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ABSTRACT

This study examined the variability and fragility of post-modern apprenticeship of clinical and biomedical scientists, different experiences of the fortunate and the unsupported, and problems facing professional associations trying to support their members professional learning. Focus was on Medical Laboratory Scientific Officers (MLSOs) working in the National Health Service in the United Kingdom. Methods for data collection were 9 surveys covering over 5,000 scientists, 260 interviews, 10 case studies of local/regional training schemes, and 30 meetings with professional groups. Findings related to the work environment identified the changing nature of scientific work in hospitals, changes in the pattern of who does the work, changes to the ways in which scientific services are facilitated and organized, and consequences for staffing levels and workloads. Findings related to training indicated funding lasted for 2-3 years, with some flexibility in length of training; MLSOs used logbooks developed by the Registration Board to specify training required in each discipline and a common core; arrangements for supervision appeared sufficient; feedback was inadequate; 18 learning processes were identified; former trainees positively endorsed training quality; and designated trainees said their academic and laboratory training were very good or good. Several issues were identified: quality assurance, professionalizing the training function, future of training for the health scientist professions, and training fit for purpose. (Contains 13 references.) (YLB)

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THE VOCATIONAL TRAINING OF SCIENTISTS ENTERING THE UK NATIONAL HEALTH SERVICE

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THE VOCATIONAL TRAINING OF SCIENTISTS ENTERING THE UK NATIONAL HEALTH SERVICE

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Aims and Focus

The aims of this 2 year project commissioned by the UK Department of Health were:

1. To evaluate current vocational training schemes for MLSOs, clinical scientists and MTOs by a combination of surveys and case studies;

2. To collect evidence of anticipated future changes in work practice and training, using a survey, expert interviews and focus groups;

3. To analyse the knowledge bases required for current and anticipated future practices;

4. To present and discuss a range of policy options for the vocationally specific training of science graduates.

The main groups studied were:

1. Clinical Scientists in the pathology based disciplines of Biochemistry, Cytogenetics, Molecular Genetics and Microbiology.
2.
3. Biomedical Scientists.
4.
3. Medical Physicists, Clinical engineers and Audiological Scientists.
4.
5. Medical Technical Officers (MTOs) in Cardiology and Rehabilitation Engineering.

Our evaluation of MTO training is not reported, because it raises a further set of complex issues beyond the scope of this paper,.

Background

Health Care Scientists are an almost invisible group of health professionals, partly because they are less numerous than most other professions, partly because they have less direct contact with patients. When the research was conducted only the biomedical scientists were nationally registered; then, in 2000, the clinical scientists (categories 1 and 3 above) voluntarily joined them. Inter-professional rivalries were diminishing during the course of the research, as they realised the need for a unified voice within the National Health Service (NHS) at both local and national levels.

About 2400 clinical scientists are employed in the NHS, distributed among 14 professional groups. Only two of these groups have a significant proportion of members working in District General Hospitals: the Association of Clinical Biochemists (about a third) and the Institute of Physics and Engineering in Medicine (about a quarter). The rest of their members and nearly all the members of the other groups work in regional centres and/or teaching hospitals. It is quite common for scientists with a purely research function and no clinical role to be appointed to Clinical Scientist Grades. Some combine both functions, and many change their prime function during the course of their career. This dual function has a very positive impact on the use of recent research in clinical practice; but it also creates difficulties for career progression and the provision of appropriate training. Appropriate first degrees are required for acceptance as a trainee clinical scientist, though many enter with postgraduate qualifications. Most trainees take a masters degree concurrently with their internal vocational training of 2 - 3 years. This is followed by a period of Higher Specialist Training and, for many, yet further study to become a Member of the Royal College of Pathologists, or a Chartered Physicist or Engineer.

The majority of the 21,000 registered Medical Laboratory Scientific Officers (MLSOs) work in the NHS, making them much the largest group of graduate scientists. About a half work in District General Hospitals, just under a quarter in Teaching Hospitals and about 15% in the Public Health Laboratory Service and Area Laboratories. MLSOs cover a wide range of pathology disciplines (see Appendix), but not respiratory physiology or physics. Their legal status is much clearer because the profession is registered with the Council for Professions Supplementary to Medicine, which regulates their training through its Medical Laboratory Technicians Board. They are represented by a single organisation, the Institute of Biomedical Science, which also gives them some coherence. The work of MLSOs is locally organised mainly through single discipline departments, each with their own laboratories - the main exception being recent mergers between clinical chemistry and haematology. Graduate entry became compulsory in 1994; and entrants with degrees not approved by CPSM have to take a top-up course during their first year of training. Over a half of MLSOs, or biomedical scientists (their preferred title) take an MSc after completing an initial training period of 1-2 years leading to Registration. In order to facilitate multi-disciplinary training, they have reduced the number of alternative logbooks to four: Cellular Pathology (Cytopathology and Histopathology), Clinical Chemistry, Haematology and Transfusion Science, and Microbiology (Bacteriology and Virology).

For most clinical scientists and all biomedical scientists the central feature of their training is a formally recognised **apprenticeship** to a department comprising members of the same professional group. This normally includes:

- A planned series of rotations around the department's work-sections, and sometimes also to other departments

- A logbook, manual or portfolio to guide and/or record a trainee's learning

- Attendance at general departmental seminars and/or teaching seminars specifically for trainees

- A certificate of competence based mainly on workplace assessment.

Theoretical Framework*[1]

The study of apprenticeship can be approached from two distinct perspectives. The first begins with the formal framework of supervision, allocation of work, feedback, documentation and assessment; then moves on to consider the extent to which the aspirations of the formal framework are achieved in practice, and the nature and efficacy of the apprentice's experience in different contexts. Although there is little formal teaching, this approach is not that dissimilar from that of programme evaluation in formal higher education; and usually matches the expectations of official sponsors. The second approach is based on the availability of learning opportunities, the disposition to take advantage of them and the social and cultural factors affecting learning. Its focus is often on workplace activities, both social and technical, levels of participation in these activities and the impact on learning of both power differentials and mutually supportive social relations. Regrettably the scale and complexity of this evaluation gave little scope for the ethnographic approach this second perspective requires. Nevertheless, we were able to conduct 10 short case studies.

Our evaluations of the quantity and quality of training and its fitness for purpose led us to seek evidence from trainees, trainers and other stakeholders about factors affecting learning in the workplace, the relevance of theoretical scientific knowledge, and whether aspects of training were superfluous or neglected. What kinds of learning opportunities were available for trainees? What kinds of learning support were most beneficial? Were they of sufficient quantity, quality and relevance? We were careful not to import preconceptions about self-directed learning, apprenticeship or the role of theory. Variations between the different professional groups and training programmes within the same profession provided an excellent opportunity to examine apprenticeship in action in a contemporary knowledge-rich context. To what extent did aspects of formal frameworks help or hinder learning? What happens to apprenticeship in unstable contexts where both the knowledge-base and the organisation of work are undergoing rapid and continuous change? What happens to learning when periods of working alongside particular experienced workers are relatively short, when some are well disposed towards trainees and others not, when even the well disposed are too busy to give trainees much "quality time"? This study examines the variability and fragility of post-modern apprenticeship, the different experiences of the fortunate and the unsupported, and the problems facing professional associations trying to support their members' professional learning.

Staffing

My co-applicant, Jocelyn Germain, the then President of the Institute of Biomedical Science, attended team meetings and gave regular advice on the pathology professions and the management of learning in laboratory settings. A full time research fellow, John James, was appointed to the project with previous experience of survey research in work contexts. Three health scientists were seconded to the project for two days a week: Scott Bowring, a medical physicist, Yvonne Cole, a biomedical scientist and Joan Pearson, a clinical biochemist. None had previous experience of social science research. The research reported in their paper was jointly conducted by this team of

[1] Further accounts of my theoretical position on workplace learning, tacit knowledge and apprenticeship can be found in Eraut (2000), Eraut et al (2000), and Eraut (2001).

six, including myself as Project Director; and all contributed to the research reported in this paper and our Final Report to the Department of Health.

Methods and Data Sources

The methods used for collecting data were 9 questionnaire surveys covering over 5,000 scientists, 260 interviews, 10 case studies of local or regional training schemes and over 30 meetings with professional groups. We began our work with theMLSOs, who were the largest and best organised group and partners in our original application. Being the only registered group, locating them was a simple task, although we did have to wait for an up-to-date register. We chose a 50% sample of all MLSOs who registered during or after 1990 from the Register of February 1997. This did not record individuals' specialisms, so our sample had to be large enough to get adequate sub-samples from the smaller disciplines. With the help of a reminder letter and a second copy of the questionnaire we received 705 completed questionnaires, 41% of our total sample of 1751.

This questionnaire served as the starting point for the other eight instruments, thus saving considerable time. However, in each case the same procedure was followed:

(1) Review of training schemes;
(2) Visits and interviews with trainers and education committee members to establish a provisional list of questions;
(3) Development of a draft questionnaire by team members;
(4) Piloting of the draft questionnaire with several recently trained scientists (6-10 for the early surveys, 2-4 for the later ones);
(5) Consultations about the draft questionnaire with officers of the relevant professional association;
(6) Final version produced by team members.

Questionnaires were dispatched with a covering letter explaining the importance of the project for the future of their profession and the strong support of their particular professional association, which had been involved in its design and had publicised the project in its newsletter.

In consultation with the project Advisory Group, it was agreed to survey the following groups of clinical scientists separately:

Medical Physics and Engineering
Biochemistry
Cytogenetics
Molecular Genetics
Microbiology

All other Grade A and Grade B 8-16 clinical scientists were sent a generic questionnaire. The location of eligible members of all clinical scientist groups was an enormous problem. Not all of them were members of their professional association and information published by local hospital personnel departments was rarely reliable. Information from different sources was inconsistent and many responses were received from scientists outside our target population. For clinical scientists, this target population comprised: (a) those who entered training during or after 1990, all of whom received most of their training under a scheme first introduced in 1991; (b) current trainees; and (c) those appointed to Grade A posts during this period, who were not centrally funded as designated trainees. There was no need for sampling, so questionnaires were sent to all identified members of the target population. The dispatch and return statistics for all seven questionnaires are presented below.

Table 1 Dispatch and Return Statistics for Questionnaire

Discipline/ Group	Dispatched	Known mishits	Total possible target	Completed	Return %	Return Designated Grade A	Estimated % of Designated Grade A
Biochem	255	19	236	123	52	73	100%
Cytogen	218	17	201	84	42	18	23%
Generic	402	17	385	116	30	20	
Med Phys & Eng	674	232	442	220	50	111	72%
Micro	209	27	182	77	42	15	68%
MLSO	1751	30	1721	705	41		41%
Mol Gen	61		61	38	62	13	68%

The selection of case studies was based on a need to observe a range of training patterns and scientist groups. So it was agreed to undertake 4 contrasting case studies of MLSO training, 2 contrasting case studies of Physics and Engineering Grade A schemes, 2 contrasting case studies of Biochemistry regional schemes, 1 study of a Molecular Genetics scheme, and 1 study of an MTO scheme. One of the Grade A Biochemistry schemes had an excellent reputation, confirmed by the survey data, and was unusual in not including a MSc course, preferring instead to commence preparation for the MRC Pathology examination. The other was more normal in including a part-time MSc within the Grade A training. For Physics and Engineering two regional consortium schemes of good reputation were chosen, one incorporating a full-time MSc and the other a part-time MSc. The linkage between MSc and work-based learning was a key issue, as was that of the role of coordination in reaping the advantages of the consortium without incurring the disadvantage of fragmentation. In general we were asked to seek good practice rather than typical examples.

In selecting MLSO case studies there was a need to study training schemes based in both a large teaching hospital and District General Hospitals of different sizes, to include a scheme outside England, to cover at least the four most popular disciplines, and to investigate the effect of students with sandwich degrees in biomedical science entering the trainee grade with some of their practical training already complete. The final selection was as follows:

(1) Large Biochemistry department in a Teaching Hospital
(2) Medium-sized Area Pathology Department (Biochemistry, Haematology, Histology, Cytology, Microbiology)
(3) Small DGH (Biochemistry, Haematology, Histology)
(4) Large DGH (Haematology, Histology, Microbiology)

One hospital had a particularly active group of training officers and close involvement with a degree course, one department took several sandwich students and trainees with and without sandwich degrees, another had trainees taking part-time BSc degrees alongside their laboratory training. One was in Northern Ireland, the region accorded the highest quality rating in our survey.

Members of the project team visited 60 hospitals, including 4 in Scotland and 1 in Northern Ireland. A large proportion of the formal interviews were carried out during these visits, but there were also a significant number of telephone interviews. The total number of interviews conducted was 260: 104 of these were carried out in connection with the 10 case studies but many of these also covered wider issues. The distribution of these interviews was as follows:

1. 84 MLSOs, from trainee MLSOs to Seniors and Chiefs: this included 18 Laboratory Managers, 15 Training Officers and Co-ordinators, a member of the MLT board and a CPSM Inspector.
2. 7 Biomedical Science students on sandwich courses for work placements.
3. 33 MTOs from trainees through to heads of departments.
4. 114 Clinical Scientists from designated Grade A trainees through to Grade C heads of departments: these included officers of 8 professional associations and regional tutors.
5. 6 Pathologists.
6. 13 others, including several industrial representatives, and a department head from a private laboratory.

The research team talked to people at more than 30 professional group meetings, seminars and conferences, several specially organised for us.

These qualitative sources of information have served a number of functions:

- Preparing questions for, then piloting the questionnaires
- Collecting information about current patterns of working practice in each discipline, the variations in practice and reasons given for them
- Collecting information about recent and anticipated changes in working practice, and the impact of technological and organisational change
- Collecting information about current training practices, the factors affecting these practices, recent and anticipated changes in training practice
- Collecting information about the knowledge base of each professional group
- Identifying and discussing issues relating to training policy
- Ascertaining the learning experiences of scientists who have had to make changes in their work role and practice after qualification.

Although each interview had a primary purpose, the opportunity was usually taken to explore other related issues in addition. Indeed, it would have been difficult not to have done so, given the interest of most respondents in our research.

All the survey reports, except that from the generic questionnaire, were sent for comment to officers of the professional associations concerned; and modifications and further analyses were made if the presentation of the data lacked clarity or its interpretation was ill informed. All 10 case studies were checked for factual accuracy with the co-ordinators of the training schemes. Throughout this time the project benefited enormously from the wide range of experience within the Project Team itself and their commitment to an independent analysis of the evidence. The report itself was discussed in draft form with members of the project's Advisory Committee, who gave useful advice throughout the project's lifetime.

The Work Environment

All the health professionals in this study worked in public hospitals, which offer free healthcare to the local community. Their patients are either referred by family doctors in community practices or arrive at their Accident and Emergency Departments. A high proportion of clinical scientists and about half the MLSOs work in teaching hospitals, which also function as tertiary referral centres for their regions. While giving excellent value for money, the NHS is constrained by the lower proportion of the national income spent on health in the UK than in some other Western European countries. Hence its hospitals are close to being overwhelmed by the growing demand for their increasingly sophisticated services, and their scientific services are at least as pressurised as the rest. We collected a considerable amount of information about changes in the work and working conditions of pathology-based scientists during our interviews and meetings; and our questionnaires asked specific questions about the extent of these changes, in particular which changes had been experienced in the previous five years and which were planned or anticipated for the next five years. This evidence covered:

- **The changing nature of scientific work in hospitals**. In most groups 50% - 85% of our informants reported significant changes, past and future, under the following headings: new specialisms, new methods, new tests, new equipment, more automation, increased use of IT.

- **Changes in the pattern of who does the work**. In most groups a majority reported an expanded role, including more clinical liaison and more management activity; the latter caused by a combination of automation and near-patient testing in which work was increasingly performed by non-scientists under the supervision of qualified scientists.

- **Changes to the ways in which scientific services are facilitated and organised**. There was competition for work between laboratories, an increase in income from outside the NHS, increased pressure on budgets; over a half of our respondents had been or were about to be involved in mergers between hospitals and/or between laboratories.

- **Consequences for staffing levels and workloads**. There was a marked decrease in the number and average grade level of all groups except molecular genetics; and a marked increase in workload.

Not surprisingly, these major changes and continuing trends were widely perceived as having a deleterious effect on training. It affected whom the trainees worked alongside, the quality and quantity of informal interaction with qualified scientists, the availability of senior staff and the general climate of the workplace. Table 2 shows the responses to our survey questions on "barriers to training".

Table 2 Barriers to Training

Workplace Factors		MLSO	Bio	Cyto	Mol	Micro
Service commitments over-ride training	FI	28	32	17	31	13
	VI	34	35	39	15	27
Supervisors/staff too busy or not available	FI	35	36	50	8	33
	VI	55	19	0	39	6
Department gave training low priority	FI	32	21	21	8	33
	VI	34	21	11	31	13
Poorly planned programme	FI	33	27	17	8	13
	VI	45	22	17	23	27

MLSOs, probably the most vulnerable group, consistently gave the most negative responses; and their opinions were confirmed by our interviews with their laboratory managers and training officers. Moreover, analysis of the MLSO data showed a highly significant connection between responses to these 'barrier' questions and trainee ratings of the overall quality of their training. When both *'MLSOs too busy to train'* and *'poorly planned programme'* were rated as *'very important'*, only 25% rated their training as *'good'* or *'very good'*. When trainees rated both factors as *'not important'* the proportion saying their training was *'good'* or *'very good'* was 94%.

20-40% of clinical scientists reported that isolation was an important barrier to training, both from other trainees and from other clinical scientists.

The Formal Training Framework

1 Funding and Length

All trainees are employed by the NHS on a trainee grade. Some clinical scientist groups require an MSc to be taken during training, either part-time concurrently with work-based training (Biochemists) or full time before embarking on work-based training (Audiology). Medical Physics uses the full-time option in some regions but not in others. The NHS funds a number of designated posts for clinical scientist trainees, which are supernumerary to service staffing but still make some contribution to service needs (these are referred to as DesA in some tables). However, hospitals also employ Grade A trainees without such funding (referred to as Not Designated Grade A or NDA). Thus we had the opportunity to compare responses from Des A and NDA groups. Nearly half the Biochemists and a quarter of the Molecular Geneticists entered training with a Ph.D.

The designated funding lasts for 2 or 3 years according to the profession but there is some flexibility in the length of training because assessment is based on documented evidence of competence and an oral examination. The training period for MLSOs for whom there are no externally funded posts is much more variable. Since degree entry became compulsory in 1994, 89% have completed in 2 years, and 61% of those with biochemical degrees completed in 18 months.

Ideally, the length of time spent on each rotation is that required to become competent in the relevant parts of the logbook. 73% of the sample said that most or all rotations were about the right length; 35% said at least some rotations were too short (they would normally be able to return to these later) and 30% said at least some were too long. Overlong rotations would normally indicate that service needs were being given priority over training needs. 18% reported an average rotation length of "6 months plus" and several quoted specific examples of "worst cases" that suggest unreasonable prolongation of the training period at the trainee's expense.

2 Documentation and Learning Materials

MLSOs use logbooks developed by the Registration Board to specify the training required in each discipline and a common core for all MLSOs. Completion is recorded by a supervisor signing off each individual entry and entering YES in a column headed '*competent*'. Completion of the compulsory parts of the logbook and the required number of optional sections has to be followed by a satisfactory performance in a final oral examination before state registration can be granted. The logbook is a syllabus rather than a teaching aid, and 30% of the sample also used supplementary training manuals developed by their training laboratory. Given that the logbook is the primary, formal method of ensuring that trainees are competent in each of the elements required for state registration, we might expect that they would be "signed off" at least as regularly as the end of each rotation. However, only 21% of MLSOs said that all their rotations were signed off as regularly as that; though a further 24% said that most of them were. Irregular signing off could be justified if the rotation had a clearly specified programme and completion of it signified competence in all its elements; but that could lead to delayed feedback to the trainee.

Clinical Scientists in pathology disciplines use logbooks or training manuals developed by their professional associations. These specify what has to be learned during Grade A Training. Typically, the more technical sections specify a core of essential items, then recommend coverage of between 40% and 60% of the rest. Each item is graded with a level of competence, each discipline using a slightly different scheme. The most elaborate example, form Immunology, is shown below.

0 *The procedure is unavailable or trainee has not had the opportunity to be trained in this function or task.*

1 *The trainee has an ability to USE a piece of equipment or carry out an assay accurately and consistently.*

2 *In addition to 1, the trainee has basic understanding of the theory of operating the equipment and the procedures used in the analysis, understands the inherent problems, and is able to take remedial action when problems occur.*

3 *In addition to 2, the trainee has a comprehensive understanding of the theoretical concepts involved in generating and interpreting data, particularly with reference to the diagnostic implications.*

4 *Has sufficient knowledge of the clinical applications and selection of appropriate investigations and interpretation of clinical significance.*

Where less technical skills are included, such as general laboratory knowledge or communication skills, they are less likely to be graded. Some disciplines use portfolios. The use and usefulness of these formal documents is presented in Table 3 below.

Table 3 Use of Training Logbook, Manuals or Portfolios

Subject	Indicator	Biochem	Cytogen		Mol Gen		Microbiol
			Man	Port	Log	Port	
Use of logbook or Training Manual or Portfolio	% Frequent Rare Never	 62 26 13	 44 0 56	 72 11 17	 62 15 23	 85 0 15	 46 27 -
Usefulness	% of users finding it *'of little use'*	-	0	0	-	0	21
Signing Off	% Frequent End of module or rotation	 26 22	 100 0	 87 7	 20 40	 23 39	 15 15

Cytogenetics is the only discipline that ensures frequent signing off of the logbook and/or portfolio as an ongoing assessment of practical competence. Molecular Genetics provides it for nearly two thirds of their trainees, Biochemistry for almost a half and Microbiology for just under a third. Signings less frequent than the end of a module or rotation are likely to be based on holistic impressions, thus devaluing the more detailed specifications devised by the professional associations

Medical Physicists and Clinical Engineers have a Training Prospectus that lists the competencies to be achieved in each specialism, and candidates keep a comprehensive record of their practical training in a large Training Portfolio.88% of the sample used the Prospectus (54% very frequently), and 75% found it useful or very useful. Unfortunately 73% of trainees found the meaning of its listed competencies unclear, as did many of the supervisors whom we interviewed.

3 Formal Assessment

The formal assessment process was not a major part of our research, but it is an important aspect of quality of training. The issues most likely to be of concern are:

- Whether the external assessment sufficiently samples the domain over which competence is expected;
- Whether there is feedback from the external assessor on the quality of training in a form that is usable and whether appropriate action is taken;
- Whether there is a clear national standard of competence.

Given that completed logbooks/training manuals or portfolios are an important component of the final assessment process, accompanied in some professions by trainers' reports and reports of theoretical training, the external assessor is a moderator of internal assessments as well as an independent examiner. Such moderation is possible for portfolios, but it is difficult to see how effective it can be for logbooks and training manuals. The clearest specifications are in Cytogenetics, which also uses a portfolio. The competencies in the Physics prospectus were described as insufficiently clear by 73% of those in the survey sample; and the entries for most other professions are even less clear. This is not to claim that wrong judgements are made, simply that the evidence for those judgements cannot be apparent to the external assessor. The CPSM formally state that:

> "Logbooks which have been filled in at the end of the training period and not in a continuous basis are **not acceptable** as documentary proof of training for state registration"

but less than half of the MLSO respondents to our survey were able to report that this happened for most of their rotations. The situation for Clinical Biochemists and Microbiologists was similar. Cytogenetics and Molecular Genetics, Physics and Engineering use portfolios that provide the external assessor with more concrete evidence. In Physics, most of our informants thought that the portfolios had become so large that the extra thickness might be lowering rather than raising the value of training. Too much writing could mean too little doing or even, if much of it is done too rapidly, too little thinking. The suggested reason for this enlargement was the demands of external assessment, and this should be investigated.

The best practice we encountered was in Cytogenetics, for which an interview account is reproduced below.

> *When a trainee is considered competent in an area of practice, he or she will be internally assessed by their trainer and evidence collected that their performance has reached the level shown by their trained colleagues. Such evidence is then included in their portfolio. When the module is complete they are assessed by an external assessor who examines the portfolio and* vivas *the trainee to confirm (or not) full understanding of the module. External assessors are trained and base their* vivas *on sets of specimen questions that have been collectively developed by the panel of assessors and annually revised. Each assessment leads to (1) feedback to the trainee (2) feedback to the trainer/head of department (3) a formal report to the Training and Accreditation Board. They have just decided that intermediate assessment (i.e. not the first and last) can be conducted at the assessor's lab rather than the trainee's lab if that is more convenient, thus saving the assessor's travelling time. The final assessment involves both the regular assessor and a second assessor who takes the leading role. The oral is very rigorous and makes much use of photos and referral cards as starting points for questions.*

Ensuring that appropriate feedback is given by assessors to training centres or departments and then acted upon has been a preoccupation in higher education for some time and Codes of Practice have been developed. These require that written reports from external examiners be sent to senior members of the training organisation, monitored for subsequent action and included in the documentation for accreditation visits. On the issue of maintaining a national standard, the research evidence (Wolf, 1995) suggests that both clear written standards (not so detailed as to be unusable) and regular assessor meetings to discuss exemplars (and agree on how to treat them) are needed. Neither is sufficient on its own.

4 Supervision and Feedback

On paper, arrangements for supervision usually appear to be sufficient. In practice, our experience in working with other health professions has been that local implementation is variable and sometimes indefensible. Thus we gave it particular attention in our survey. We have already reported that logbooks were signed off promptly for less than a half of MLSOs, clinical biochemists and microbiologists; thus considerably reducing this opportunity for informal feedback. However, 69% of MLSOs did get informal feedback at the end of each rotation or more frequently. On the negative side, 38% of MLSOs never received any formal feedback, 17% reported no informal feedback and 13% received no feedback at all. Of those who did receive feedback, 21% found formal feedback of little or no help and 14% reported this for informal feedback. Table 4below reports the evidence from the pathology-based clinical scientists.

Table 4 Supervision and Feedback

Subject	Indicator	Biochem	Cytogen	Mol Gen	Microbiol
Meetings with Supervisor	% Very regularly (1-2 months)	63	83	77	46
	% Very infrequent	33	17	15	31
	Of little use	10	6	8	7
Formal feedback Frequency %	At least monthly	1	25	0	8
	End of rotation	16	62	44	15
	3-6 monthly	11	0	22	23
	Annually	57	12	0	15
	Never	15	0	33	39
Informal feedback Frequency %	At least monthly	28	94	42	33
	End of rotation	35	6	17	0
	3-6 monthly	20	0	17	17
	Annually	6	0	8	8
	Never	11	0	17	42
Quality of feedback for those who got it	% "of little or no help"				
	Formal	16	19	0	10
	Informal	22	12	8	17
Quantity of formal feedback wanted	% "a lot more"	23	12	15	62
	% "a little more"	35	25	31	15
	% "about right"	43	62	54	23
Quantity of Informal feedback wanted	% "a lot more"	31	6	23	62
	% "a little more"	27	18	31	8
	% "about right"	42	76	46	31

These figures suggest both a management problem and a training problem. The management problem is to ensure that both formal and informal feedback are given with sufficient regularity; the training problem concerns the quality of feedback and the sensitivity towards learners to judge what kind of feedback is needed and how often. Cytogenetics is the only discipline to have achieved a defensible level of support across the country, and microbiology is particularly weak.

Another approach to feedback is **formative assessment,** for which the evidence from trainee Medical Physicists and Engineers is presented below. Only 5% of them had had written tests (omitted from the table); but there was a system of **monitoring, reporting** and **assessment- like discussions** which students were able to recognise and report. 73% of these Physicists met their supervisors at least monthly but 49% would still have liked more feedback, including 17% wanting *a lot more* feedback.

Table 4 Frequency of each type of assessment

Type of Assessment	Frequency %				
	Daily-weekly	2-4 weeks	End of placement	Never	No response
Discussions of theory	30	38	11	9	12
Discussions of practice	39	36	10	6	9
Check practical work	45	22	7	12	16
Observe practical work	43	23	4	17	13
Assess report	9	27	41	13	10
Oral tests	1	1	3	86	9

74% of MLSO trainees reported informal assessment-like discussions with their Senior MLSOs (about half were weekly or monthly and a further third at the end of a rotation); and 65% experienced tests: 52% oral, 32% practical, 15% written. Biochemistry figures were 38% oral, 33% written and Cytogenetics 51% oral, 50% written essays. 85% of Molecular Genetics trainees reported assessment-like discussions but only 47% of Microbiology trainees.

There is no clear reason for such wide differences in practice on such key aspects of training, and one suspects that much depends on what the local professionals feel able to handle. Those who like to present a rosy picture of apprenticeship will emphasise the informal feedback and be less worried by the absence of formal feedback, though there is no evidence that one replaces the other. However, our MLSO sample was large enough for us to investigate the link between feedback and trainee ratings of the quality of training. Partly for presentational convenience (important when seeking to influence policy) we defined "**good feedback**" as receiving both formal and informal feedback at the end of each rotation or more frequently; and "**no feedback**" as those 14% of trainees who reported no feedback of any kind. Table 5 below shows a strong link between feedback and trainee ratings of the overall quality of their training.

Table 5 Links between Feedback and Quality of Laboratory Training

Level of feedback	Overall quality rating			
	Very good	Good	Adequate	Poor/very poor
Group 1 - good feedback	22%	48%	26%	4%
Group 2 - no feedback	7%	14%	41%	39%

Learning Processes

18 different learning processes were identified in the interviews and discussions that informed the design of the first questionnaire; and the MLSO respondents were asked to assess the frequency and usefulness of each. The top six activities were centred round the workbench itself and were all experienced either fairly frequently or very frequently (see Table 6). The three reading activities were used *fairly frequently;* while writing activities (not shown) were less than *infrequent*. The workbench activities also received the highest usefulness ratings, closer to *very useful* (2) than *fairly useful* (1). The least frequent of them *one to one coaching* received the highest usefulness rating.

Table 6 Frequency and Usefulness of most common Learning Processes

Learning Activity	**Frequency - Mean * 0 (not used) to 3 (very frequent)**	**Usefulness - Mean + 0 (not useful) to 2 (very useful)**
Routinely working alongside qualified MLSO	2.57	<u>1.75</u>
Being verbally instructed	2.56	<u>1.69</u>
Asking someone	2.39	<u>1.65</u>
Watching someone	2.31	1.58
Talking with MLSO Grade 1	2.16	1.59
One-to-one coaching	2.07	<u>1.84</u>
Reading Manuals	1.74	1.30
Self-directed study	1.70	1.37
Reading journals, textbooks	1.62	1.37
Talking to other trainees	1.34	1.25
Talks, seminars with seniors/chiefs	1.26	1.43
Attending general seminars	0.97	1.15

A similar design process led to the identification of 20 learning processes used by trainee clinical scientists in pathology. Their mean ratings for their 15 most important learning processes (reported in Table 7 below) show marked differences from the MLSO, which indicate much greater involvement is quasi-academic work within the laboratory setting. This reflects the higher formal knowledge base required by Clinical Scientists. Bench-based learning is still important but not quite so dominant. Coaching is still highly valued but relatively infrequent; so also are projects and case discussions.

The high frequency and usefulness of independent reading is confirmed by the high average hours spent reading each week, which ranges from 8.5 to 9.8 according to the professional group. The figures suggest that, on average, up to a half of this time is spent at work, and at least a half at home. This is about double the 4.7 hours a week reported by MLSOs for their first year, though this figure rises to 10.3 hours a week in the two months immediately preceding their formal oral examination.

Table 7 **Frequency and Usefulness of Learning Processes (mean ratings)**

	Frequency (0-3) *				Usefulness (0-2) □			
Laboratory Based	Bio	Cyto	Mol	Micro	Bio	Cyto	Mol	Micro
Asking someone	2.4	2.2	2.2	2.4	1.6	1.8	1.7	1.5
Watching someone	2.4	2.1	2.2	2.4	1.4	1.8	1.8	1.2
Routinely working alongside senior colleagues	1.9	2.2	2.1	1.7	1.6	1.6	1.5	1.7
Working under supervision	2.1	1.7	1.9	2.1	1.6	1.5	1.4	1.9
Being verbally instructed	2.0	2.0	2.1	2.1	1.6	1.5	1.8	1.4
One to one coaching	1.9	2.0	2.1	2.1	1.8	1.9	1.8	1.8
Individual Learning								
Reading textbooks	2.6	2.7	2.2	2.3	1.7	1.9	1.8	1.6
Reading journals	2.4	2.3	2.9	2.7	1.5	1.7	1.9	1.9
Attending lectures/seminars	2.6	1.6	1.8	2.1	1.6	1.3	1.2	1.6
Project work	1.8	1.0	2.1	2.3	1.5	1.2	1.8	1.8
Essay writing	1.6	1.1	2.1	1.2	1.4	1.4	1.5	1.5
Interacting with others								
Talking with B/C Grades	2.2	2.3	2.4	2.0	1.7	1.6	1.7	1.6
Talking with MLSOs	2.4	-	0.7	2.3	1.4	-	1.0	1.3
Case discussions	1.6	1.5	1.4	0.8	1.7	1.6	1.5	1.7
Shadowing senior staff	1.4	1.4	1.8	1.0	1.5	1.4	1.3	1.0

* Mean frequencies of 2.2 or more are underlined. Responses of 0, 1, 2 and 3 mean Never, Infrequent, Fairly Frequent and Very Frequent.

† Mean frequencies of 1.7 or more are underlined. Responses of 0, 1 and 2 mean Not Useful, Fairly Useful and Very Useful.

Another interesting question is the relative contribution to trainees' learning of the various grades within their own profession (1-4 for MLSOs; A, B and C for clinical scientists) and those from other professions. For the two Genetics disciplines the practice is quite simple: the largest contribution comes from newly qualified lower Grade B colleagues, the next from upper Grade B and the next from Grade C. Both Biochemists and Microbiologists learn a lot of their analytic techniques from MLSOs, especially in their first two years when rotations are planned for this purpose, hence MLSOs were rated the highest contributors during that period, followed by the more senior grades of clinical scientist who run the lecture/seminar programmes. For Physicists and Engineers, their placement supervisors and recently qualified Grade B colleagues are reported as making the greatest contribution, closely followed by technical staff. They also spend about 10 hours a week reading, though this average figure disguises large individual variations.

The Quality of Training

Judgements about the quality of training were sought in several different ways, partly to cross-check evidence but mainly to obtain a more complex understanding of quality than a single rating could provide. We also looked at variations in quality with location, time, type of hospital and trainee characteristics for the large MLSO sample.

MLSO respondents to the questionnaire were all state-registered, 75% of them had completed their training at least 2½ years before they completed the questionnaire; so they knew from experience what the job of a MLSO Grade 1 entailed and could judge their training with the hindsight of that experience. The survey incorporated several different approaches to former trainee judgements of their training, starting with the overall quality of their **academic learning** and their **laboratory training**.

Table 8 Overall Quality Ratings (%)

	Academic Learning	Laboratory Training
Very Good (5)	23	16
Good (4)	47	34
Adequate (3)	25	35
Poor (2)	2	10
Very Poor (1)	1	4
No data	1	2
Mean Rating	3.91	3.49

These generally positive figures disguise a significant level of regional variation, with the highest ratings for both academic learning and laboratory training coming from Northern Ireland.

Table 9 Distribution of Mean Quality Ratings by Region

Mean rating (by region)	Academic Learning	Laboratory Training
North East & Yorkshire	3.8	3.6
Trent	3.6	3.5
East Anglia & Oxford	4.0	3.5
Thames North	4.0	3.3
Thames South	3.9	3.5
South West	4.1	3.7
West Midlands	3.8	3.4
North West	3.9	3.3
Wales	4.2	3.4
Northern Ireland	4.3	4.1
Scotland	3.7	3.5

Breakdowns of the ratings for laboratory training were investigated for year of registration, gender, age, discipline, degree or HNC, and type of employer. The most important aspects of this data are:

- No discernible pattern of improvement over time;
- Large differences between disciplines which raise important questions for further research (why should Cytology be highest with a mean of 3.6 and Histology, one of the lowest, with a mean of 3.2?);
- Rather smaller differences between type of employer.

Another approach to the quality issue was to ask whether training rotations had satisfied the trainees' needs in three domains - practical skills, theoretical understanding and combined needs (relating theory to practice). This revealed a small

11% 'tail' for practical skills, comparable with the 14% tail of *poor* and *very poor* ratings of the overall quality of laboratory training (Table 8) and 13% of respondents who reported no feedback of any kind.

Table 10 Proportion of Rotations Satisfying Training Needs

Type of need	All rotations	Most rotations	Half or less
Practical skills	42	47	11
Theoreticalunderstanding	16	45	38
Combined	18	48	34

Given the very small 3% tail for the overall quality of academic learning, we would interpret the more disappointing figures for theoretical understanding and combined needs as indicating that academic learning often takes place not in the rotations themselves but in the seminar programmes run by laboratory training officers and through independent study. Breakdown of this data showed:

- Some regional variation in practical skills
- Rather more variation between regions for theoretical understanding
- Relatively small variation between types of hospital.

Thus, apart from the small tail and a more general lack of feedback (discussed earlier) the quality of training was positively endorsed by former trainees. However, there were rather more concerns about its quantity, prompted we assume by trainees' assessment of the gap between their competence at registration and later expectations of registered MLSOs. One such concern was linked to multi-skilling. 88% of the sample reported that training in another pathology discipline would be useful (41%) or very useful (47%); but only 43% received it, only a half of whom considered it sufficient. This could be ameliorated by the use of the new bi-discipline CPSM logbooks, but not without a corresponding increase in training time. Table 11 below gives another indication of quantitative insufficiency.

Table 11 Percentages wanting More Training in 13 aspects of MLSO job

Aspect of the job	A lot more training	A little more training
Research methods	39	39
Management	37	37
Troubleshooting	28	46
Computer - data handling	31	33
Theoretical justification of SOPs	19	36
Monitoring - interpreting results	18	34
Maintaining equipment	12	35
Methods of quality control	12	34
Understanding purpose of SOPs	11	29
Health and safety	9	21
Learning SOPs	7	17
Operating equipment	5	16
Specimen handling	2	8

When respondents were asked if they wanted more or less training in 13 identified features of the MLSO's job, the demand for more training was shown to be very high indeed. In no case did more than 5% of the sample want less training and in eight areas it was less than 2.5%. This need for further training is confirmed by laboratory managers reporting that most post-registration MLSOs need a few further months before being ready to undertake "on call" duties

When respondents were asked to rate the quality of training for these 13 aspects of the MLSOs' job, the correspondence with their quantity assessments was remarkable. The four ratings below *adequate* (3) were the four aspects of the job for which more than 60% of the sample wanted more training; **research methods** (quality rating 2.3), **management** (2.1), **troubleshooting** (2.9), **computers and data handling** (2.7). **Specimen handling** gets the highest rating of 4.0 just above *good* (4); and the other eight aspects all lie between 3.2 and 3.6, midway between *adequate* and *good*. These figures show that quantity issues can depress quality ratings of individual topics without affecting overall quality ratings. The overall ratings appear to be more focused on the general quality of delivery, and may also be influenced by trainees' financial need to keep their pre-registration training reasonably short. This raises the question of whether this need for more training is better met by extending the length of initial training or introducing a more formalised system of post-registration training. The former would be more honest, the latter more popular.

Unlike the MLSOs a half of the pathology-based clinical scientists were still in training when the questionnaire was dispatched; so their judgements of quality may have been a little premature as well as vivid. However, it would be unusual if they had not discussed many of the issues with B grade scientists on a number of occasions and become well aware of what was yet to come. As before, the first judgements to be made were two ratings of the overall quality of the **academic/theoretical** and **laboratory** components of training:

Table 12 Ratings of Overall Quality of Training

Quality Ratings		Biochem	Cytogen	Mol Gen	Micro
Academic/	Mean (1-5 scale)	4.1	3.6	3.8	4.1
Theoretical	% Poor or Very Poor	2	6	15	0
Laboratory	Mean	4.0	4.1	4.5	4.0
	% Poor or Very Poor	5	0	8	7

Only the biochemistry ratings could be justifiably broken down. Neither showed significant changes over time, nor between responses from district general hospitals and teaching hospitals. However there was a significant regional variation. Because of the small numbers of respondents in each region only those four with the greatest number of respondents are shown.

Table 13 Regional Variation in Quality Ratings for Biochemistry (means)

Component/Region	Thames N	Thames S	Midlands	North-West
Academic/Theoretical	4.2	4.1	4.5	3.7
Laboratory	3.9	3.8	4.2	3.7

The lowest **academic/theoretical** ratings come from the two Genetics disciplines, which have only a 2 year training period and do not incorporate an MSc course. However, the highest regional rating for Biochemistry came from the Midlands, the region which does not have an MSc course.

Also relevant to judgements of quality were the questions asked about rotations and modules. 74% or more respondents in each discipline thought that *most* or *all* rotations/modules were about the right length and the rest were nearly evenly divided between *some too long* and *some too short.* A fairly small proportion (see Table 14 below) thought that a *half* or less of the rotations/modules met their theory needs and practical needs.

Table 14 % claiming that a 'half' or less rotations/modules met their needs

	Biochem	Cytogen	Mol Gen	Microbiol
Theory needs	30	11	15	20
Practice needs	11	0	16	13

This confirms that, while there is scope for improvement in some regions, the overall quality of programmes for Designated Grade A trainees in these four pathology-based disciplines is excellent. Nevertheless, we still found a substantial demand for more training. Our consultations prior to the survey identified for each discipline a list of between 13 and 19 key features of their job; which we then used to find out where more training was wanted. Table 15 shows those features for which more than a half of the respondents from at least one discipline wanted more training. All except the last are generic.

Table 15 % Trainees wanting More Training

	Biochem	Cytogen	Mol Gen	Microbiol
Information Technology	56	61	62	53
Communication/presentation skills	33	84	31	47
Method development & evaluation	57	56	31	-
Troubleshooting	70	73	23	67
Audit	63	50	46	47
Applied Statistics	83	-	62	53
Clinical liaison/interpretation	74	62	23	73
Quality assurance and control	59	28	31	40
Data analysis and evaluation	57	-	39	-
Evidence-based pathology	73	-	15	66*
Dev & analysis of family studies	-	-	54	-

* Epidemiology of Disease

Comparison of current Grade A trainees in Biochemistry with former trainees now in Grade B, and therefore able to avoid premature judgements, indicates that 50% of current Grade B respondents would have liked more training in all the topics rated at over 50% in the above table, thus disconfirming the "too early to judge" hypothesis. Grade B scientists clearly need these aspects of competence for their current jobs. Three responses are possible; some adjustment across the boundary between Grade A training and higher specialist training in Grade B; or a strong emphasis on these features of clinical scientists' work at the beginning of Grade B; or a combination of the two. We shall return to this issue later.

Medical Physicists and Engineers responded to the same sets of questions; and overall quality ratings also showed high regional variation (see Table 16) but only small differences between types of hospital.

Table 16 Regional Variations in Quality Ratings

Region	Academic (mean)	Practical (mean)
Thames South	4.3	4.0
Trent	4.3	4.0
Thames North	3.4	3.8
North East & Yorkshire	3.7	3.8
East Anglia & Oxford	3.8	3.7
South West	3.8	3.6
West Midlands	3.6	3.5

When asked how many placements had met three kinds of need, over a third were dissatisfied with one placement and a small minority with two:

Table 17 Number of Placements Meeting Training Needs (% responding)

Type of Need	1	2	3
Theoretical understanding	7	37	56
Practical skills	8	36	56
Relating theory to practice	10	34	56

Presumably those satisfied with two of their three placements gave an overall rating of *adequate* or even *good*, if their placement in their intending specialism was good. There may also have been some quantitative as well as qualitative concerns. 71% said that most or all of their main placements were about the right length, 23% that some were too short and 8% that some were too long.

Like the other scientist groups, the overall quality rating was good, although there is scope for improvement in some areas. But many scientists would still have liked more training. A different breakdown, using four aspects of the job revealed that between 27% and 45% of the sample wanted more training; while quality ratings (1-5 scale) were little more than *adequate*.

More surprising perhaps is that only a minority of the sample reported receiving any training in seven job-related practices. We also asked whether those who had received training now felt *very comfortable* (2), *OK* (1) or *not comfortable* (0) when doing these activities, with not entirely convincing results. While some of these skills might be expected to be "picked up" rather than taught, one might have hoped for greater confidence in data handling and statistics after Grade A training and two degrees.

Table 18 Training in Selected Processes

Process	% Receiving training	Mean on comfort scale (-0-2) for those trained
Data handling	41	1.2
Statistics	24	0.9
Report writing	41	1.4
Oral presentation	41	1.2
Bedside manner	21	1.2
Other work with patients	29	1.2
Working with senior medics	23	1.0

Although 25% said that their MSc course did not cover the underpinning theory for their practical placements, ratings of its usefulness for their work as a clinical scientist course were generally positive:

Essential	18%	Reasonably Useful	25%
Very Useful	45%	Little or No Use	12%

The Benefits of the Designated Trainee System

The survey enabled us to compare the experiences and quality ratings of centrally funded Designated A Grade Trainees (Des A) and other novice Grade A scientists who relied only on local funding or good will for any training they received (NDA). A significant feature of the data is that NDA scientists only responded to some questions, presumably those where they felt able to make meaningful replies. We believe that those who took the trouble to return the questionnaire would not have ignored questions they would have found meaningful, so that failure to make a response should usually be construed negatively. The tables presented below give three percentages for each profession: one for the Des A group, one for the NDA scientists who answered the question and one for the NDA scientists who did not answer the question (referred to as *NDA no response*). Where the *no response* rate for the Des A group is 10% or more, the figure is starred.

Tables 19 and 20 below show that far greater proportions of the Des A group said that their academic training and laboratory training were *very good* or *good*. The two *no response* rates may indicate that a third or more NDA Biochemists and Microbiologists did not regard themselves as having received any training. This rate is noticeably lower for Cytogenetics where special effort was made to provide training for NDA scientists.

Table 19 Overall Quality Rating of Academic Learning
% selecting *very good* or *good*

Profession	Des A	NDA	NDA No response
Clinical Biochemistry	83	27	47
Clinical Cytogenetics	50	47	13
Clinical Molecular Genetics	77	47	21
Clinical Microbiology	67*	34	34

Table 20 Overall Quality Rating of Laboratory Training
% selecting *very good* or *good*

Profession	Des A	NDA	NDA No response
Clinical Biochemistry	74	43	47
Clinical Cytogenetics	83	63	10
Clinical Molecular Genetics	92	37	32
Clinical Microbiology	67*	19	49

The differences between the two groups are larger still when questions are asked about rotations, largely due to an extremely high *no response* rate from NDAs. The figures for rotations satisfying practical training needs, their prime purpose, are shown in Table 21 below. The *no response* may indicate that there were no rotations, thus confirming the view that NDA training is likely to be narrow.

Table 21 Proportion of rotations satisfying practical training needs
% selecting *all* or *most*

Profession	Des A	NDA	NDA No response
Clinical Biochemistry	82	27	70
Clinical Cytogenetics	72*	43	50
Clinical Molecular Genetics	69*	0	100
Clinical Microbiology	47*	0	98

Another important difference is the amount of supervision. Table 22 indicates that most Grade A trainees met their supervisor very regularly, whereas NDAs did not. Indeed the *no response* could mean that they did not even have a supervisor.

Table 22 Meetings with Supervisors
% reporting *very regular* meetings (every 1-2 months)

Profession	Des A	NDA	NDA No response
Clinical Biochemistry	63	13	63
Clinical Cytogenetics	83	33	37
Clinical Molecular Genetics	77	47	42
Clinical Microbiology	40*	34	29

In addition to the 111 designated Grade A trainees, responses were received from 89 Medical Physicists and Clinical Engineers who entered the profession in the 1990s but did not have a designated Grade A post. Table 23 below shows that the overall quality of both **academic teaching** and **practical training** was judged to be *good* or *very good* by a much smaller percentage of NDAs, 40% of whom did not respond to this question, probably because they did not regard themselves as having received any training.

Table 23 Overall Quality Rating of Training
% respondents selecting *very good* or *good*

	Des A	NDA	NDA no response
Academic Teaching	63	38	43
Practical Training	62	33	40

Only a quarter of the NDAs claimed to have an active supervisor in most placements (compared with 81% for Des A trainees) and only 37% answered the question. Most of those who did have active supervisors reviewed progress with them fairly frequently: 44% at least weekly, a further 16% at least monthly and a further 24% quarterly. Only 28% met a training co-ordinator, a half of whom had progress reviews at least quarterly. The rest probably received little formal support. Most of these meetings were described as very helpful or reasonably helpful.

The quality ratings were higher for the Des A group in the areas of **equipment** and **applications,** but not in **quality** or **health and safety.** More training was wanted by those NDAs who responded in all these four areas than by the Des A trainees. However, the difference was not very large, the biggest being 44%, rather than 27% wanting more training in **quality.**

Quality Assurance

Assessment is an important part of quality assurance and failure rates are an important indicator of quality of training (and possibly also selection). But to rely on failure rates alone would fail to do justice to the majority of trainees who achieve more than is required for a pass and the trainers who devote much of their personal time to supporting them. Quality assurance must be concerned with process as well as outcome, in order that we can be assured that the process is giving the appropriate added value. The evidence of our surveys suggests that, within the current approach to the vocational training of scientists, the following features are important:

- Design and implementation of the training programme;
- Usefulness for trainees of the training prospectus, logbook or manual;
- Good access to appropriate learning opportunities;
- Feedback of sufficient quantity and quality
- An assessment system which provides some formal intermediate checks on trainees' progress; and an appropriate indication of their learning outcomes at the point of completion;
- On-the-job learning support of sufficient quantity and quality to maintain an appropriate rate of trainee progress and an appropriate standard of performance.

Postgraduate vocational training in complex environments necessarily depends on trainees developing a capacity for self-directed learning. Not all trainees will have acquired this during their degree courses, and not all find it easy to transfer that capability from a highly individual academic environment to a work environment where much of the desired knowledge is situated in other people rather than in published material. These features are aimed at developing a capacity for autonomous professional learning after qualification, not at spoon-feeding; and this involves fostering a climate of questioning and independent thinking, not a dominant aspect of traditional apprenticeship unless one has a Socratic model in mind (and his practical activities were rather limited).

Many of these features are covered by the training schemes and timetables required for accreditation as a training laboratory by CPSM or professional associations of clinical scientists. But the current system does not guarantee that those plans will be implemented. The survey results reported in chapters 2-5 suggest where improvements in feedback and learning opportunities are most needed by a significant number of trainees. The introduction of a "student entitlement" might help; and good monitoring ought to provide some better safeguards for the minority of students who get less than the good support received by the majority. However, this requires a training officer or co-ordinator with sufficient time to maintain the coherence of what is often a complex training programme, and to perform this monitoring role. An example of good practice from a physics case study is quoted below.

> *At centre Q there is a formal schedule of meetings and assessments throughout each major placement. The process starts with a pre-placement meeting between the training co-ordinator and the supervisor. The trainee usually also attends (and always does so if the meeting is for their first major placement). The aim is to ensure that the supervisor and trainee both know what is expected of them and that any foreseeable problems in meeting any of the competencies are addressed. Once the placement starts the trainee is responsible for completing weekly and fortnightly report forms and for sending copies of these to the co-ordinator. The weekly form provides for a summary of the areas worked on during the week and is simply countersigned by the supervisor. The fortnightly form is aimed to be a record of a more formal fortnightly meeting between the trainee and supervisor at which the previous fortnight's work is reviewed and the next fortnight's work is planned in more detail. Again a copy of this is sent to the co-ordinator. This system does not, of course, always work and the system of fortnightly meetings can become irregular and informal. However a shortage of forms received by the co-ordinator is always investigated and approximately every six weeks the co-ordinator joins the trainee and supervisor for one of their fortnightly review meetings to ensure that the placement is proceeding satisfactorily. Towards the end of the placement these meetings also become an opportunity for the co-ordinator to ask the trainee "mock oral" type questions and thus elucidate areas of possible weakness where additional effort should be concentrated. Finally, either soon after the end of the placement, or when the trainee has completed writing the portfolio for the placement, a more formal meeting is held in the form of a "mock oral" examination lasting about an hour, as opposed to the 20-30 minutes allowed in the real thing. In addition, both trainee and supervisor are asked to complete "feedback" forms asking what they felt was good and bad about the placement; and these are used to help improve future placements.*

Sufficient authority and backing from the head of department is vital to see that deficiencies are remedied. Improving on-the-job learning support will depend on ensuring that trainers have both sufficient time dedicated to that role and training in teaching skills appropriate for work-based learning and in-house seminars. Training should also include giving constructive feedback and assessing trainee performance.

Those parts of the survey concerned with the quantity and quality of training provide important information for the design of programmes. It is difficult to tell whether the high level of demand for more training is due mainly to the amount of learning support or the quantity of material in the syllabus: probably both are important factors. Quality is best ensured by realistic decisions about how much has to be covered in a given training period; sometimes progression means doing something better rather than doing more things less well. One major problem is that currently people do not feel they can rely on the continuation of training after the traineeship has ended (our evaluation of Higher Specialist Training is not reported here); and if they could, there is no formal system for supporting continuity of learning across the 'qualification' boundary. If expectations of learning outcomes at the end of traineeship were clearer, this would help both trainers and trainees to have clear goals.

Not all the issues are within the profession's control, but even when other parties are involved, framing the problem and backing that diagnosis with evidence is an important first step towards solving it. In those aspects of training receiving low quality ratings there are two possible courses of action: either dropping the requirement or improving the teaching. The latter may be best achieved by finding and disseminating good practice, or by asking a training consultant. This kind of trouble-shooting should be a role for the professional associations. Problems concerning the development of theoretical understanding linked to practice should be included in this approach.

One of the difficulties facing smaller professions is the scarcity of people to develop and maintain a national training network. We shall return to this issue later. Meanwhile we suggest that, although formal assessment has to be done by a member of the profession concerned, much of the quality assurance role described above need not be discipline specific. A training co-ordinator with a quality assurance role across the pathology disciplines would be an economic proposition, as well as promoting the exchange of training experience across professions. Some aspects of the external monitoring might also be shared.

Professionalising the Training Function

Vocational training schemes for MLSOs and Clinical Scientists have been developed by the Medical Laboratory Technicians Board of CPSM for MLSOs, and by the professional associations for Clinical Scientists. These schemes are evolving through experience and adapting to the rapidly changing needs of the NHS. All of them involve a framework of supervision, assessment and feedback, which formalises some aspects of apprenticeship but leaves others to the discretion of local laboratories and individual trainers. Accreditation of laboratories for training requires approval of their training plans and resources. Although the maintenance and ongoing development of this framework puts considerable demands on the professional associations and the CPSM, none of our informants suggested that the system was unnecessarily bureaucratic or that it weakened the personal dimension of apprenticeship.

Other features of the system such as log-books and manuals have also been developed by professional associations, the CPSM board and local trainers; and these are widely (though not universally) used and valued. They do not constitute part of the most traditional apprenticeship model, but have been used in several occupations for a considerable period of time. The main argument is that such navigational aids are needed to guide and monitor a trainee's learning, when there is no longer a single expert-apprentice relationship but a series of rotations between professional teams with learning support mostly being provided by qualified but relatively junior staff. However, the design of such aids, and indeed of the framework itself, is not a simple task. It requires knowledge of learning processes, close acquaintance with the work itself, design skills and experience of working with trainees. This makes it a distinct professional function for which expertise needs to be developed.

Scientists, even more than doctors, rely on up-to-date scientific knowledge. It is the growth and increasing importance of that knowledge which has led to the development of the clinical and biomedical scientist professions. While much of this knowledge is acquired in academic contexts, learning how to use it in practice can only happen in working contexts. This is supported by a seminar-tutorial component in or near the workplace, another addition to the basic apprenticeship model. Seminar programmes of this kind are a regular part of postgraduate medicine with protected time for attendance; and are supplemented by teaching rounds and case presentations in those departments that give additional priority to teaching and sharing experience. They are even more important for scientists, because the use of scientific knowledge for the benefit of patients is their *raison d'étre.*

The teaching role of linking theory to practice in a meaningful way is also very challenging; and it requires that both trainer and trainees occasionally take some time away from service demands. However, the evidence given in our interviews with MLSOs and scientists at every level was that budgetary and productivity pressures are increasingly eroding any training time that might have been available in the past. Their prediction is that time for training can no longer be extracted from service time, and service pressures will inevitably reduce the quality of training. The response to this problem should not be an attempt to separate training from practice, but rather a recognition that exploiting the learning potential of participating in practice requires at least some time to collectively think and talk about what is going on and why.

Our interviews with senior professionals consistently emphasised the need for dedicated time for trainers to enable them to give trainees the attention they require; and the need for trainers, supervisors and training officers and co-ordinators to be properly trained for the job. We would endorse these recommendations, which would directly affect the level and quality of learning support for trainees, and indirectly lead to improvements in training programmes as the role becomes more professionalised. Cytogenetics is the only discipline that insists on a training course (1 week) for all its trainers. Cardiff runs a training of trainers course for MLSOs in Wales, and so too does the Royal Free Hospital in London.

Evidence of the impact of a "professionalised" training officer can be seen in the following excerpt from a MLSO Case Study.

The three training officers had received training for their practice tutor roles in a sandwich degree in Biomedical Science; and been assessed by the university on their ability to teach in the workplace. The training co-ordinator had taken a Diploma in Health Service Management and initiated a Training Needs Analysis. Another training officer had taken an NVQ Assessors award some years ago, as part of a regional group writing an NVQ for MLAs. She had found this to be a very useful experience, and it also provided materials for assessment, which she used to train MLSOs. She is currently taking a postgraduate certificate in teaching. All three strongly believe that training officers need formal training in order to be effective.

The training officer in haematology had developed an internal training manual to provide a basic structure for training in her department.. She keeps updating the training manual and cross-referencing it to the CPSM logbook, so that when part of the training manual has been completed, the CPSM logbook can be signed off at the same time. This is done every three months. The training schedules reflect the level of work required, but need to be adaptable so that, if any problems arise, more time can be allocated. They felt that watching someone did not give much benefit and that trainees only learned when they had hands on experience. So they tended to do one-to-one coaching. They would start with a demonstration then follow with hands on experience with kits and reagents that had passed their expiry date. The trainees were then questioned about why things go wrong and their understanding of the background. The training officer had a one-to-one with them and really questioned them after their first bout of training. They also had training notes which had to be filled in to make them think about what they were doing and why. The logbook was signed off only when the training officer was sure that the trainee had sufficient expertise and a professional approach, so it was not just a matter of following an SOP..

Another indicator of a professionalised training function would be evidence-based training. However, we have been unable to locate any research investigating detailed aspects of the teaching and learning of scientists in the NHS. Questions about the relative effectiveness of different learning processes have yet to be systematically addressed. This project has had to rely on user opinion rather than evidence from outcomes. Research into various kinds of laboratory-based training could play an important part in any future improvement of the training function.

The Future of Training for the Health Scientist Professions

Our earlier section on the work environment included the evidence we collected on the ever-changing work contexts of health scientists. One feature of this context was that strategic decisions about these services were being made quite rapidly and with limited consultation. The training function was dependent in terms of resources, organisation and climate on how scientific services were managed within each Trust. However, there was also a growing sensitivity to quality throughout the NHS which had given both quality assurance and training a higher profile. In addition, concerns over the recruitment and retention of scientists were drawing attention to their often stressful working environment as well as their low remuneration.

Alongside this exploration of how their training could and should be managed in hospitals, we conducted some analysis of the changing knowledge bases of the professions and the competence/expertise expected at various stages of health scientists' careers. Some of the *more training needed* responses reported earlier indicated inconsistencies between job expectations and training provision. One professional group experienced what might best be described as a "wake-up call" when we pointed out that their practice of starting their trainees with almost exclusively laboratory training was at odds with their view that in the future their clinical role, for which training was minimal, would be of critical importance. Our research fellow from that profession followed this up by investigating and consulting about the competencies required for this clinical role. This provided an annex for our report, which was then published in their professional journal (Pearson, 1999).

A parallel development, in which I was also involved, was a feasibility study of the scope for a common framework of occupational standards for all health scientists, engineers and technicians. This required co-operation across professional boundaries, over which there had previously been some ill feeling. It reached a positive conclusion and the project proper is now in progress. At the same time all the clinical scientist professions successfully applied to become state-registered through the CPSM, which is soon to be reincarnated as the Health Professions Council.

Both our evaluation project and these parallel developments owed much to the patient diplomacy of the Chief Scientific Officer at the Department of Health, Dr Peter Greenaway. He also persuaded the NHS to set up a National Advisory Group for Scientists and Technologists (NAGST) in time to review our evaluation report. At their second meeting they endorsed our recommendations and forwarded them for action by hospital NHS Trusts and the Education Consortia which fund and commission their training. The net result has been to create a unified group of professions who can work together with the NHS on training frameworks, quality assurance guidelines and funding arrangements. In turn, we hope that the training of scientists will become better supported in health care organisations.

Training fit for purpose

Fitness for purpose is an important principle, but there is always a danger that it will be only partially applied. In particular, there is a tendency to focus attention on evidence of **fitness** without giving equal consideration to **purpose,** which is often highly problematic. Given the rapid rate of change, and its effect on what scientists in the NHS are expected to do, there will always be important policy issues about what services scientists should provide and who should provide them. Such issues are difficult for Trusts to address because:

(a) Most of them have very little knowledge of scientific work, nor of the circumstances where scientists are likely to be better informed than doctors or *vice versa*;
(b) The research landscape is changing so rapidly that such knowledge soon becomes out-of-date.

Decisions about value for money require evidence about the medium as well as short term outcomes of policies and practices, and that evidence is not always readily available. Even if it were available, the necessary analysis might not have been done.

The question of who should provide services has two aspects. One concerns the location of more specialist services. Clinical scientists are sparsely distributed. Some specialists only work in teaching hospitals and regional centres, or in agencies such as the Public Health Laboratories Service and the Blood Transfusion Service. Others also work in larger District General Hospitals. But while some areas of scientific work are becoming increasingly specialised, even supra-regional in their coverage, others are becoming increasingly automated and the consequent efficiency gain may require larger units in order to be fully realised. The new philosophy of the NHS will be helpful for a service that depends on collaboration for its effectiveness.

The second aspect of the "who should provide" question concerns skill-mix. We received a great deal of evidence that professional boundaries are changing in a number of areas. The occupational standards project will map out some of the problematic issues within the scientific and technical workplace; and flexible approaches will be needed to make the best use of the available talent and expertise. Boundaries between clinical scientists and doctors, radiographers and nurses are changing, as new areas of scientific expertise are developed and recognised and the possibilities of extended roles are further explored. As always, some local practices are ahead of what seems to be officially recognised and some are far behind.

The impact of this introduction is that training fit for purpose depends on there being both clarity of purpose and continuity over time. Continuity means flexible planning ahead with regular modification of plans as new evidence and opportunities become available, i.e. it is a dynamic rather than static concept, but smooth rather than jerky. The ideal context for planning and implementing training fit for purpose is one where there is a strategic plan for scientific and technical services within each Trust, including appropriate agreements with other Trusts, GP partnerships and Health Authorities. The introduction of rolling 3 year purchasing contracts will greatly facilitate this. Patterns of inter-professional collaboration and mutual consultation will also need to be established. Within such plans provision will need to be made for rapid responses to changes in science and technology, and the professional associations could usefully consider the kind of information service that could best support the planners.

Strategic service plans are an essential pre-requisite for the formulation of strategic training plans to meet new service demands, and contribute to succession planning and the supply of scientific and technical manpower. Funding can then be sought from the appropriate sources, the organisation of training established, and appropriate budgets and quality assurance procedures approved. Such plans should cover Initial Training, Higher Training, CPD, Training of Trainers and Management courses. The planning of Training of Trainers and Management courses should take advantage of Trust-wide provision for generic competencies, but also give full attention to aspects specific to science and technology. A strategic decision by a Trust to seek Investors in People accreditation would greatly facilitate this process. In order to achieve fitness for purpose, three things have to happen:

(1) There has to be congruence between the strategic plan for the Trust's scientific and technological services, people's job descriptions and the organisation of their work, and the training plan.

(2) The training has to be delivered according to the plan and must be of the right quality; and this needs to be sustained by quality assurance.

(3) The outputs of training in the form of learning outcomes need to be confirmed as demonstrating the acquisition of the required knowledge, skill and expertise.

We believe that achieving congruence will be facilitated by the development of occupational standards. The enthusiasm, commitment and responsiveness of the professional associations during the course of this project suggests that the development of the next version of their Training Prospectuses will be symbiotic with the work on occupational standards to which they are the principal contributors. One recurring problem will be that of keeping training frameworks locally adaptive and up-to-date. We advise that local adaptation be achieved by an element of choice (a feature of all current schemes) rather than by excessive vagueness. Local issues should be documented and justified for the benefit of trainees and accreditation. Some of them will benefit from clearer specifications of intended outcomes. While Prospectuses would normally determine the general shape of the training programme and be renewed every 3-5 years; it would be advisable to have fast track procedures for updating specific requirements within that framework.

The evidence from our evaluation suggests that there is very little inappropriate training. Very few respondents reported having too much of anything, and theoretical components were rated as highly, sometimes higher than practical components. However, large numbers of respondents in most programmes wanted more training. For initial training this can be interpreted in several ways:

(1) Less training occurred than planned because of the pressure of service needs and/or time being insufficiently available

(2) The training period is too short.

(3) Some of the "extra training" ought to occur after qualification as part of higher training.

Our evidence suggests that (1) is an important contributing factor but that (3) also needs to be considered. This would require clearer specification of the linkage between Initial Training and Higher Training. This sensible course of action is deterred by current weaknesses in the provision of higher training. Low participation rates in Physics and Engineering already have implications for the quality of the service; and lack of supervision is reported by a large proportion of B Grades in the pathology disciplines, who also report that their experience is very limited in many important aspects of their job.

The main generic quality factor emerging from our study was Feedback. Most students did not get enough feedback, and though most of it was helpful, some of it was not. The recommendations of CPSM and the professional associations regarding the frequency of trainee meetings with supervisors are not being generally implemented. Training deserves the same level of quality assurance as that given to scientific work in accredited laboratories. Hence an urgent need for both dedicated time for trainers and training of trainers. In most training programmes there were a significant number of topics or aspects in which scientists felt seriously under-trained. These need to be given special consideration by the professional associations. What has caused problems in those particular areas and what can be done about them? Given the current strategic emphasis on evidence-based health issues, the consistently less than adequate attention to statistics and, in two disciplines, evidence-based pathology should be of particular concern

Apprenticeship revisited

AERA2001 - Finale

The vocational training of scientists is often portrayed as being based upon the apprenticeship principle, but what does that mean in practice? Because support for the principle of apprenticeship and other approaches to work-based learning is no guarantee that learning will occur either in the intended directions or to the desired level. It is also important to differentiate between the romantic image of the apprentice craftsman, the servile image of the perpetual tea-maker and the type of apprenticeship that might be appropriate in the complex working environment of a hospital.

To investigate learning in any particular apprenticeship context one has to ask:

(1) Which of the features associated with apprenticeship are intended to be present?
(2) To what extent are these features actually present?
(3) What evidence is there about their effect on learning?
(4) What other factors are significantly affecting the learning process?

From a person-centred perspective, our evaluation revealed a number of issues. First, it is individual trainees who are seeking to be certified as competent, qualified members of their chosen profession and properly prepared for any subsequent career. Second, both formal and informal feedback are highly valued, and guidance is sought to ensure that their self-directed learning is efficient as well as effective, i.e. focuses on the more critical aspects of (a) the job and (b) their formal assessment. This is congruent with a hospital system of personal accountability for competent practice and personal responsibility for Continuing Professional Development. Thirdly, however, trainee scientists are not apprenticed to a single 'master' nor, where training schemes are regionally situated, to a single department. The role of 'master' is shared between one or more heads of departments, a training officer and/or training coordinators, and section heads or placement supervisors; and the combination varies according to formal and/or informal local and/or regional arrangements. Those with official training roles usually have little time and no training for this aspect of their work. Department and section heads tend to be preoccupied with their service responsibilities.

The decentred perspective is supported by the evidence we collected of learning from workplace colleagues of differing seniority. The strong off-the-job component of scientist training, unlike that in many other work-situations, is an integral part of their professional culture. Scientists in particular value links with universities and codified, research-based knowledge because they provide the basis of their competitive advantage over doctors in key aspects of health care practice. However, the balance between learning at work and providing cheap labour to keep the service afloat is becoming increasingly perilous. Many MLSO trainees complained of being treated as "just a pair of hands"; and clinical scientists felt that their Higher Specialist Training needs were disregarded. The allocation of work was dominated by service demands in a manner that often minimised participation in challenging activities from which they needed to learn. Moreover, trainees were not situated in traditional communities of practice. Often neither the membership of the work group nor the work itself remained the same for very long; and some trainees were rotated through a series of placements, which allowed limited time for developing strong social relationships.

Another feature associated with apprenticeship (Lave and Wenger, 1991) is induction into the social relationship between professionals and their clients. However, laboratory-based scientists rarely met patients; and their communications with their real clients, the doctors, were usually short, at a distance, and business-like. Interpersonal communications took place only at a more senior level and outside the laboratory. Clinical scientist trainees were expected to consolidate their laboratory skills before being given much opportunity to meet patients and other health professionals, thus delaying this important aspect of their socialisation process.

In general, our interviews and case studies supported the findings of a parallel research project investigating the mid-career workplace learning of engineers, business people and health professionals that informal learning is (a) extremely important but (b) highly dependent on the learning climate of the local workplace (Eraut et al 2000). In the hard-pressed, rapidly changing work context we observed in both projects, few groups were sufficiently stable or coherent for a positive learning climate to develop spontaneously. Our analysis suggests that a group climate for learning has to be created, sustained and recreated at regular intervals; and this has to be a management responsibility. The learning of individuals and work groups has to be high on managers' agendas, and managers have to be educated and supported in this role. The type of apprenticeship we find in complex, knowledge-rich, post-modern, work environments is an unpredictable, and variably effective, hybrid of person-centred and decentred features. The idealistic portraits of apprenticeship that appear to have captured the imagination of the educational research community belong, literally, in another world.

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