Subject knowledge enhancement (SKE) courses for creating new chemistry and physics teachers: do they work?

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ABSTRACT During extended subject knowledge enhancement (SKE) courses, graduates without chemistry or physics bachelor degrees prepared to enter a Postgraduate Certificate in Education (PGCE) programme to become chemistry or physics teachers. Data were gathered from the exit survey returned by Liverpool John Moores University SKE students about to start their science PGCE course. Lesson analysis and final report forms from the PGCE course and an early survey of first destinations were also analysed. Findings suggest that the 2011–12 SKE students valued their course highly. Many issues encourage caution when interpreting PGCE assessment information but, on summative assessment of subject knowledge and overall teaching, there was no statistically significant difference between the frequency of grades awarded to 2011–12 PGCE trainees who had followed a SKE route and those who entered the science PGCE directly. Early indications were that their employment rates in teaching were also similar.

It is difficult to question the notion that appropriate subject knowledge is fundamental to a person's capacity to teach. Its importance has been underlined in the training section of the guidance for the Government's new School Direct programme (Teaching Agency, 2012) where schools and providers are charged with a shared responsibility for developing the subject knowledge of trainee teachers.

An urgent subject knowledge issue for school science is the worrying downward trend in the number of university departments and/or the number of students enrolled on undergraduate courses associated with physics and chemistry (Breuer, 2002; Institute of Physics, 2012). This has contributed to difficulties in teacher recruitment in secondary schools and an unavoidable increase in the number of non-specialists teaching these subjects. One response to severe teacher shortages in key subjects such as the physical sciences has been to retrain graduates to teach shortage subjects. Since September 2008, Liverpool John Moores University (LJMU) has provided one-year full-time chemistry and physics SKE courses. Candidates suitable for teaching but with a need to improve their subject knowledge in chemistry or physics were offered a place on a one-year SKE course leading to a Graduate Diploma. Successful completion of the SKE course was a condition for taking up the deferred place on our science PGCE the following year. Students on LJMU SKE courses in chemistry and physics who did not complete the course, or completed it but did not meet the assessment requirements, could not take up their PGCE chemistry or physics places. However, they could still apply to other PGCE providers on the basis of their first-degree qualifications that year. They could not re-apply to LJMU for a PGCE place in their first-degree subject until the next year because of the conditional nature of their original offer.

The purpose of this article is to examine data available from course documentation concerning the impact of the chemistry and physics SKE courses at LJMU and so to begin to evaluate their effectiveness. The questions it seeks to answer are:

- How did SKE students perceive their course as a preparation for PGCE?
- What did the judgements of teachers and mentors recorded on lesson analysis and final report forms indicate about the quality of subject knowledge demonstrated by SKE trainees?

- Were newly qualified teachers (NQTs) who followed the SKE route as employable as NQTs with a first degree in their subject specialism?

This small-scale quantitative study cannot claim to answer these questions other than within the context of the providing institution. However, by looking at numerical data generated by LJMU PGCE and SKE course documentation during the 2011–2012 academic year, interesting questions are raised that indicate some possible directions for future course development and for further qualitative investigation. The future of long SKE courses in subject shortage areas and their mode of delivery are under continued Government policy review. This study's findings are consistent with the most recent large-scale evaluations of SKE courses (Gibson *et al*., 2013) and add to the debate on their future.

Initial teacher training/education in England

The current model for initial teacher training/education (ITT/E) provision began in 1992 when partnerships between higher education institutions (HEIs) and schools became the established norm. Partnerships and collaborations among schools without HEI involvement have always been an acceptable alternative, with the first school-centred initial teacher training (SCITT) scheme starting in September 1993. These schemes signalled a strong motivation by the Conservative Government of the day to bypass HEIs in favour of on-the-job training for teachers and initiated the development of an assessment system that focused on specified teacher competencies (Barton *et al*, 1994).

The move towards the assessment of teacher competencies led to the qualified teacher status (QTS) standards and ITT/E requirements that apply to all ITT/E programmes. These arose out of the Education Act (HM Government, 2002) in 2003. Trainee teachers must meet all of the standards set down by the Government, including those concerning subject knowledge, and provide evidence that they have achieved a satisfactory level of performance to gain QTS. The latest revision of the *Teachers' Standards* took effect from 1 September 2012 and now applies to trainee teachers and qualified teachers throughout their careers (Department for Education, 2011).

Trainees currently spend the majority of their PGCE time in school (a recommended 120 out of 180 days) and must, at least, pass two training placements in different schools. School-based assessment of trainees against the *Teachers' Standards* is the responsibility of school-based tutors and professional mentors, although final outcomes are subject to quality assurance and moderation either internally or supported by university tutors if an HEI is in partnership with the school. Lesson observations are a crucial assessment mechanism to generate evidence of competence during school placements. Another purpose of assessing trainees during lesson observations is to be able to give accurate focused feedback. During developmental phases, formative feedback informs the training programme to facilitate trainee progress. At review points and at the end of training, assessment informs the trainers and eventually the QTS award body (at the time of writing the Teaching Agency) concerning the trainee's capacity to teach.

Since the start of school partnerships with HEI providers and the development of mentoring in schools, various challenges have been identified associated with assessing competencies and standards (Kerry and Shelton Mayes, 1995). Assessors need to be confident that their assessments are fully fit for purpose. Their assessments must support the inferences made from them, with all the associated outcomes and implications for pupils' learning and trainees' career progression that may arise. Assessment of trainee subject knowledge and overall teaching performance during school placement can be a highly contentious issue. Although assessment is evidence based, it relies on teacher, mentor, trainee and liaison tutor judgements of teacher competencies that are unavoidably subjective and use descriptors for standards that are open to interpretation. When disagreements occur, they can take time to resolve.

Stevens (2010) carried out a small-scale study examining course documentation from five PGCE courses as well as conducting student teacher interviews. The main study focus was the variety and timing of transitions experienced by trainees developing into teachers. A finding that has implications for those making overall judgements of competence highlighted occasions where better performance in one area was associated with less effectiveness in another. For instance, greater confidence in managing the classroom and lesson delivery was often accompanied by less willingness to be innovative and take risks in the classroom. His interviews also highlighted the restricted range of reflections on subject knowledge made by trainees when evaluating their progress in this area.

Hager and Butler's (1996) model for the progress of members of occupations and professions describes three developmental levels or stages. For any profession or occupation, there are the knowledge, attitudes and skills that have to be acquired. Performance can then be simulated in practice domains, leading, eventually, to personal competence in real situations. Hager and Butler's arguments are then extended to discuss the characteristics and uses of the Scientific Measurement and the Judgemental Models of Assessment to gauge performance at these stages. These two models can be seen to form opposite ends of an assessment continuum. In their analysis, both can be demonstrated to satisfy, in different ways, general principles for assessment in higher education such as validity and reliability. Martin and Cloke (2000) later applied these two models to the assessment of QTS standards during ITT/E.

The Scientific Measurement Model uses assessment tools that measure attainments quantitatively. It emphasises objectivity, validity and reliability, and focuses on examinations taken under controlled conditions. On the other hand, the Judgemental Model seeks to infer competence through a qualitative approach. Using a variety of assessment events simulating life situations, it draws on multiple sources of direct evidence and emphasises avoiding bias through triangulation and the use of informed judgement (Hager and Butler, 1996).

Subject knowledge for teachers fits into this analysis as the first criterion for credible teaching and is an entirely appropriate target for assessment using a Scientific Measurement Model and traditional assessment tools. Trainees offered a place on a science PGCE are deemed to have sufficient prerequisite subject knowledge following analysis of their existing qualifications in science-based subjects where the assessment structures almost invariably have formal examinations as a major component. The purpose of the one-year SKE course is to enhance subject knowledge in physics or chemistry with a fully examined and accredited Graduate Diploma for Intending Teachers in one of those subjects.

The application of a Judgemental Model of Assessment appears to be more appropriate to the simulation or practice and demonstration of competence stages. These stages can be equated with a trainee's experience on teaching placement and the NQT's reassessment during their induction year. However, it should be noted that during this study the assessment data for subject knowledge in chemistry and physics for comparing PGCE trainees on SKE and non-SKE pathways arises entirely from a Judgemental Model of Assessment. As such, the assessment data are the results of mentor and university tutor judgements against criteria for competencies based on evidence from lesson observations, planning materials and resources prepared by the trainee.

This approach is aimed at evaluating subject knowledge as it is applied in the classroom during teaching, learning and assessment. It cannot claim to assess chemistry or physics subject knowledge in the same way that an examination would. It does demonstrate the levels of confidence in trainee subject knowledge expressed by practising science teachers working with LJMU science PGCE trainees during the 2011–2012 academic year. The accuracy, reliability and validity of such assessment data can always be questioned, as these characteristics depend on the procedures in place for quality assurance and moderation of assessment. Given the issues associated with the assessment of competencies and standards, and of subject knowledge in particular, care is needed when attempting to interpret the data collected during this study. However, it should be remembered that these Judgemental Model style assessments remain and are the evidence on which all recommendations are made to award QTS or not.

Data and findings

The SKE student exit survey 2011–12

This group started their PGCE in September 2012, and 35 of 37 students (95%) returned their anonymous questionnaires concerning the SKE course in the previous academic year.

Students were asked for their level of agreement or disagreement with eight positive statements (Table 1) covering the key areas for which tutors were seeking feedback. Qualitative

Table 1 SKE student exit survey responses, May 2012; the two students (5%) who did not return their questionnaires are included in the "Did not answer" column percentage for each statement

Statement	% of cohort ($n=37$)				
	Strongly agree	Agree	Disagree	Strongly disagree	Did not answer
I feel highly motivated to participate in my PGCE next year due to my involvement in my SKE course	81	11	0	0	8
The SKE course has developed my SKU throughout the year	78	16	0	0	5
The teaching on the SKE course has supported my learning well	70	22	0	0	8
I feel well prepared to embark on my PGCE course next year due to my engagement on the SKE course this year	62	30	0	0	8
I have enjoyed the content in the course this year	62	27	0	0	11
The feedback in the sessions has supported my development and understanding	51	43	0	0	5
The tutor(s) have given me sufficient support throughout the year	51	35	5	0	8
The feedback I have received regarding my assignments has supported my development and understanding	46	49	0	0	5

SKU = subject knowledge and understanding

statements were also collected but only for internal diagnostic use.

The response on exit from the course was overwhelmingly positive. All the respondents strongly agreed or agreed with the eight statements, apart from two students who disagreed with the statement that there had been sufficient support from their tutor. So, at the end of their course, most LJMU 2011–12 SKE chemistry and physics students expressed positive perceptions about the course content, its teaching, its impact on their learning and its role in preparing them for the PGCE year. The less positive responses centred on feedback and support but even in these areas the majority of students held positive viewpoints.

Assessment data from the science PGCE cohort 2011–12

Just over half (29) of the 2011–12 PGCE science cohort (53) entered the course directly from university or employment and the remainder (24) had just successfully completed a one-year LJMU SKE Graduate Diploma in Chemistry or Physics.

Both populations were routinely assessed using a Judgemental Model of Assessment (Hager and Butler, 1996) against the previously used Government teaching standard for subject knowledge (Q14) requiring that subject knowledge and understanding and relevant pedagogy is secure for the age and ability range to be taught. Under the new *Teachers' Standards* (Department for Education, 2011), subject knowledge requirements are located mainly in standard S3, although aspects of subject knowledge arise in descriptors within standards S2 and S4.

Subject knowledge was assessed formatively throughout school placements by examining a variety of sources:

- lesson observations;
- planning forms;
- feedback on pupils' work;
- teaching resources prepared or modified by the trainee.

Summative judgements were recorded at review points during the course and finally at the end of the second school placement. It should be noted that the assessment of science subject knowledge was not divided into separate science subjects and the authors have no way of knowing exactly how many biology, chemistry or physics lessons actually contributed to any individual's assessment. However, those trainees designated as chemistry or physics PGCEs (SKE and non-SKE route) were placed with school science

Table 2 Formative assessment with written feedback given to science PGCE trainees during their last school placement in 2012 from a voluntary sample of 34 lesson observation forms

Teaching competency	% of observations assessed as			Mean % of assessments supported by written comments
	Working beyond or achieved	Working towards	Not evidenced or not assessed	
Subject knowledge and understanding	79	15	6	8
Classroom management and organisation (including behaviour management)	53	41	6	24
Suitability of resources	53	38	9	13
Teacher exposition	53	38	9	13
Lesson structure and focus	50	41	9	24
Pupil experience, interest and challenge	50	44	6	40
Planning and preparation	47	44	9	15
Personalised learning and differentiation	47	47	6	28
Homework/out of classroom	41	21	38	9
Monitoring, assessment and giving feedback	29	50	21	31

departments and mentors intending to provide a timetable rich in those subjects for the trainee.

At a final triangulation meeting, school mentors and university liaison tutors compared evidence from a variety of sources with the trainees' own portfolio of evidence. Competence was judged against Government teaching standards, including subject knowledge, in preparation for completing each trainee's final review form. Based on this assessment profile, the award of QTS and an overall teaching grade were recommended for successful trainees.

Information from lesson observation forms

During 2011–2012, schools, mentors and trainees were invited to take part in a project looking at assessments made during lesson observations and at the written feedback given on LJMU lesson observation forms. Participation was voluntary and anonymous. Thirty-four lesson observation forms were received during the final school placement. The LJMU partnership agreement requests that trainees are observed formally at least twice a week. Therefore, this represented a very small proportion of the potential number of forms that could have been returned. As such, the sample was too small to allow a comparison of SKE route and non-SKE route trainees or to be considered representative of the science mentors working with trainees in LJMU partnership schools. They do indicate the formative assessment and feedback practices of some of the teachers working with 2011–12 PGCE science trainees during their last phase of training and the teachers' attitude towards subject knowledge. The assessment categories used on the lesson observation forms were:

- working beyond;
- achieved;
- working towards;
- not achieved;
- not evidenced.

Teachers, school-based tutors and professional mentors were required to judge trainees' performance against teaching standards or clusters of related standards (Table 2 shows the teaching competencies assessed) in the context of the phase of training and the trainees' experience at the time of the observation. This continues to be the Government's expectation:

Providers of initial teacher training (ITT) will assess trainees against the standards in a way that is consistent with what could reasonably be expected of a trainee teacher prior to the award of QTS. (Department for Education, 2011: 3)

There was no expectation that a judgement be recorded against every standard or cluster for each observation. Free response boxes provided the opportunity to support judgements with commentary and analysis that could be used as evidence.

PGCE training at LJMU is currently divided between time spent at university and two 12-week school experience placements. The school-based training is divided into three phases:

1 Orientation;
2 Beginning/developing teaching and classroom management;
3 Qualifying to teach.

The first placement emphasises trainee performance during phases 1 and 2. However, during the final placement in phase 3, the emphasis changes to developing strategies for maximising pupil performance and constructing a portfolio of evidence for the award of QTS. Judgements about pupil experience, interest and challenge, monitoring, assessment and giving feedback, and personalised learning and differentiation were most likely to be supported by written feedback. This reflected the planned course progression described above, as these clusters of standards were identified in trainee and mentor handbooks as focus areas for the second school placement. More fundamental teacher competencies developed in the first placement – classroom management and organisation (including behaviour management), and lesson structure and focus – formed the second tier of written comment.

In the lessons observed, subject knowledge and understanding (SKU) was most likely, by a considerable margin, to be perceived positively by teachers and assessed as achieved or working beyond and least likely to be assessed as working towards. It also shared the least rank with three other clusters of standards for no evidence or no assessment made. However, SKU was also the least likely standard or cluster to have any written comment or evidence accompanying the judgements made. A property shared with most of the other categories was that the more negative the assessment the more likely it was to be supported by written feedback (Table 2).

Although the LJMU PGCE course requires that judgements should be evidence based, one possible interpretation for the lack of written feedback on SKU in this small-scale survey of lesson observation forms is that in the second semester placement both the teachers and their trainees had reached consensus over what constituted acceptable and good SKU in science lessons and how to assess it. The teachers routinely and positively reinforced trainees' SKU more than other skills and competencies. Mistakes were still noted and discussed but these seem to have been the exception not the rule. As the participants did not have prior knowledge that SKU was a particular focus for the study, this could reflect their perceptions of the fundamental importance of SKU to aspiring teachers. It also suggests high levels of teacher confidence in its assessment.

Information from final review forms and results summary

In order to complete a trainee's final review form, the school-based mentor and a visiting university tutor applied QTS standards and Ofsted descriptors for final year students to lesson observations and portfolio evidence using a four-point scale:

1 outstanding;
2 good;
3 satisfactory;
4 fail.

Each teaching standard was graded separately and the trainee's profile of grades used to arrive at an overall teaching grade. Trainees must provide evidence for all standards to at least a satisfactory level to be awarded QTS and are routinely allowed to submit evidence gathered during the PGCE course from sources other than their final placement to strengthen the evidence base.

Final phase 3 review forms and the final results summary for the 2011–2012 cohort of PGCE trainees were used to compare the frequencies with which different final overall teaching grades and subject knowledge grades were awarded to those from the SKE and non-SKE routes. The cohort's results summary spreadsheet was used as the source for the overall teaching grade, as the grade recommended on the final review form can occasionally be amended later in the light of assessment of evidence in portfolios. Statistical correlations between final subject knowledge and overall teaching grades were also investigated. Non-parametric statistical tests of significance (Pearson's chi-squared and Spearman's rank correlation) were used to avoid any issues associated with small sample size and non-normal distributions in the data.

No statistically significant difference was found between the observed and expected frequencies with which final grades 1 and 2 (or below) for subject knowledge or overall teaching were awarded to PGCE science trainees who had followed the SKE route or those who been accepted directly (Tables 3 and 4 and Box 1).

There was a strong positive correlation between the overall teaching grades and the subject knowledge grades within the whole PGCE group. The correlation was highly significant for non-SKE route (direct entry) trainees but among SKE route trainees the correlation was weaker (Table 5). In fact, in seven of the nine occasions when the SKE cohort final grades did not match, it was the subject knowledge grade that exceeded the overall teaching grade. Used in this context, the calculation of correlation coefficients does not seek to establish a causal link but to test the strength of a relationship which should already exist. The relationship between subject knowledge grades and overall teaching grades is prescribed by the assessment procedures followed at the end of the PGCE course described earlier. Subject knowledge is one of the standards judged separately by mentors before looking at the trainees' profile of strengths and areas for development and deciding a grade for overall

Table 3 Contingency table: final subject knowledge grades awarded to 2011–2012 PGCE science trainees

Grade	Observed (expected) counts		Total
	SKE route	Non-SKE route	
1	14 (15)	19 (18)	**33**
2 or below	6 (5)	6 (7)	**12**
Total	**20**	**25**	**45**

Chi-squared value 0.47; 1 degree of freedom but Yates's correction not necessary; critical value 3.84 (5% level); null hypothesis accepted

Table 4 Contingency table: final overall teaching grades awarded to 2011–2012 PGCE science trainees

Grade	Observed (expected) counts		Total
	SKE route	Non-SKE route	
1	8 (9)	13 (12)	**21**
2 or below	12 (11)	12(13)	**24**
Total	**20**	**25**	**45**

Chi-squared value 0.36; 1 degree of freedom but Yates's correction not necessary; critical value 3.84 (5% level); null hypothesis accepted

BOX 1 Using the chi-squared test and contingency tables to compare grades

For those not familiar with the chi-squared test and contingency tables, the observed count totals can be used to calculate the expected numbers of SKE route PGCE science trainees gaining a grade 1 in each contingency table. For Tables 3 and 4, the calculation from first principles would be:

probability of being an SKE route trainee (p) = SKE route total/all PGCE total

probability of gaining grade 1 (q) = grade 1 total/all PGCE total

expected number of SKE route trainees awarded grade 1= all PGCE total $\times p \times q$

The other expected values are obtained by subtracting this calculated figure from the appropriate row and column totals. For example, in Table 4, if 9 out of a total 20 SKE route PGCE trainees were expected to gain a grade 1 for overall teaching then 11 could be expected to get grade 2 or below.

The chi-squared value is obtained by summing the results of the calculation $(\text{observed} - \text{expected})^2/\text{expected}$ for each pair of observed and expected counts in the contingency table. The number of degrees of freedom for a contingency table is defined as the (number of rows − 1) × (number of columns − 1). So for Tables 3 and 4 it is 1. If there is only 1 degree of freedom when the chi-squared value is calculated, Yates's correction (subtract 0.5 from the difference between the observed and expected count regardless of sign before squaring) may be applied particularly if there are expected counts of less than 5 in any part of the table. This was not necessary and it could be argued that the calculated expected values were so close to the observed counts in Tables 3 and 4 that a statistical test was redundant. However, the point of applying a statistical test of significance is to remove any subjectivity in drawing conclusions about the raw numerical data.

Table 5 Spearman's rank correlation two-tailed test on final overall teaching grades and subject knowledge grades for 2011–2012 LJMU PGCE science trainees

Trainees	Correlation between final overall teaching grade and subject knowledge grade			
	Correlation coefficient	*n*	Significant	Probability of error
All science PGCE	0.639	45	Highly	< 1% (critical value 0.382)
All non-SKE route (direct entry)	0.726	25	Highly	< 1% (critical value 0.511)
All SKE route	0.536	20	Yes	5% (critical value 0.447)

teaching. The weaker correlation among SKE route trainees could suggest that their subject knowledge grade contributed less to the decision about their overall teaching grade than it did for non-SKE route trainees. It could also indicate a distinction in the minds of assessors between knowledge of a subject and knowledge of how best to teach it.

LJMU 2011–12 PGCE science trainees' first destinations

Information on the destinations of NQTs after their course updates continually but the exit survey indicated that around half the SKE route PGCE science trainees had been successful in obtaining a first teaching position. At first glance, the data suggest that their reported success rate was better than that of the direct entrants to the science PGCE (Table 6). This might be thought a reasonable outcome because SKE applicants have their first degree specialism as well as their SKE subject Graduate Diploma to offer their prospective employer together with a year's extra training and experience to illuminate their responses at interview. However, percentages can be misleading. Chi-squared contingency table analysis of the differences between the observed and expected frequencies of SKE route and non-SKE route PGCE graduates notifying LJMU of successful job applications indicated that this difference was not statistically significant (Table 7).

Although it is probable that those who did not respond to the survey had no teaching post to report, this may be a false assumption. A cautious conclusion would be that there were no indications of a difference between the early reports of success in gaining employment in schools between the two PGCE routes.

Discussion

The nature of subject knowledge for teachers is still a matter of debate but a commonly cited model is that proposed by Shulman (1986), who made the distinction between subject matter content knowledge (SMCK), pedagogical content knowledge (PCK) and curricular knowledge (CK). This approach is reflected in the relevant standards set down (Department for Education, 2011). SMCK and CK appear in standard S3 and PCK appears in standards S2 and S4.

Table 6 Early notifications of destinations for 2012 PGCE science graduates

Graduates	Destinations (summer 2012)		
	Teaching job	Did not respond	Left teaching
Non-SKE route (direct) entrants			
Applied science	2	4	0
Biology	2	4	0
Chemistry	7	4	0
Physics	3	2	1
Total	**14 (48%)**	**14 (48%)**	**1 (3%)**
SKE route entrants			
Chemistry	10	6	0
Physics	4	4	0
Total	**14 (58%)**	**10 (42%)**	**0**
All PGCE science			
Total	**28 (53%)**	**24 (45%)**	**1 (2%)**

Table 7 Contingency table: early notifications of destinations for 2012 PGCE science graduates

First destination	Observed (expected) counts		Total
	SKE route	Non-SKE foute	
Teaching	14(13)	14(15)	**28**
Other	10(11)	15 (14)	**25**
Total	**24**	**29**	**53**

Chi-squared value 0.31; 1 degree of freedom but Yates's correction not necessary; critical value 3.84 (5% level); null hypothesis accepted

Since their introduction, the use of competencies and standards in ITT/E has never been seriously challenged by practitioners in schools or higher education. However, some researchers have expressed concerns about relying solely on the use of teaching standards criteria to judge and accredit new teachers:

Although the standards can be useful as criteria for judging the abilities and attainment of beginning teachers, this article contends that the model of teaching this list presents is impoverished. (Turner-Bisset, 2006: 40)

To illustrate her thesis, Turner-Bisset (2006) presented a detailed and comprehensive discussion of the PCK demonstrated by a history teacher during a lesson. She then sought to provide a model to supplement the ideas of subject knowledge competency implicit in the QTS standards.

The ability to reliably assess subject knowledge and other teacher competencies with consistency across and within PGCE providers begins with the provision of clear descriptors or criteria. The new *Teachers' Standards* (Department for Education, 2011) seek to provide sufficient clarity about what is required of teachers but continue to give little guidance on how standards should be interpreted or assessed by those involved in teacher training or appraisal.

Leshem and Bar-Hama (2008) debated the issues surrounding the use of teaching competencies and criteria compared with holistic assessment during teacher training in Israel. Their study found that students initially perceived lessons analytically but saw quality as the sum of the parts. The students needed clear criteria and disliked assessment based on unknowns. Students felt criterion-based assessments were valid and shared their tutors' view that impressionist marking was subjective and unreliable. The analytical use of criteria was considered valuable for all students during feedback sessions to focus and aid discussion. However, students still expressed a preference for holistic assessment when summative judgements were made during observations. PGCE trainees in England must provide evidence that they have reached a satisfactory level of competence in all the *Teachers' Standards* (Department for Education, 2011) in order to be recommended for QTS. This implies that an analytical approach to their assessment should be taken. However, in the absence of clear assessment guidelines to accompany statements of standards, this may not be the case for individual standards or judgements of overall teaching ability. This is an issue that reduces confidence in trainee assessment outcomes.

It was beyond the scope of this study to investigate the consistency of approach and assessment methods used to assess trainees on school placement across LJMU–school partnerships. The study gave no indication of the way university tutors, trainees, teachers and mentors viewed the various aspects of science subject knowledge for aspiring teachers or how to assess it. Nor did it investigate the priority assigned by assessors to knowing how to teach the subject (PCK) compared with knowing the subject discipline in the first place (SMCK). However, while accepting the limitations of a quantitative investigation of course documentation as a research methodology, it is still possible to make tentative conclusions and recommendations useful in the context of ITT/E at LJMU.

If the data collected from the PGCE science trainee lesson observation forms (Table 2) are typical across the LJMU partnerships, it would suggest that trainee subject knowledge was assessed during most lesson observations and usually positively reinforced. Written feedback tended to be given when subject knowledge was not adequate. It was not clear whether assessors separated chemistry, physics and biology subject knowledge or assessed science as a single entity. It is important to acknowledge that teachers, mentors, tutors and trainees will differ in the way they define and then assess subject knowledge. A qualitative study of teacher feedback would be required to illuminate these issues and enable the evidence used when making judgements to be investigated.

There is a suggestion from the correlation coefficient calculations (Table 5) that mentors may have distinguished between SMCK and PCK and reflected this in judgements of SKE route trainees' overall teaching grade. The correlation between final overall teaching and subject knowledge grades was weaker for SKE trainees, and where different the subject knowledge grade usually exceeded the overall teaching grade. Using Shulman's (1986) model, the purpose of SKE courses is to teach SMCK not PCK or CK. It is difficult to separate these completely and, in response to student feedback in the first years of the SKE course at LJMU, delivery of PCK and CK has been increased. There may be a case for an even more integrated approach to SKE to ensure the other aspects of subject knowledge for teachers, apart from SMCK, are developed to a similar level in the first year.

In summary, SKE route trainees were very positive about their course and their level of preparation for PGCE and it appears from assessment data that this confidence is justified in terms of PGCE course outcomes. Teacher assessments of final overall teaching and subject knowledge grades for the 2011–12 PGCE cohort indicated that SKE route overall teaching and subject knowledge was perceived to be of a similar standard to that of direct entry trainees. The weaker correlation between final overall teaching and subject knowledge grades for SKE route trainees suggests, at least, that other competencies or PCK may have had a greater impact on this assessment outcome. SKE route PGCE graduates were not found to be at any disadvantage on early returns when seeking a job for their induction year. These findings support the view that the LJMU SKE chemistry and physics Graduate Diploma courses are capable of succeeding in their aim to equip more science graduates with the subject knowledge that enables them to find employment and teach these shortage subjects.

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