education officer will impact on the situation in the light of knowledge of legal requirements, local resource allocation procedures and prevailing good practice. The teacher is not only the recipient of these diverse knowledge inputs but must draw on his/her own pedagogical knowledge base to incorporate them into an appropriate learning programme. When to all this are added the child's self-knowledge and the

parents' knowledge of their child, the complexity in knowledge terms of this single situation is evident.

Finally, the modest scale of educational research has to be noted. In the United Kingdom, total expenditure on educational research is estimated at £50-60 million per annum, in stark contrast with the pharmaceutical industry, for instance, where the equivalent figure is over £2 billion (Shamoon, 1999). Similar disparities are found in comparisons with other sectors, and these must be taken into account in indicator construction.

Basic attributes of a knowledge base

Foray offers two parameters to characterise the basic attributes of a knowledge base: the extent to which knowledge is codified or tacit; and the extent to which knowledge exists in a competitive environment. Competition intensity as a factor that distinguishes education from other sectors is certainly relevant, but it belongs more to the context of knowledge generation and use rather than to the nature of a knowledge base. Foray's account is quite brief and the issue is not considered further here.

The codified/tacit distinction is important in education, as elsewhere. As an aside, other oppositions could be invoked such as contested/agreed or validated/non-validated. The reality to be encompassed is complicated, however, and such binary approaches map poorly on to it. Aside from the fact that there are multiple knowledge bases in education - cognitive psychology, child development, neuro-linguistics, sociology and so on in addition to pedagogy and subject disciplines - the structures of the individual knowledge bases and the knowledge actors' relationships to them are more differentiated than any number of elegant dichotomies would allow.

Teachers' pedagogical knowledge can be used to exemplify the argument and develop it further. Turner-Bisset (1999) draws on Shulman's concept of 'pedagogical content knowledge' introduced in his 1985 presidential address to the American Association for Educational Research (Shulman, 1986) to develop a model of knowledge bases for teaching. This combines Shulman's 'categories of the knowledge base' and Dunne

and Harvard's 'dimensions of teaching' (1990) with empirical data drawn from observing primary teachers. The model comprises ten elements: substantive subject knowledge, syntactic subject knowledge, beliefs about the subject, curriculum knowledge, general pedagogical knowledge, knowledge/models of teaching, knowledge of learners - cognitive, knowledge of learners - empirical, knowledge of self, knowledge of educational contexts, and knowledge of educational ends.

Turner-Bisset's model offers a nuanced account which displays the complexity of the pedagogical knowledge base. It is likely to have high relevance to teacher education and could well make a useful contribution to measuring the knowledge base. An alternative approach is offered here, however, that is geared more explicitly to the task of generating indicators. This is based on the twin strands of the conceptual construction of the knowledge base and the production of different kinds of knowledge.

Measuring the knowledge base in education requires an appropriate metric, which in turn depends on an underpinning conceptual framework. The conceptual construction of the knowledge base is logically prior to the empirical generation of knowledge but in practice it derives from and evolves in interaction with the knowledge base. Establishing an agreed conceptual map in education is singularly difficult, in part because of differing values, traditions and organisational structures for education, in part because of contested areas of discourse and in part because of the relatively undeveloped status of educational enquiry. This results in conceptual confusion and incoherence where similar phenomena are described differently or where terms have contradictory meanings.

A concrete example of these conceptual difficulties is the use of categories of special educational need or disability. It can be supposed that all countries have pupils who exhibit difficulties in learning and behaviour at school and that these merit some specific policy and research attention. It might be further supposed that a common language for describing these pupils and discussing their educational difficulties and programming would have emerged. Far from it, however. A UNESCO study (1995) found that, of 63 countries providing information, 36 used formal categories to

characterise these pupils, with the number of categories in use ranging from three to ten; of the countries not using formal categories, some explicitly eschewed their use on the grounds that they led to misrepresentation of the pupils' educational situation. As a result, an individual pupil is likely to be described - and dealt with - quite differently depending on which country s/he lives in; discourse on programming, to establish relative efficacies, for instance, is correspondingly uncertain.

This example illustrates some of the difficulties in establishing an agreed conceptual framework in education. Similar examples could be multiplied, all illustrating a singular weakness in educational discourse and the need to develop a common language and set of conceptual frameworks. So far as indicators are concerned, success in this respect will be most evident in thesaurus construction and use. A thesaurus is of course more than a listing of terms; it also provides a semantic map of an area of discourse, that displays the inter-relations of concepts and refines the definition of key terms. Thesauri are more usually considered in the context of accessing and disseminating knowledge but they are fundamental also to measuring the knowledge base.

Two relevant indicators can be proposed: (a) the availability of a comprehensive thesaurus and appropriate sub-thesauri, and (b) the extent to which this thesaurus is used.

The situation in education is relatively under-developed. The most widely used thesaurus is that developed under the auspices of the Educational Resources Information Centre (ERIC) of the Office of Educational Research and Improvement in the United States. This reflects 30 years' monitoring of the educational literature and contains more than 10,000 vocabulary terms. Despite its growing use internationally, it remains oriented toward US concepts and educational organisation. Other major thesauri include the Australian Thesaurus of Educational Descriptors, the British Educational Thesaurus and the European Education Thesaurus. The first two of these draw substantially on the ERIC thesaurus whilst reflecting specific local considerations. The European Education Thesaurus is the only indexing tool currently available that makes it possible to search across languages. It is multi-

lingual, being available in 11 languages, and seeks to list all terms with their equivalents in the other languages.

A second strand of indicators comes from a consideration of the different kinds of knowledge that make up the education knowledge base. The distinction between codified or explicit and tacit knowledge which Foray offers has a long pedigree from Polanyi's (1958) formulation through to Nonaka and Takeuchi's (1995) account of knowledge-creating companies. Useful measurement of the knowledge base in education requires something more, however, and a fourfold division is proposed:

i) knowledge deriving from primary research
ii) knowledge deriving from scholarship and review
iii) knowledge embedded in materials and procedures
iv) knowledge located in practitioners.

These categories overlap but each offers a distinctive purchase on the measurement of knowledge. If we take a curriculum framework or a classroom test as representing embedded knowledge, this will be based on empirical research and may well draw on research review and practitioner input in addition. Its locus in the knowledge base is independent of any underpinning knowledge components, however, and as a consequence it requires a distinct metric.

i) Primary research. Primary research provides the basic building blocks of the scientific edifice. Various measures are available to track the *quantity* of research being done - publication figures, research productivity rates, citation counts and so forth. These are useful in establishing the volume of research activity in a field and the topics being worked on but they do not in themselves measure the knowledge base. At best they offer a proxy measure that is often crude if not misleading. (Education is not alone in this problem. In medicine, for instance, Sackett et al, 1997, claim that the application of rigorous scientific and clincial relevance filters results in the rejection of 98 per cent of the clinical literature.)

To determine the contribution of primary research to the knowledge base measures of *quality* are required. Whether it is worth doing so in respect of individual studies is of course debatable; Harlen (1997) echoes a common view with her claim that single studies are unlikely to provide a firm base for decision making about policy or practice and even less so for adding to our understanding of issues in education. In other words, their contribution to the knowledge base is limited. Nevertheless, quality measures are sought through processes such as peer review and practitioner scrutiny. The Research Assessment Exercise conducted by the United Kingdom higher education funding bodies is a source of relevant data here. This is an exercise designed to assess the quality of research in universities in the UK (for purposes of selective distribution of research funding) and is based largely on judgements of the research outputs of individual researchers/academics (HEFCE, 1998). (See Kerr, 1998, for an analysis of the 1996 Research Assessment Exercise for Education.)

ii) Scholarship and review. Research review is integral to the validation of the knowledge base, and the review process can generate powerful indicators. Review activity can be grouped broadly into (a) individual scholarship and review, (b) meta-analysis and (c) systematic review. Indicators can be derived to measure the volume of activity at each level and the consequent potential for contribution to the knowledge base.

It is likely that attention should be focused on systematic reviews since these are the most explicit about the nature of the evidence base. Systematic reviews are different from other types of review in that they adhere to a strict design to ensure that they are comprehensive, that key methodological parameters are set out systematically for each study and that the conclusions reached are independent of reviewer bias. (See Cooper and Hedges, 1994, for a comprehensive handbook.) Education and the social sciences more generally have barely begun to engage in systematic review, unlike medicine where the Cochrane Collaboration is well established. There is a solid tradition of scholarly reviews, some of which have added materially to the knowledge base, and a more recent engagement in meta-analyses. The need then is for indicators which reflect these different levels of activity.

iii) Embedded knowledge. Embedded knowledge is a significant feature of the knowledge base in education. Tests and other assessment instruments, curriculum frameworks, the academic organisation of schooling, are all based on prior investigation and other accumulated knowledge which the teacher is not involved in and may not advert to at the point of use. Embedded knowledge makes a range of intellectual resources available to teachers which improve their understanding of individual students, strengthen their curriculum programming and enrich their pedagogy. (Some teachers will of course be directly involved in developing materials and procedures; the point, however, is that such explicit engagement is not routine, nor is it necessary to the efficacy of embedded knowledge.)

Indicators here require two dimensions, reflecting the amount of knowledge embedded and the extent of usage respectively. A multi-attribute psychological test such as the British Ability Scales or the Wechsler Intelligence Scale for Children which has undergone a full development process and has extensive standardisation data covering different age ranges and populations is richer in information terms than a simple rating scale designed for use with four-year-olds. A first measure, therefore, relates to the amount of knowledge embedded in the test or curriculum framework or school routine.

An instrument may of itself be information-rich but be little used, however. This could be because of mismatch with the information needs of potential users, limited target audience, or pragmatic factors such as marketing and cost. Whatever the reason, such an instrument has to be regarded differently from a similar instrument which is in widespread use and which generates substantial amounts of information in practitioners' hands. Hence, there is need of a further set of indicators geared to use and the generation of knowledge in practice.

iv) Practitioner knowledge. Teachers' knowledge base is exceedingly diverse, as noted above, and direct measurement of it is probably not feasible on a widespread basis. Some direct measures are taken, as for example when teachers' certification is based on the measurement, through examinations and observation of teaching

practice, of knowledge and competences or when serving teachers are rated in terms of a knowledge-related framework.

Indirect measures are more likely to be used, however, and there are a number of indicators or quasi-indicators based on either pre-service or in-service training, on the grounds that length and level of initial training and opportunities for continuous professional development are associated with expanding the teacher's knowledge base. European Union statistics on education provide indicator information on the duration and level of initial education and training of teachers in 24 European countries (European Commission, 1997). A thematic study on in-service training of teachers by a unit of the Commission provides information on budgets for in-service training, teacher participation in in-service training and the content of in-service programmes across 17 countries (EURYDICE, 1995). UNESCO figures, which attempt to capture global data, report the percentage of first-level teachers by level of diploma, though for many countries the data are missing (UNESCO, 1993). Ambitious proposals have been set out by a joint committee representing UNESCO and the International Labour Organization to collect comprehensive data on teacher indicators, including pre-appointment qualifications and further education opportunities (UNESCO, 1998); it is hoped that this will be taken forward by UNESCO's new International Institute for Statistics.

Particular studies collect information on teacher training in specific areas. This is routine in studies conducted by the International Association for the Evaluation of Educational Achievement. In the Third International Mathematics and Science Study, for instance, the certification requirements for mathematics and for science teachers are reported in terms of number of years of post-secondary education, teacher practice or experience, and evaluation or examination. For an example, see Martin et al (1997). Information on teacher training requirements in respect of special educational needs has been collected in a number of studies including Hegarty (1995), UNESCO (1995) and Meijer (1998).

Research to practice

Foray identifies seven descriptors to encapsulate the process of feedback and linkages in the 'systems and mechanisms for transferring knowledge between university/public research and areas of the production of goods and services'. Two of these are considered here in terms of their resonance with the education sector.

The area of production for education is taken to be schools and teachers. In reality the user group for educational research findings is wider than this - in ways that impinge on the dissemination process. Education managers, policy makers and, in a significant way, parents particularly of children with special educational needs are all producers of goods and services in Foray's sense and are part of a differentiated user group.

D3. Links between research and user groups

Foray identifies three essential parameters for this descriptor: (i) general economic context of R&D policy, (ii) the importance and relevance of research for the area of production, and (iii) the existence of an intermediate space between the two. These are examined here in relation to the education sector and possible indicators suggested.

i) General economic context

This is defined by Foray in terms of resources available for academic research, volume of industrial R&D activity and extent of research outsourcing. For education, some measure of the resources available for research is clearly an important starting point, not least in view of the relatively modest resourcing of research in education by comparison with other sectors. For education, some overall figures are available but they are relatively crude and efforts to disaggregate them are likely to run into definitional problems. (See Stoney, 1995 for a categorisation by topic across European Union countries.) Foray is right to highlight the significance of a

breakdown of support by character of work (Ij), but in education it is likely that only imprecise distinctions with substantial overlaps would be achieved in practice.

A number of additional indicators could be considered:

Number of professional researchers. The availability of a cadre of skilled, committed researchers is critical to national research capacity. Appropriate statistics could highlight skill shortages and help in identifying mismatches between training provision and career requirement. It would appear for instance that many doctoral programmes provide poor training for would-be researchers and that they are an inefficient resource so far as research careers are concerned. If data on skill distributions were available, it is likely that research training could be organised in a more rational way and resources for research used more efficiently. An associated sub-indicator here could relate to the availability and take up of specific research training.

Distribution of researchers. Educational research appears to be characterised by a high incidence of individual researchers ploughing sole furrows in contrast with the norm in some other sectors where sizeable research teams provide critical mass, programme coherence, infrastructure and continuous professional development. Again, systematic data are required to guide change as necessary with a view to maximising the research effort.

Determination of research topics. There is a balance to be struck in determining research priorities between the interests of competing groups - funders, researchers and users. It can be argued that the history of educational research is one of moving from excessive determination of topics by researchers to excessive determination by funders, the one constant being the ignoring of users. In any event, what is required is a comprehensive account of research topics and programmes, regularly updated, both to secure efficiency and to balance legitimate interests in programme determination.

ii) Relevance of research to users

This is a vitally important area and it is all the more imperative that appropriate models of the links between research and users are invoked. Education has suffered from simplistic views where research findings are expected to feed straight into practice in a linear, near-mechanical way. In reality, research is only one of the inputs that shapes teaching behaviour; it sits alongside subject knowledge, experience, knowledge of pupils, pedagogical skills, values and beliefs in helping to generate the succession of insights and decisions that characterise good teaching. Likewise for policy, research is only one source of evidence and has to take its place alongside experts' views, input from lobbyists, existing theories and beliefs. Evidence in its turn is only one input to policy, and not necessarily the most powerful input.

Given these models of the links between research and practice/policy, appropriate indicators will be a subset of the research volume and quality indicators referred to above. Not all educational research is relevant to shaping teaching behaviour but some is, and the requirement is to identify the latter and subject it to quality checks. One set of indicators then would refer to research findings, assessment instruments and other materials that were deemed relevant to teaching. A similar set could be derived that applied to policy making.

Utilisation needs to be considered as well. An assessment instrument may be well constructed and readily available but not be used; research findings on the teaching of literacy may be widely ignored by teachers. This points to the need for a measure of utilisation or impact. Such measures are difficult to construct, however, in view of the multiplicity of factors at play, and it is unlikely that robust indicators will be easily achieved except where the output of research is a specific product such as an assessment instrument or a set of instructional materials.

iii) Intermediation

The first indicator offered by Foray is the presence or absence of a field or discipline dedicated to building bridges between academic research and the user group. His

claim that such a field is generally absent in education is true in a literal sense. Education does not have a profession of research or policy analysts but there are at least two counter-considerations. First, there **is** some formal mediation activity. More significantly perhaps, a number of the functions of an intermediation discipline are discharged in other ways.

The outstanding example of formal mediation activity is the Regional Educational Laboratory Program in the United States. This is the Department of Education's largest R&D investment encompassing a network of ten regional 'laboratories' and designed to enhance staff and student learning across the education system. Significant elements of the Program's mission are to ensure that everyone involved in educational improvement has access to the best available research and knowledge from practice and that research findings and successful initiatives from one setting can be applied appropriately elsewhere. Other examples of research mediation occur when academics/researchers work alongside teachers and policy makers to develop the implications of research for practice and policy. A further activity to take account of in indicator construction is when individual educators are assigned to a research mediation role. This can be when a teacher in a school or an officer in a school district or local authority is charged as part of his/her role to scan the research literature, draw colleagues' attention to relevant findings and possibly negotiate local participation in research studies.

The more general point is that much mediation in education takes place outside the confines of a mediation discipline. The most widespread intermediary group is teacher educators. An important charge on the providers of both initial teacher education and in-service education is accessing and translating research findings. Doubtless, this responsibility is discharged unevenly and empirical investigation is required to determine the extent to which teacher education is informed by research. This would include an examination of different models of training provision, including in particular the relationships with the academic/research community on the one hand and with schools on the other. Such investigation would lay the groundwork for relevant indicators of intermediation in teacher education.

Other possible intermediation indicators would refer to (i) products designed to mediate research findings between researchers and users, (ii) media or channels to facilitate the use of such products, and (iii) take up. Products at the simplest level are research summaries, written to reflect the interests and level of discourse of different target audiences. SET produced by the New Zealand Council for Educational Research and TOPIC produced by the National Foundation for Educational Research are examples of products which seek to distil a wide range of research findings specifically for teacher audiences. Channels of communication have been predominantly the professional press but, increasingly, electronic dissemination will be the medium of choice and website activity will yield an important indicator. In addition to information on products and channels to disseminate them, measures of take up and use are needed to relate the intermediation process to the world of practice.

Foray offers four other indicators of intermediation: firms' 'connectedness' to the research system, university-industry R&D centres, spin-off activity and personnel mobility. These could be translated into indicators for education sector purposes if the volume of germane activity was judged to be sufficient to warrant it. The equivalent to spin-off activity, for instance, might be the establishment of educational programmes or indeed whole schools on the basis of research evidence; examples might be the Success for All programme, Cognitive Acceleration through Science Education and the Higashi schools for children with autistic spectrum disorders. Personnel mobility as an intermediation factor has limited relevance to the school sector since relatively few researchers switch to school teaching, but has stronger relevance to groups such as school psychologists, advisory and management staff, and policy makers where such transfer is more common.

D4. In-house learning processes

Foray's analysis of in-house learning does less than justice to the education sector, and the indicators he proposes - L, experimental learning, and M, feedback loops between learning by doing and in-house R&D - are unlikely to be able to represent the full range of learning that takes place in schools.

The outstanding characteristic of schools is that their outcome is learning as opposed to improvements in health or material products. Measuring this learning is therefore the first priority. There is in fact a great deal of measurement of student learning at classroom, school, national and international levels, using methods that range from teacher judgement to sophisticated multi-level modelling techniques. Much of the concern regarding indicator construction here has to do with technical adequacy; this is as it should be since the measurement issues are complex and their resolution is important both for the conduct of research and for decisions regarding the allocation of educational goods.

There are at least two other issues of strong concern, however: school learning outcomes which do not lend themselves readily to measurement; and isolating the school's contribution to student learning from other sources of learning. Schools aim at more than achievement in mathematics and science and the other subject divisions. They want students to know how to learn, to have respect for others, to be able to relate to them in a diversity of appropriate ways, to grow in self-knowledge and responsibility; they seek personal development and growth in affective areas which have a significant cognitive underpinning. Measurement in these domains is much more difficult, and the ready quantification of a mathematics test is not available. The challenge then is to ensure that the availability of data or the robustness of indicators on particular educational outcomes is not taken as a measure of their significance.

Measuring schools' precise role in student learning is a highly contested topic both in research and in school reform policy. Children and young people have multiple lives outside of school and isolating the specific contribution made by schools to their learning is not a trivial task. There is a sizeable body of knowledge on the factors that characterise effective schooling, but the interactions between different pedagogies and ability, attitude, age and maturational level are not well understood and indicator construction is necessarily tentative as a consequence.

School learning is not confined to students of course, and when we speak of the school as a learning institution we also have in mind learning and knowledge creation on the part of teachers. Turner-Bisset's (op. cit.) model of knowledge bases for

teaching outlined above suggests a framework for measurement purposes; it is likely that the indicators to emerge will be similar or closely related to those proposed for continuous professional development.

Going beyond student learning and the personal learning which is essentially teachers' professional development, we must also take account of the knowledge creation activities in schools which contribute to the general knowledge base. Hargreaves (1998) paints a picture of schools as learning organisations which engage in research, professional development and dissemination, and have collaborative partnerships with higher education institutions. While there may be few schools which are learning organisations in this sense, two sets of indicators can be considered, concerned respectively with activity and with output. Activity measures would cover the various forms of teacher research activity which has been a feature of English education for some 30 years (Elliott and Sarland, 1995) and in the United States is documented in the work of the Center for Teaching and Learning at Michigan State University. A particular initiative in recent years has been the support, including funding, by the Teacher Training Agency in England for research to be conducted in schools by practising teachers.

Output measures would overlap with other measures of outcomes to the extent that teacher research approximates to academic research. However, the distillation and codification of experience which teacher research encompasses are likely to constitute grey literature for the most part and will not be picked up in conventional indicators. Education has no equivalent of the commercial databases covering legal cases, for instance, but there are growing pockets of activity where e-mail discussion groups and websites collate information on teaching practice; these include case studies, reports on research applications and solutions to pedagogical challenges.

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