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### Article

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# Subject knowledge enhancement courses for creating new chemistry and physics teachers: the students' perceptions

Richard Tynan, Robert Bryn Jones, Andrea Mallaburn and Ken Clays

**ABSTRACT** Subject knowledge enhancement (SKE) courses are one option open in England to graduates with a science background whose first degree content is judged to be insufficient to train to become chemistry or physics teachers. Previous articles in *School Science Review* have discussed the structure of one type of extended SKE course offered at Liverpool John Moores University, and its impact on outcomes for students. This article focuses on the qualitative responses collected from the anonymous exit questionnaire surveys returned by chemistry and physics SKE students about to continue on to their science Postgraduate Certificate in Education course. The main positive course characteristic cited was student support. The main positive outcomes perceived were improved subject knowledge and skills and increased confidence.

Aspiring teachers in England can currently apply to a number of different types of programmes that lead to Qualified Teacher Status accredited by a variety of higher education and school providers. One response to severe teacher shortages in key subjects such as the physical sciences has been to use a bursary system to encourage graduates in related science subjects to enhance their subject knowledge to enable them to teach chemistry or physics. Such training has taken a variety of forms, from online distance learning to traditional face-to-face offerings, over varying time frames from a few weeks to whole-year courses (Gibson *et al.*, 2013a, 2013b).

Funding changes led to the suspension of subject knowledge enhancement (SKE) courses during the academic year 2013–14. However, the difficulty in recruiting to shortage subjects remained and funding for SKE courses was later reinstated for candidates who held a conditional offer of a place on a teacher-training course. Employers of science teachers will continue to receive applications from candidates who may not have a first degree in that science subject but in a related science subject with an additional relevant SKE course accreditation.

However, recent experience of the application process at Liverpool John Moores University (LJMU) has indicated that the need to attract applicants to teach science shortage subjects and also accelerate science teacher recruitment to

schools has affected the balance of SKE course provision. These constraints have encouraged the use of shorter SKE courses, which range from those requiring full attendance to distance-learning packages that take place fully online and whose effectiveness has yet to be evaluated.

This is the final article of three published in *School Science Review* investigating the impact of one-year, full-time, higher education certificate chemistry and physics SKE courses offered at LJMU between 2008 and 2012. In the first article, the course structure and aims were discussed (Inglis *et al.*, 2013). The second (Tynan *et al.*, 2014) examined quantitative data from course documentation in order to evaluate the outcomes for SKE students. These outcomes were similar to those of the Postgraduate Certificate in Education (PGCE) trainees who joined the course with honours degrees in chemistry and physics. In this article, the emphasis is on the qualitative data found within open-response boxes linked to eight Likert-type items (Clason and Dormody, 1994) and two free-response questions from the anonymous exit survey for the 2012–2013 SKE chemistry and physics cohort. Taken together, the three articles offer an insight into one type of extended science SKE course with a significant 'face-to-face' component that will be of interest to those who seek to recruit teachers in science shortage subjects.

## Administering the survey

At the conclusion of the 2012–13 chemistry and physics SKE courses, all students were given the opportunity to complete an anonymous exit feedback questionnaire within a timetabled session. At this time, the SKE courses were expected to recruit and run during the next academic year and the emphasis was on seeking student feedback for the purpose of course improvement. Students were informed of the intention to analyse the anonymous data for publication and that ethical approval had been granted by the appropriate university committee. As the students were about to start their PGCE science course at LJMU after the summer break, it was necessary to take care to ensure that all students knew that completion of the questionnaire was completely voluntary, with no possible repercussions for those not wishing to participate. The return of a completed or partially completed questionnaire implied informed consent.

## Findings

The total possible number of respondents for each question was 26, with similar numbers of chemistry and physics SKE course participants (Table 1). There were more female chemists and more male physicists but the total numbers of male and female participants across both courses were almost equal (Table 1).

**Table 2** Numerical responses to questionnaire items

Question	Strongly agree	Agree	Disagree	Strongly disagree	Total
1. The SKE course has developed my subject knowledge and understanding throughout the year.	18	8	0	0	26
2. The teaching on the SKE course has supported my learning well throughout the year.	20	6	0	0	26
4. The feedback in the sessions has supported my development and understanding.	15	11	0	0	26
5. The feedback I have received regarding my assignments has supported my development and understanding.	15	11	0	0	26
6. I have enjoyed the content in the course this year.	14	10	1	0	25
7. I feel highly motivated to participate in my PGCE next year due to my involvement in my SKE course.	21	5	0	0	26
8. I feel well prepared to embark on my PGCE next year due to my involvement in my SKE course this year.	20	6	0	0	26
	<b>Strong impact</b>	<b>Good impact</b>	<b>Slight impact</b>	<b>No impact</b>	<b>Total</b>
3. The tutor(s) has/have given me sufficient support throughout the year.	21	5	0	0	26

All students answered all the Likert-type items except for one who did not respond to Question 6. Numerically, the feedback was very positive. Most respondents chose the most positive category for the majority of questions (Table 2). For three questions there was a more even split between the two positive categories and one respondent used a negative category for one of the questions (Table 2). This indicated a less positive endorsement of the feedback received and enjoyment of the course content.

## Additional comments for each question

**1 The SKE course has developed my subject knowledge and understanding throughout the year.** Most free responses reinforced the respondents' perception that their subject knowledge and understanding had improved through the course and that self-confidence in their subject knowledge had increased. More chemistry SKE than physics SKE students commented on their improved confidence levels. Other strong themes were that the

**Table 1** SKE course cohort characteristics 2012–13

Subject	Male	Female	Totals
Chemistry	5	10	15
Physics	7	4	11
<b>Totals</b>	<b>12</b>	<b>14</b>	<b>26</b>

course had been good revision of previously known material and that it had been valued as good preparation for teaching. A group of respondents clearly saw their course as a framework for their own personal programme of study. Several others cited the course content and delivery as supporting their learning. However, there were four individuals who had personal preferences for content or modes of delivery other than those on offer during the course.

- 2 **The teaching on the SKE course has supported my learning well throughout the year.** The open responses cited a variety of reasons for a positive perception. The most common themes were the ease of access to tutors and the high quality of support. This was followed by the high quality of the teaching. A variety of other aspects were also mentioned by one or two respondents. For example, the course format was considered to be effective in giving opportunities for clarifying subject content and misconceptions. Also, the inclusion of skills needed in preparation for PGCE had increased confidence.
- 3 **The tutor(s) has/have given me sufficient support throughout the year.** The participants clearly perceived this as an area of strength for this type of SKE course format. There were no negative or qualified open response comments for this survey item.
- 4 **The feedback in the sessions has supported my development and understanding.** No strong common themes emerged from the open responses. Respondents made a variety of comments on the quality and nature of the feedback received in sessions and the ways it had been personally useful to them.
- 5 **The feedback I have received regarding my assignments has supported my development and understanding.** The respondents wrote about several themes. They commented positively on the nature and sources of the feedback received and gave examples of where they had individually found it useful. Comments mentioned attributes of feedback received on assignments that respondents valued. In descending order of frequency they were: constructive, clear, focused, necessary, informative and prompt. Comments demonstrated a keen awareness of the utility of feedback in relation to identifying strengths and areas for development, and improving general performance or achieving grade criteria.
- 6 **I have enjoyed the content in the course this year.** The descriptors linked to enjoyment of the content of the course cited by one or more respondents, in descending order of frequency, were: fun, interesting, the subject content, engagement, the tutors, personal development, pedagogy and links between separate sciences. Some sessions that challenged individual respondents resulted in a range of negative comments: some sessions were not enjoyable, reflective log was a 'necessary evil', uneven distribution of workload, negative references to a specific module, coverage in sessions, lack of challenge, more depth wanted and specified content that had been omitted and should be included in future.
- 7 **I feel highly motivated to participate in my PGCE next year due to my involvement in my SKE course.** Common themes among respondents were based upon confidence or increased confidence to start their PGCE course. Some expressed this as feeling well prepared and looking forward to starting PGCE after SKE. Although not a primary function of the course, pedagogical issues were a key and integral part and respondents welcomed opportunities to microteach and present in order to develop teaching skills in preparation for the PGCE course.
- 8 **I feel well prepared to embark on my PGCE next year due to my involvement in my SKE course this year.** Again, increased confidence and feeling well or better prepared for the PGCE year were the explanations most often linked to the positive response to this item. Most respondents saw this in terms of having acquired new subject knowledge and understanding, being more up to date or recently revising the topics needed for teaching. A few cited modelling of pedagogy, microteaching, gaining experience or developing presentation skills as positive experiences. The feeling that support would continue into the next course was valued. However, several respondents were more guarded and demonstrated awareness that even more subject knowledge development would be needed during the PGCE year.

### Free response questions

- **Write a few sentences to summarise what the SKE course/tutors do well.** A wide variety of comments were made that fell into two main categories: comments based upon individual preferences related to aspects of the course and those related to attributes of tutors; there were no strong common themes.
- **Write a few sentences to summarise what we could do better.** Comments about a particular module and its mode of delivery demonstrated some respondents' preference for the adoption of a didactic approach throughout the module and for all tasks within it to contribute to assessment outcomes.

### Summary of main findings

#### Positive outcomes

- Respondents ended the course with high levels of motivation towards their PGCE course and feeling prepared for its challenges.
- Respondents felt their subject knowledge and understanding in chemistry or physics had improved over the course.
- Respondents felt more confident to teach chemistry or physics.
- Most participants enjoyed the course.
- Tutor support was highly valued and seen as a strong positive aspect of the course.

#### Areas for development

- Session and assignment feedback was found to be useful for a variety of reasons, but some qualified statements sought formal feedback more often, more quickly after assignments and in more detail.
- Structural course improvements were suggested by some respondents. The most common was to increase the amount of contact time. On occasion this suggestion was linked to a desire to reduce the overall course length.

### Discussion

A wide-ranging and detailed evaluation of SKE courses was undertaken by CooperGibson Research for the UK government Department for Education (Gibson *et al.*, 2013a, 2013b). This entailed a large-scale national survey of students at the start and end of SKE courses, on PGCE courses and during the newly qualified teacher (NQT) year. All SKE subjects and courses were included across the range of

course lengths and models of delivery on offer. This research indicated that SKE courses were very well perceived by students and seen as excellent preparation for PGCE courses (Gibson *et al.*, 2013a). Course satisfaction ratings were mostly high and students expressed perceptions of improved subject knowledge and greater confidence in their SKE subject and their ability to teach it (Gibson *et al.*, 2013b). Although the national survey respondents constituted a self-selecting sample across all SKE subjects, the survey data from the start and end of SKE courses originated mostly from respondents preparing to teach chemistry, mathematics and physics (Gibson *et al.*, 2013b). This was useful for comparison with the local data collected for this article. The data from LJMU students is indicative of the findings of the national survey but more focused in referring only to chemistry and physics SKE students and one type of extended SKE course.

Respondents to the LJMU chemistry and physics SKE student feedback survey gave very positive feedback about its content and delivery. Philpott (2014) considered a wide range of models for professional learning that are used by teacher trainers and educators. Initially, it might appear that models that emphasise the individual's cognitive and psychological aspects of learning, such as Kolb's (1983) experiential learning cycle, would be most relevant to the design of SKE courses. Models that focus on the social aspects of learning, such as Wenger's (1998) communities of practice, might appear to have more relevance to the process of initial teacher training/education (ITT/E) in school. When making positive comments, the LJMU SKE students appear to have considered their own progress from a social learning perspective. When thinking of areas for course improvement, a more personal and psychological learning model was adopted.

The students agreed on the value of regular contact sessions that enabled them to receive support from tutors and each other over an extended period of time. However, the reservations expressed often reflected the differences in their personal attitudes to individual learning and in their expectations of what a SKE course should cover. Some favoured a shorter, more intense course with a didactic approach throughout in order to include more subject knowledge covered efficiently in more depth. While most welcomed the opportunities



provided to practise skills and develop chemistry and physics pedagogy, this was not to be at the expense of the subject knowledge content covered.

Both the national data (Gibson *et al.*, 2013b) and the local findings reported in this article suggest that SKE chemistry and physics students are likely to feel confident and in possession of the necessary subject knowledge to teach. However, student self-evaluation means little unless tested and confirmed by third-party evaluations or assessments. For LJM U SKE chemists and physicists completing their PGCE courses in 2012, Tynan *et al.* (2014) found no difference in the grade distributions on final review forms for subject knowledge and overall teaching grades compared with those who had commenced the PGCE with a chemistry or physics first degree. Early employment data for both groups were also similar (Tynan *et al.*, 2014). Furthermore, to pass an accredited higher education certificate course, participants must meet all its assessment requirements. This suggests that the LJM U SKE student survey expressions of confidence and perceptions of improved subject knowledge in chemistry and physics are linked to measurable outcomes. The national survey did not look at outcomes for SKE students (Gibson *et al.*, 2013b).

A model for development that helps make sense of the differing approaches to assessment encountered while learning to do a job or profession was proposed by Hager and Butler (1996). This was applied to the assessment of teacher competencies by Martin and Cloke (2000), who described a model for professional

development congruent with the pattern of initial teacher training at LJM U at the time of this study (Figure 1). SKE courses offered prior to the commencement of teacher training can be seen as an extension of the initial phase of professional development involving the acquisition of fundamental subject-specific knowledge, attitudes and skills (Figure 1). However, this model of professional development suggests that the methods of assessing new subject knowledge will not only vary depending upon the model of delivery and length of the SKE course but also with the phase of professional development.

Once participants embark upon their teacher training in school, the assessment emphasis shifts away from testing and a scientific measurement model towards a qualitative judgemental one based upon observations of learning and teaching (Martin and Cloke, 2000). This reflects different purposes of subject knowledge for teachers during the practice and demonstrating personal competency phases of development (Hager and Butler, 1996; Martin and Cloke, 2000). Here, the emphasis is to develop and practise teaching and assessment skills to enhance another's learning of subject knowledge and skills. Competence in the teachers' standards (Department for Education, 2011) is judged by the impact on pupils' learning over time so there must be a change in emphasis from assessing a teacher's personal knowledge and understanding of a subject discipline to judging the impact that their subject knowledge has upon their learners' progress.

This client-led approach has resulted in the current resurgent popularity of clinical practice ITT/E models among education policy makers

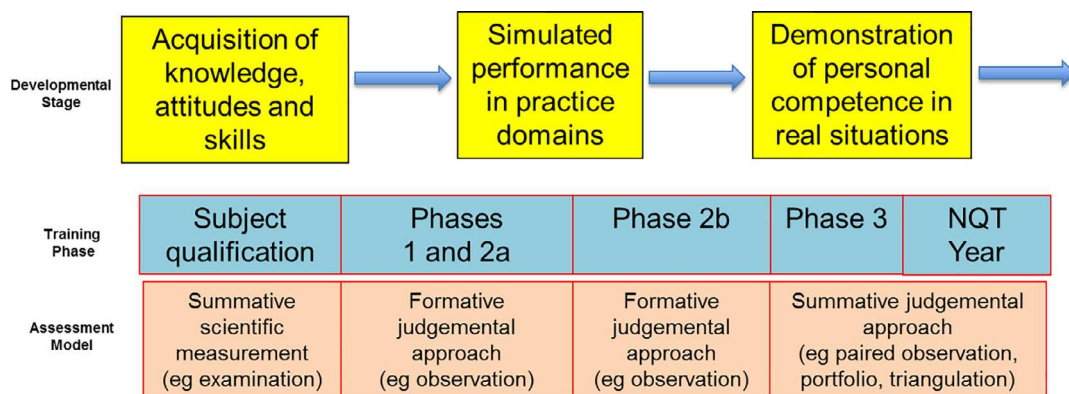


Figure 1 A model for ITT/E professional development; after Hager and Butler (1996) and Martin and Cloke (2000)

(Philpott, 2014). The perceptions of improved chemistry and physics subject knowledge expressed by the LJMU SKE participants in their feedback and their increased levels of confidence would be important in helping them perform as credible teachers of physical sciences in the eyes of learners and teaching colleagues. This could also help explain the parity of assessment and then early employment outcomes of LJMU PGCE students with SKE qualifications compared with those with first degrees in physical sciences reported by Tynan *et al.* (2014).

SKE courses in chemistry or physics do not claim to provide the same depth and range of subject knowledge and understanding as a first

degree in those subjects. Furthermore, the way subject knowledge is acquired and assessed can differ greatly between undergraduate physical science, SKE and PGCE courses. Together, these considerations should lead potential employers of chemistry and physics teachers to take care when considering the subject knowledge of an applicant with a SKE qualification. On the other hand, there is a pressing need to accelerate the process of training new teachers of chemistry and physics. The evidence gathered so far supports the idea that SKE courses in chemistry and physics can help recruitment to these shortage science subjects and provide confident and capable physical science teachers.

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