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RESEARCH AND RESEARCH UTILISATION IN CHEMICAL EDUCATION

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ABSTRACT: Despite the enormous growth of science education research (including chemical education research) during recent decades, its impact on the practice of science education has remained relatively low. Reasons for this include the following: (i) Neglect by researchers of genuine ‘application studies’, in favour of ‘diagnostic’ ones. (ii) Undue attention in researches on ‘fashionable’ areas (e.g., pupils’ misconceptions and alternative frameworks), without adequate consideration of the practical usefulness of the findings. (iii) Insufficient elaboration by researchers of the implications of their findings for the practice of science education. (iv) Unawareness on the part of many science teachers, even experienced ones, of the findings from science education research or their tendency to ignore such findings. (v) Practitioners’ inclination to rely on ‘common sense’ and/or ‘personal knowledge’ in their practice of science teaching. To enhance this impact of science education research on the practice of science education, it is suggested that attention is paid in the planning and conduct of researches on: (1) the adoption of lines and areas of science (chemical) education research that are practice-related and, hence, potentially useful for the practitioner; and (2) the development of strategies for improving practitioners’ responsiveness towards and awareness of science education research findings, including their willingness and competence to adjust their practices in the light of such findings. These aspects are explored in the paper. [*Chem. Educ. Res. Pract. Eur.*: 2002, 3, 327-343]

KEYWORDS: research utilisation; impact of research on practice; practice-relatedness; pedagogical knowledge; awareness of research findings; teacher involvement in research

* This is a the full text of a plenary lecture delivered by *Prof. Kempa* at the 6th ECRICE/2nd ECCE in the *University of Aveiro*, Aveiro, Portugal.

INTRODUCTION

If I had to characterise the content and direction of my lecture (and also that of my concerns as a chemical educationist) by means of one single term, it would be that of ‘research utilisation’. By ‘research utilisation’ I mean the extent to which the outcomes of research in chemical education find application in the classroom or teaching laboratory, in such a way that they have an impact on the nature and quality of the chemical education to which we expose our pupils and students.

The issue of ‘research utilisation’ in chemical education and other branches of science education is far from new. It has been raised on many previous occasions and numerous references to it can be found in the literature. The general conclusion that can be drawn from

these references is that, broadly speaking, findings from science education research have so far had little impact on the way(s) in which science is actually taught.

Occasionally, assertions about the continuing gulf between science education research and the practice of science education have been accompanied by attempts to identify possible reasons for this state of affairs. In the main, the focus in these attempts has been on the nature of the researches themselves, and in this context the issue of 'practice-relatedness' has frequently come to the fore. For example, in 1995 Kempa put forward two main reasons for the lack of interaction between research and practice of chemical education. These were that:

- Researchers themselves have concentrated largely on the generation of research findings, but have given low priority to exploring their implications for, and application in, the classroom or teaching laboratory.
- In the choice of issues for research, insufficient attention has tended to be given by researchers to the notion of 'practice-relatedness', with the result that the issues tackled by researchers are frequently not those that practitioners regard as important and relevant to their work.

In order to exemplify and support his assertions, Kempa referred to a detailed evaluation of science education researches previously undertaken by Pfundt and Duit (1991). Their findings were that genuine 'teaching studies' accounted for, at the most, 10 per cent of all published researches concerned with aspects of learning and concept formation in science. Thus, in the overwhelming majority of science education researches, the issue of 'practice-relatedness' – if it was considered – was accorded only a subordinate role.

Let it be said that the gulf between research and practice exists also in other areas of education. For example, in a recent study concerning university level education, Terenzini (1999) found significant gaps between what research reveals about how students learn and contemporary academic and pedagogical practices. A similar conclusion was reached by Smith (1999) in relation to vocational education and training. Referring to an earlier (1997) symposium, he states that the linkages between research and its applications (in the form of educational decision-making) are 'weak' and that it is a 'rickety bridge...that is nowhere near as strong as it should be'. Other areas featuring in relatively recent studies of the impact of research on practice have included nurse education, teacher education and distance education. Sometimes these studies have been combined with attempts to raise practitioners' awareness and utilisation of research; however, in the main these studies testify to the still existing gap between research and practice.

As far as one can judge from the literature, the question of what impact research has had, is having or should be having on the practice of science education appears to have attracted much less interest in recent years than in other areas of education. Empirical studies in this area are almost non-existent, although – occasionally – articles can be found in which opinions on the theme are voiced. For this reason, it is pleasing to know that at this university (the University of Aveiro) a group of science educators (led by Dr Nilza Costa) is actively probing into the question of how the interaction between education research and the practice of science education can be developed and promoted. Not surprisingly, the key emphasis in this work is on 'research impact' and 'research utilisation'.

Let me briefly return to the two reasons given above for the lack of interaction between research and practice in science education. It will not have gone unnoticed that they focus on the researchers themselves and the issues chosen by them for investigation. No reference is made in them to the fact that the practitioners themselves have an important role to play in the process of 'translating' the findings from science education research into classroom practice. There is, of course, little point in trying to deal with the complex question

of research utilisation without also reflecting upon the position of the practitioners as potential implementers of research findings. It is my intention here to do this, in the hope that ideas will emerge that can help us to strengthen the impact of science education research on educational practice. May I also say that I see this as a natural development from contributions to previous ECRICE meetings in which my concern was with the nature and direction of science education researches (Kempa 1993, 1994).

As part of examining the practitioners' role as potential research implementers, I want to ask and consider four key questions. These are:

- What are the knowledge bases used by practitioners when making decisions about professional practices? Do they include findings from science education research?
- If knowledge about education research findings does not form part of the practitioners' knowledge repertoire, what can be done to ameliorate this situation?
- Even if practitioners can be led to an increased awareness and knowledge of education research findings, is this enough to bring about an enhanced research utilisation in the practice of science education? If not, what additional steps and strategies have to be considered?
- What are the responsibilities that fall upon practitioners and researchers to ensure an improvement in the quantity and quality of research utilisation compared with the present state of affairs?

I should perhaps explain at this stage that I am deliberately avoiding here talking specifically about chemical education and chemical education research. Instead, I am focusing on the broader area of science education and science education research. My reason for doing this is that many of the issues about the teaching and learning of chemistry about which we seek illumination through research are common to the sciences in general. To want to introduce rigid boundaries between chemical education research and research relating to education in the other science areas really makes little sense.

What are the purpose(s) of science education research?

I said at the beginning that my concerns about science education research relate to its impact on the practice of science education. Implicit in this is the belief that in science education (as, indeed, in other areas of education) research and practice should be seen as complementary, not as separate, pursuits. Many science educators support this view. For example, Hurd (1991) asserted that:

There is little reason to do research in science education unless there is a pay-off in the classroom.

In relation to chemical education, Kempa (1992) expressed a similar view:

Chemical education research should (seek to) generate insights and information on the basis of which informed decisions can be taken (by curriculum developers and practitioners) about major aspects of the teaching of chemistry.

It has to be admitted that, although many science educationists endorse this kind of sentiment, others take a different view in that they regard science education research as an activity that is carried out primarily for the purpose of gaining knowledge and insights about, e.g., learning, concept formation, etc., and not chiefly in order to influence educational practice. For example, Schmidt (1995) – speaking at a previous ECRICE – expressed this view by stating that chemical education research should first and foremost be seen as a

‘scientific discipline’, thereby implying that criteria concerning the applicability of such research are not of primary importance.

It seems to me to be a futile exercise to engage in a debate about these two positions: they are reminiscent of the two positions that we also find in the science domain, which is whether scientific research should be ‘pure’ or ‘applied’. In fact, as is well known, both types of research coexist and each has its own role and function. What to me is important, though, is that even if some science education researches are not directly concerned with aspects of teaching and learning, they should at least deepen our understanding of the broad educational issues in science education and would, hence, be of interest and potential value to the practitioner. This is also the position taken by, e.g., Good (1993) and Gilbert (1994) who argue that science education research should be ‘relevant to teaching’ even if its outcomes are not directly related to classroom practice.

The fact that different positions are held about the purpose(s) of science education research does, of course, not invalidate the issue raised here, which concerns its impact on the practice of science education.

SOME REASONS FOR THE LACK OF IMPACT OF SCIENCE EDUCATION RESEARCH ON EDUCATIONAL PRACTICE

Starting with the premise that a major gulf exists between science education research and its application in practice, several authors have sought to identify possible reasons for this state of affairs. Apart from attempts that have focused predominantly on the nature of the researches done and their potential relevance to teaching, one can find in the literature an increasing number of pronouncements about science teachers’ reactions and attitudes towards the findings from educational research. Two particular positions are identifiable in this context, which are that:

- Teachers tend to view most research findings as ‘impractical, difficult to interpret, and rarely possible to implement’ (Jenkins, 1999) or that they simply ‘ignore’ the findings from education research (White, 1998).
- Science teachers, even experienced ones, are relatively unaware of the findings from science education research and conduct their teaching in ‘ignorance’ about research-based information.

No doubt, examples of both positions can be found in reality. Nevertheless, if our intention is to bring about a greater utilisation of education research findings in the practice of science education, it is important to know which of the two positions is the more important one. Were the first position the predominant one, our efforts would have to be concentrated on working out ways in which research findings can be translated into practical actions. In the second case, the initial task would be to generate among teachers an awareness of key education research findings, before addressing the task of promoting their incorporation into teaching programmes. We have tried to resolve this issue, at least in part, by focusing in some of our recent studies on the nature of science teachers’ awareness of, or knowledge about, findings from educational research. For example, in a paper published in 2000, we reported a small-scale study of science teachers’ awareness of findings from science education research (Costa *et al.*, 2000). Without wanting to go into details about the nature of the study, let me briefly draw attention to the two key results to emerge from it. These were that:

- Science teachers’ knowledge of education research findings is generally very limited.

- What science teachers regard as sound pedagogical knowledge is usually derived (or claimed to be derived) from personal experience or ‘common sense’; such ‘knowledge’ does not tend to be questioned as to its compatibility with research findings.

In the light of these findings, the authors of the paper concluded that the gap between science education research and the practice of science education is predominantly due to teachers’ ignorance about the findings generated by research, rather than its rejection. They suggested that to narrow the gap between research and practice should be a high-priority task to be addressed by researchers and practitioners.

Following on from Costa *et al.*’s investigation, Castro (2000) has recently completed a more detailed and wider-ranging study of the didactic and professional knowledge held by Portuguese chemistry and physics teachers. Unlike the Costa study, which involved a rather limited and specially selected sample of teachers, that of Castro covered over 200 chemistry and physics teachers from the Aveiro area of Portugal. In fact, the Castro study involved practically the full cohort of physics and chemistry teachers working in schools in the Aveiro region. For this reason, her findings about science teachers’ pedagogical knowledge and understanding must be regarded as distinctly more representative than those reported by Costa *et al.*

As part of her study, teachers were given a series of statements (or assertions) expressing items of pedagogical ‘wisdom’ and asked, firstly, to assess their validity (on a five-point scale ranging from ‘always true’ at one extreme to ‘always false’ at the other) and, secondly, to indicate the type of knowledge on which their assessments were based. To help teachers in the second task, seven response categories were suggested on the basis of which they might judge the validity, or otherwise, of the assertions. These were:

- ‘Common sense’ knowledge.
- Personal experience.
- Consensus among professional teachers.
- Information derived from teacher trainers, inspectors, etc.
- Information contained in official syllabuses and similar documents.
- Information derived from books and/or general professional literature.
- Knowledge obtained from research literature or research reports.

Teachers were also given the opportunity to use any additional categories, if they so wished, or to omit a response if they felt unable to associate an assertion with a particular knowledge or information source.

Our interest here is not in examining to what extent teachers’ pedagogical knowledge agrees or conflicts with (as the case may be) findings or insights derived from education researches. Instead, our concern is to establish on what types of knowledge teachers base their judgments about the validity, or otherwise, of educational procedures. The information in Table 1, which is based on the Castro study, sheds light on this issue for a limited number of assertions. The figures in the table represent the percentages of teachers referring to the various ‘knowledge types’, rounded up or down to the nearest 0.5 of a per cent.

Castro’s results confirm those previously published by Costa *et al.* (2000). They show convincingly that the knowledge system within which most practising teachers operate and make decisions is largely independent of the findings of educational research. As is seen, ‘personal experience’ is by far the most important knowledge source for teachers, with

TABLE 1. Sources of knowledge referred to by teachers when judging the validity of statements expressing educational 'wisdom'.

Assertion	Percentage of teachers referring to source of knowledge when judging the validity of assertion							
	Common Sense	Personal Experience	Consensus among Professionals	Imposed Knowledge	Statements in Official Documents	Books/General Literature	Research/Research Literature	No response
Science teaching that takes account of students' alternative conceptions is more effective than science teaching that is predominantly expository	4.5	30.5	6.0	19.0	0.0	2.5	10.0	27.5
Laboratory work has a motivating effect on students learning science	5.0	56.5	4.0	3.0	2.5	0.5	4.0	24.5
In science, learning by discovery is more effective than expository teaching	8.0	38.5	4.5	10.0	0.5	3.0	7.0	28.5
One of the main objectives in science education is to bring about in students an understanding of every-day phenomena	11.0	34.0	8.5	7.0	9.0	3.5	3.0	24.0
The more motivated students are, the better they learn	14.5	53.0	3.5	4.5	0.0	0.0	0.5	24.0
The subject matter taught in science classes is intrinsically more difficult than that in non-science subjects	16.5	23.5	11.0	5.5	0.5	1.0	0.0	42.0
Problem solving is an essential component of the science curriculum	2.5	33.0	10.5	8.0	6.5	6.0	9.0	24.5
Metacognitive activities are a valuable help to students' learning of science	5.5	19.5	3.5	11.0	0.0	4.5	5.0	51.0
The assessment of students' scientific understanding is a problematic issue for teachers	4.5	45.0	10.0	2.5	0.0	2.0	0.0	36.0
When students work in groups, they learn from one another	7.5	56.0	3.5	3.5	0.0	1.5	0.5	27.5
AVERAGE	8.0	39.0	6.5	7.5	2.0	2.5	4.0	31.0

'common sense', 'consensus among professionals' and 'imposed knowledge' featuring as minor knowledge sources. Even if the assumption is made that knowledge about research can be derived from both the literature-based sources of knowledge mentioned (i.e., 'books/general literature' and 'research/research literature'), together these two knowledge sources were referred to in fewer than seven per cent of the teachers' responses.

It is beyond the scope of this lecture to examine whether and, if so, to what extent the various assertions in Table 1 are supported or contradicted by research findings. We have reported on this aspect elsewhere (Costa *et al.* 2000). Let me merely say that, not infrequently, practising science teachers hold widely different views about whether items of professional 'wisdom' like the ones shown in the table are correct or incorrect. Consequently, at least some teachers must hold beliefs that, in terms of objective findings, are unsubstantiated, if not wrong. Even in situations where a high consensus exists among

practitioners about the validity, or otherwise, of a statement, it is not uncommon to find that teachers' views or convictions are at odds with the findings reported in the research literature.

Although we may regret the fact that practitioners of science education are largely uninformed about the findings from science education research, we must resist the assumption that decisions taken by them on the basis of personal knowledge are inevitably invalid and questionable. On the contrary, we have to admit that 'personal knowledge' can be, and often is, a very powerful basis for decision-making, particularly since it usually encapsulates the practitioner's detailed knowledge of his or her own teaching environment. However, it also has to be recognised that, unlike research-based knowledge, personal knowledge tends to be subjective and that it remains so unless it is subjected, at least from time to time, to a critical appraisal. It is in this respect that, I believe, practitioners often fall short of what, ideally, we would like them to do: what practitioners accept as 'personal experience' is generally assumed by them to be fully valid. The practitioners' belief in the validity of such knowledge tends to be maintained even if the results of their pedagogical actions taken are at odds with their expectations. However, we shall return to the issue of teachers' personal knowledge later in this paper.

WORKING TOWARDS THE APPLICATION OF EDUCATION RESEARCH FINDINGS IN PRACTICAL TEACHING

The chief conclusion to be drawn from what has just been stated is that, on the whole, the practitioners of science education are insufficiently aware of, or informed about, findings from science education research. Awareness generation about 'what science education research has to tell the teachers' must thus be regarded as an important first task for us to address in our work with our colleagues in the schools. We need to convince our colleagues that the objective, research-based exploration of teaching and learning has led, and is still leading, to many important messages for the organisation and conduct of science education in our schools and colleges.

However, this does not mean that once teachers have become aware of the messages from science education research, this will inevitably result in their translation to classrooms or teaching laboratories. If, as White (1998) has suggested, teachers tend to reject the results from education research or if, following Jenkins' (1999) view, they find such results difficult to interpret and implement, the process leading from 'awareness' of research findings to their application in practical teaching is clearly more complex than we sometimes imagine it to be. For this reason, this process itself merits exploration.

The literature offers little guidance about the ways in which education research findings become integrated in educational practice, at least not when integration on a large scale is considered.[§] For the purpose of developing some thoughts about the process by which a wider-scale translation of education research findings into practice might be achieved, we may initially argue that this process is not unlike that described by Cooper (1977) for 'curriculum innovation', by which is meant the process leading from the generation of a new curriculum to its incorporation by teachers into their educational practice. Cooper suggested the following five phases as essential components of the curriculum innovation process:

- The practitioner becomes aware of a (curriculum) project's existence.

[§] It is true that strategies like action research have proved to be effective in bringing about changes in educational practices. However, since such strategies normally require close collaboration in the classroom between researchers and practitioners, their impact is usually limited in terms of scale.

- The practitioner acquires knowledge about the project's philosophy, and the ideas and materials generated by it.
- The practitioner makes limited use of the project's materials.
- The practitioner adopts the project; this involves the acceptance of the project's philosophy and the extensive use of its materials.
- The practitioner 'implements' the project; he/she teaches it in full accord with the project's philosophy and with regard to his/her students' needs and aspirations.

Cooper's argument was that, for an innovation to have taken root, teachers must have made at least limited use of its ideas and materials – which corresponds to the third stage. However, a project would not have reached the highest level of impact unless the practitioner operates at the 'implementation' stage in the process. Implementation here means that the practitioner not only uses the materials, but also adjusts and modifies them in accordance with the needs of his/her students, rather than merely applying them in a mechanical way.

It seems to me that the process whereby education research findings become incorporated into educational practice is not dissimilar to Cooper's curriculum diffusion process. Therefore, we may stipulate the following five (sequential) aspects for the 'research diffusion' process, i.e., the process whereby the findings from education research become absorbed and integrated into educational practice:

- Teachers' awareness/knowledge of research findings.
- Teachers' initial response to the research findings.
- Teachers' considered response to them, after having examined the research findings in some detail.
- The actions embarked upon by teachers, following the detailed consideration of the research findings under (3).
- The degree of impact of the research findings upon educational practice.

Figure 1 incorporates these points, but does so in an elaborated way. In particular, it seeks to explore the relationships between teachers' responses to education research and the likely impact of the research on educational practice. Its purpose is to provide a framework

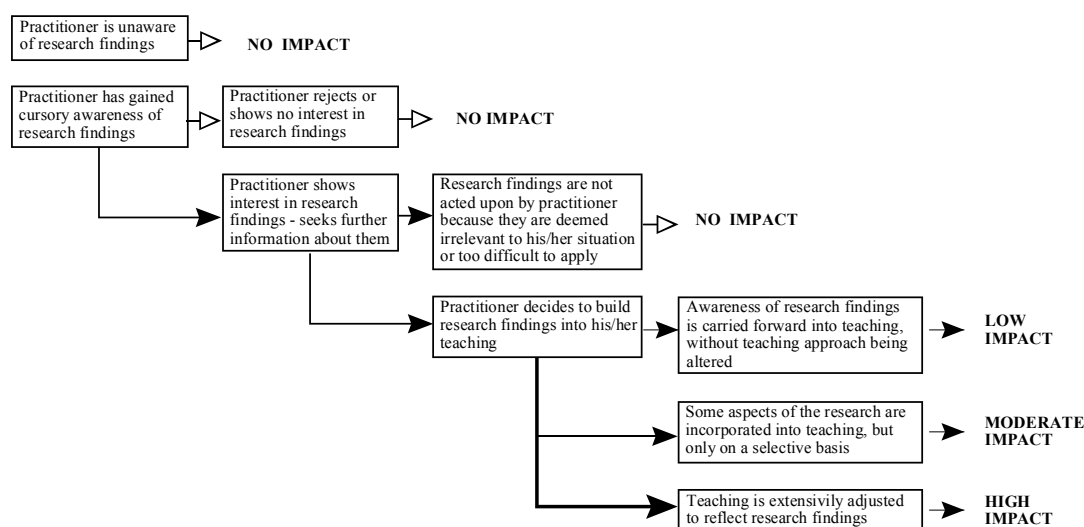


FIGURE 1. Levels of practitioners' response to education research findings.

within which we can determine what conditions or prerequisites have to be fulfilled for research findings to have a genuine impact on educational practice.

As Figure 1 suggests, there is no straightforward answer to the question of how best the findings from education research can be transformed into educational practice. Instead, we need first to ascertain at what stage in the scheme the practitioners find themselves and take this as the starting point for our subsequent actions and interventions to narrow the gap between research and practice. For example, if it is found that practitioners are unaware of any of the insights that research has produced, the first line of action should be to concentrate on informing practitioners about 'what research has to tell them'. This corresponds to the awareness/knowledge generation stage in the five-point scheme.

The importance of informing science education practitioners about education research findings was recognised quite a few years ago, when the American National Science Teachers Association embarked on a series of publications entitled "What Research Says to the Science Teacher" (e.g., Yager, 1982). More recently, Monk and Osborne (2000) have released a similar publication under the title "Good practice in science education: what research has to say". These are but two examples of science educators recognising the importance of bringing the findings from science education research to the attention of classroom practitioners.

Whilst awareness of, or familiarity with research findings, is a necessary condition for their application in practice, it is not a sufficient one. As Figure 1 indicates, even if practitioners have acquired knowledge of particular research findings, they may show no interest in them or ignore them, in which case the findings will have no impact on practice. But even if practitioners become interested in the findings from education research and seek further information about them, we frequently find that such information is not acted upon. There are several reasons for this, which may include the following:

- The research does not address issues that the practitioner recognises as relevant to his/her own situation.
- The research findings may be regarded by the practitioner as too trivial to merit an adjustment in teaching approach.
- The researchers fail to address the question of how their research findings may be translated into actions in the classroom or teaching laboratory.
- The application of the research findings may require the practitioner to make adjustments to his/her teaching of a magnitude that (in his/her view) undermines its overall effectiveness.

No claim is made that the foregoing points cover all the situations where practitioners prefer to remain passive with respect to research findings, instead of acting upon them. Nevertheless, they give an indication of the reasons or explanations why the results of education research generally find little application in practice. The issue here again is that a 'no impact' situation results.

It follows then that, if education research findings are to find application in the practice of education, practitioners do not only have to be conversant with the findings, but they must also take a positive decision to incorporate them into their teaching. This does, of course, not automatically guarantee that the findings are carried in full into educational practice. As is suggested in Figure 1, we can think of different 'degrees' of research application. These can range from teachers being aware of research findings and occasionally acting upon them (for example, in an attempt to interpret their students' learning behaviour), to their full acceptance by teachers, coupled with a major adjustment of teaching procedures and strategies to reflect the research findings. An intermediate situation would be one where some of the research findings are accepted and incorporated into a teaching strategy, without

the practitioner adjusting his/her customary pedagogical procedures in a major way. Although in each of these situations we may claim that the research has an impact on educational practice, the actual degree of this impact will vary from 'low' via 'moderate' to 'high'.

A closer look at teachers' pedagogical knowledge

In this discussion so far, the focus has been on science teachers' knowledge of education research findings and the extent to which such knowledge is translated into educational practice. Essentially, this kind of knowledge represents part of what may be referred to as the practitioner's 'pedagogical knowledge', to distinguish it from his/her 'subject knowledge', i.e., the knowledge and understanding of the subject taught by him or her. As researchers like Buchmann (1982) and Tobin and Garnett (1988) have previously convincingly argued, both pedagogical knowledge and subject knowledge are essential components of the science teacher's professional knowledge repertoire.

However, even if we could bring about a situation where our science teachers' professional knowledge incorporates an adequate level of information about education research findings, this in itself is not enough to ensure that such findings are translated into educational practice. What is also required, to argue in line with, e.g., Cochran, DeRuiter and King (1993), is a detailed knowledge on the practitioners' part of:

- the learning characteristics and attributes of the students, including, for example, their prior knowledge, misconceptions, motivations, and study habits;
- the social, political and cultural environment in which the students are expected to learn.

The foregoing knowledge aspects may be regarded as aspects of practitioners' 'personal knowledge', not unlike the 'personal experience' type of knowledge identified by Costa *et al.* and by Castro in their studies or the 'classroom knowledge' recently referred to by Barnett and Hodson (2001).

Like pedagogical and subject knowledge, 'personal knowledge' forms an important component of the practitioners' total professional knowledge repertoire. However, unlike the former it is bound to have a substantial 'subjective' element, which stems from the fact that it is generated by teachers within the 'closed system' of the classroom or teaching laboratory and that, hence, it is specific to the teaching situations in which the practitioners operate. It cannot simply be obtained from the research literature, except in the most general sense.

The fact that practitioners' personal knowledge is largely subjective adds to the complexity of the process of translating research findings into educational practice in a valid and meaningful way. The key problem, it seems to me, is that practitioners tend not to question knowledge that they hold to be irrefutably true. Knowledge based on, or derived from, 'personal experience' is particularly affected by this tendency. Often, of course, such knowledge is entirely valid and justified in the context of the practitioners' sphere of operation. Alas, there are also situations where this is not the case, where educational practices based on practitioners' 'personal knowledge' are not in line with the findings from education research. Unfortunately, practitioners are usually not in a position to distinguish between the two, unless they happen to have access to research-based information. Their practices may thus embrace some actions and activities that are not the most effective in terms of students' learning and learning outcomes.

Recognising this problem, some authors have proposed strategies for inducing practitioners to take a more critical and questioning stance towards the ideas they regard as true. For example, Cochran (1997) recommended that teachers should 'keep a personal

notebook describing their teaching' over a limited time span or that they should 'videotape or audiotape a few class periods' as a means of gaining insight into their own teaching and their students' learning. Whether they can be persuaded to do so, whether it is possible for them to do so in practice or whether they are capable of making full sense of the events recorded by them, are of course different matters. However, let it be said that, even if practitioners seek to extend their professional knowledge by these or other means, the knowledge arrived at is bound to be coloured by personal views and, possibly, value judgements. This, I would argue, is not at all a bad thing: it is a feature of the normal work of a professional person.

Possible lines of action

Having reflected on the complexity of the process whereby the results of education research find their way into educational practice, I now want to turn to the question of what can be done by us and by others to promote this process.

Let us take as our starting point in this the realisation that, whilst knowledge about research and research findings is important for the application of research in the practice of education, it is little more than a prerequisite. Equally important, if not more important, is that practitioners should be in a position to judge the relevance of research findings to their own professional situation and decide to adopt or adapt them in accordance with what they perceive to be their own and their students' needs.

As we have suggested, it is at this stage that knowledge of research findings on its own ceases to be adequate. Instead, it has to be merged with the type of personal ('subjective') knowledge that relates to the practitioner's professional circumstances (and, of course, also with the teachers' subject matter (science) knowledge) to form what, in the literature, has been referred to as 'pedagogical content knowledge'. It is the integration of these components that, we may argue, leads – or, at least, can lead – to a purposeful application of education research findings in the practice of science education.

The key question now must be how this integration can be achieved. Is it a task that we can simply expect practitioners to cope with or should it be regarded as a task for the researcher? I want to suggest that it is a task that can only be solved in purposeful partnership between researchers and practitioners. My reason for this lies not so much in the practicalities of seeking research applications in education (which require, e.g., access to students in classrooms and/or laboratories), but in the recognition that each partner group has its own distinctive knowledge to contribute to the research implementation process. Whilst, on the one hand, the researchers may be credited with having a wide knowledge of research and research findings, they are likely to lack the detailed 'personal' knowledge of the educational circumstances in which the research is to be applied and implemented. The practitioners' knowledge, on the other hand, will be strong in the latter respect, even if it is less extensive and deep in relation to the former. What we should aim at generating, therefore, are what might be called 'symbiotic partnerships' of researchers and practitioners, which seek to bridge the traditional gulf between education research and its application.

It would not be appropriate here to put forward firm suggestions concerning ways and means whereby the creation of such partnerships might be achieved. This is an issue that ultimately has to be addressed at a national, regional or even local level, and must take into consideration the prevailing experiences and/or traditions of collaboration between researchers and practitioners. As a starting point to this, it is useful to look at examples of researcher-practitioner collaboration reported in the literature, in the hope that some of them may serve as models for future developments.

In Britain, for example, so-called “science teachers’ centres” flourished widely during the 1970s and 1980s. Most of these centres were located in university education or science departments and provided valuable forums for academics and teachers to meet and discuss ways and means of introducing innovation in science education. It is true that the popularity of these centres has somewhat diminished since their heyday in the 1980s (partly because educational priorities have changed, partly because of a reduction in funding); nevertheless, some continue to exist and to promote the interaction between researchers and practitioners. One can point to similar developments in other countries. In Italy, for example, some very successful university-school partnership projects were initiated in the late 1970s and early 1980s (see, e.g., Arcà and Vicentine-Missoni, 1979). Although these aimed by and large at bringing about a modernisation of teaching schemes and approaches in Italian schools and not at the conduct of education research *per se*, they can nevertheless be referred to as interesting experiments in bringing teachers and academics together in efforts to improve science education.

The notion of ‘the teacher as researcher’ has also gained some popularity as a possible approach to narrowing the traditional gap between research and practice in education. Indeed, several reports have appeared in the literature that demonstrate a successful involvement of teachers in science education research and the dissemination of its results. The impact of such teacher involvement in education research has perhaps not been as strong or widespread as one could have wished. The main reason for this is that teachers tend to operate within their own school or, at best, a group of schools. This obviously places limitations on the sphere of their influence.

The desirability of collaboration between researchers and practitioners, as a means of bridging the research/practice gulf in science education, has also been stressed in the research literature itself. For example, in a paper entitled ‘The role of research in science teaching’, Kyle *et al.* (1991) make the following recommendations, among others:

- Research should be a collaborative endeavour.
- Teachers should be action-researchers.
- Research must be close to the classroom.

It is difficult not to agree with these points. Indeed, many other authors have argued along similar lines. For example, it appears logical that research findings, arrived at through a collaborative effort of researchers and practitioners, will have far more credibility to the practitioner than findings ‘imported’ from studies of situations that the practitioner does not recognise as his/her own. An additional advantage stems from the fact that, if practitioners have a partnership involvement in the generation of the findings, they are far more likely to apply them, not least because they share in the ownership of the findings. Also, conducting research in the ‘naturalistic’ environment of the classroom or teaching laboratory must inevitably lead to a closer connection between research and its applications.

The foregoing points about research as a collaborative endeavour, teachers’ involvement in action research and a strong focus in researches on the classroom, are ideologically very appealing. They are fully in line with the notion of ‘teachers as researchers’, a notion that has been widely advocated over the past two decades. The problem is that, by and large, the advocacy of the teachers-as-researchers concept has usually come from non-practitioners, rather than from the practitioners themselves. Thus, we should ask how realistic and practicable this notion really is.

The evidence we have suggests that, on the whole, practising teachers do not see themselves as participants in education research. Hancock (1997) looked in detail at the

reasons for teachers' reluctance to become involved in educational research.[§] Some of the reasons identified by him are specific to the British educational scene, for example that (at the time of the study) teachers felt 'undervalued' and marginalized from the government's agenda for change. Other reasons, however, were of a more general (and probably more universally valid) nature. These included:

- The demanding nature of teaching which leaves little time and energy for research.
- The mismatch between many of the methodologies applied in research and teachers' normal professional ways of working in the classroom.

Action research, so widely regarded as a 'natural' process for practitioners, is not excluded from criticism. For example, Johnston (1994) observed that:

Action research, although appearing on the surface to be a natural part of what is considered good teaching, actually does not fit with the processes that reflective, inquiring teachers use.

As an additional reason for teachers not to become involved in practice-related research, one can point to the relative isolation in which they normally work. The culture of many working environments is such that they do not encourage contact and interaction between practitioners and researchers. This is even true in many initial teacher-training programmes, at least in the UK. The problem here is that teacher-training functions are normally undertaken by staff with 'recent, relevant experience' of work in the classroom. (In Britain, accreditation of teacher-training programmes is dependent on institutions being able to demonstrate that they employ sufficient staff with this type of experience.). These trainers' knowledge of research, let alone about research is usually quite limited, with the consequence that trainee teachers learn little about research, its findings and methodology. Thus, the vicious circle continues to exist, with the gap between research and practice (and between researcher and practitioner) perpetuating itself.

Towards a solution?

Where does this leave us? Do the observations made so far point in the direction that to think of bringing research and its applications closer together is more a Utopian idea than a practical proposition? If not, what can be done, what can we do, in order to close the traditional gap between research and practice in science education?

The *first* point I want to make, in an attempt to answer these questions, is that we need to approach the issue of how we can bridge the gap between research and practice in science education with a good measure of realism. It makes little sense to put forward ideas and suggestions that have little chance of succeeding, because they ignore the circumstances under which teachers operate or make assumptions about what is possible for teachers to accomplish in practice. Thus, the notion that practitioners should function as researchers strikes me as unrealistic, at least in the short term. The focus in any development work with practitioners should primarily be on the application of research findings, not their generation.

My *second* point concerns the need to raise practitioners' awareness and knowledge of the findings from educational research. It may be tempting to look towards published materials, as an appropriate means for bringing the results and implications of science education research to the attention of the practitioners. After all, if well written, such materials should appeal to the practitioners, as opposed to the usual type of research

[§] On a related note, Hancock also poses the question of why researchers are often reluctant to engage in classroom teaching.

publication that seems to be aimed at researchers only. The problem with this line of action is that it has been tried in the past and not been found to be particularly effective, as far as one can judge from the still existing gulf between research and practice in science education. Therefore, some caution is advisable before investing a great deal of time and effort in the production of 'a guide to research findings' (or similar) for practising science teachers. It is also worth bearing in mind that, according to our findings, practitioners tend to rely largely on their 'personal' knowledge; therefore, the communication of 'lessons from research' through publications is unlikely to reach a substantial proportion of them.

My *third* point takes me back to the notion of collaboration between researcher and practitioner. The collaboration between researchers and practitioners, the recognition by both partners of a common purpose and a joint commitment to it are, it seems to me, essential ingredients of any strategy by which the impact of education research on educational practice can be enhanced. Although one may, in the long run, look here for a genuine partnership in the conduct of research, the immediate emphasis should be on the application of research findings. This often requires their careful adaptation to the practitioners' own circumstances, and it is in this respect that the researcher/practitioner partnerships seem to be not only desirable but also potentially valuable.

I am very much encouraged in this view by the experience of a group of my colleagues at Keele University. Led by Debbie McGregor, this group has for the last few years worked closely with science teachers from schools in North Staffordshire and surrounding counties (the region in which the university is located) on the implementation of findings and insight from the CASE (Cognitive Acceleration in Science Education) project originally developed at King's College, London. Without wishing to go into details of the work done by McGregor and her team, let me merely say that it has so far led to a successful implementation of the CASE materials in over 50 regional secondary schools. Having initially concentrated on the adoption and adaptation of the CASE scheme, the group is now moving towards partnership research with some of its partner-practitioners from the schools. If successful, this should ensure the transition from the 'application of research in practice' to 'practitioners functioning as researchers'.

What I have just reported is but one example of a successful attempt to translate findings from science education research into practice in the classroom and/or teaching laboratory. My own assessment is that its success is largely due to the close professional links that my colleagues have been able to form with the practitioner counterparts in schools in the region of the university and that researchers and practitioners have been able to work together as equal partners. Initially, the impact of this partnership work was restricted to the few schools collaborating with the Keele group during the early stages of the work, but it is interesting to note that, as other schools became informed about the activities, their interest was aroused and they too became associated with the group. In this way, the impact of the researcher/practitioner collaboration is clearly growing, and will, my colleagues hope, continue to grow.

The Keele example is just one instance of researchers and practitioners working in partnership to translate findings from science education research into actual classroom practice. No doubt, many other examples of successful researcher/practitioner collaborations exist. It would be valuable, in my view, if information about them could be gathered and made widely available to the research community: it might encourage the formation of partnerships through which research and practice can be brought closer together than is currently the case.

CONCLUDING COMMENT

In developing the thoughts presented here, my main concern has been with the issue of what can be done in order to enhance the impact of science education research on the practice of science education. The main message, arrived at in the light of the available evidence, points clearly to one conclusion, which is that neither researchers, nor practitioners alone are in a position to bring about an effective utilisation of education research. Instead, what is needed are partnership endeavours, in which researchers and practitioners work together to decide whatever is required to achieve a linkage between research and practice.

I should like to suggest that the researcher/practitioner partnership can begin at practically every stage of the research implementation scheme shown in Figure 1. Already at the initial 'knowledge transmission' stage, a collaboration between researcher and practitioner is potentially fruitful, because it enables both partners to work out how a particular research finding can be adapted to the practitioner's particular circumstance. Knowledge acquisition thus becomes a two-way process, allowing the researcher's knowledge of research findings to be integrated with the practitioner's 'personal' knowledge. As we have argued above, the integration of the two knowledge types is essential if research is to have a genuine impact on practice.

Given the fact that, if research implementation is to be effective, it needs to be brought about in the context of the conditions prevailing in a particular school or group of schools, we should accept that, initially at least, its impact will be rather localised. Whilst this may limit the spread of the research utilisation, i.e., its rate of impact, this should not be seen as a disadvantage: it is far better in my view to progress steadily with the assurance that the interventions are successful, rather than to want to bring about a swift research up-take without knowing that it really has the desired effects.

I mentioned in passing the 'teacher-as-researcher' notion that has repeatedly been advocated as a means of bringing about research-based changes in educational practice. There is no doubt that this notion is an attractive one and that it merits our attention. After all, a competent practitioner whose knowledge system embraces both knowledge about research and the kind of 'personal professional' knowledge referred to above, would be an ideal person to ensure a sound and effective utilisation of research. However, few such people exist at present, and – as observations have demonstrated – the working conditions under which they operate do not always allow them to use their talents.

Having so far focused chiefly on the practitioner of science education, I want finally to make a few observations about the current state of science education research itself. As we all recognise, science education research has, since the 1960s, become a major academic and intellectual pursuit. The many learned journals in which science education researches are now published testify to this. Without question, many of these researches have given rise to findings and results that could (and should) find their way into the practice of science education, for the benefit of learners and teachers alike. Yet, much of what is published in these journals is inaccessible to the practitioner. It is as though, in communicating their findings, researchers are addressing themselves primarily to the research community.

This observation is far from new. For example, during a previous ECRICE, I commented on "researchers' failure to address in their work issues of importance to practitioners and/or to elaborate and communicate the practical implications and applications of their research findings". Other authors have made similar observations. I want to suggest that it is high time now for all who are engaged in science education research to accept the challenge of looking beyond their immediate research interests and commitments in order to

identify ways and means of ensuring that the outcomes of their research are integrated into the practice of science education.

Let me conclude with a quote taken from a brief article published by Hurd (1993) under the title ‘ Comment on Science Education Research: A Crisis of Confidence’:

The write-up (of science education research) should not only offer a credible interpretation of the research but be expressed in a language that has meaning for teachers, parents, and school administrators. A next step is to provide concrete examples of how research findings influence the rationale, tactics, or strategies for teaching school sciences.

I believe that this is advice that deserves to be taken seriously.

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