# *Changes in Perceptions and Attitudes of Pre-service Postgraduate Secondary Science Teachers: a comparative study of programmes in Israel, England and Wales*

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ABSTRACT *This study dealt with the development of English–Welsh and Israeli pre-service secondary science teachers immediately before and after their initial teacher education (ITE) courses. Data were collected through a questionnaire and interviews conducted during and at the end of courses. The main findings of the study are four-fold: (1) Both groups possessed progressive ideas about science education before entering the programme. (2) Almost all the original significant differences between the two groups remained after the students had participated in the programmes. (3) Throughout their teaching practices, almost all students passed through a dynamic process of transformation and changed their perceptions/attitudes about science education in schools. The British students, however, developed more progressive ideas and positive attitudes of a professional kind than the Israelis. (4) The influence of university tutors was effective only whilst the students found that their ideas provided them with useful, practical teaching tools. The students only dimly understood the relevance of many theoretical and philosophical ideas presented. Here, too, the English–Welsh programme was more effective, whilst the Israeli students expressed a clear dissatisfaction with theirs. It is suggested that the university- and school-based partnership model in England and Wales for the education and training of secondary science teachers is more effective than the Israeli university-based model. However, even the British course is not effective enough and there remains a need for significant changes in pre-service and early in-service teacher education.*

## Introduction

Much research effort has been invested recently in looking for conceptual changes in serving science teachers. Growing interest in this area is driven by the notion that reform in science education is highly dependent on our ability to change conservative ideas that many science teachers, all over the world, hold in relation to teaching and learning, e.g. that pupils will learn much from merely listening, from memorizing, from carrying out 'recipe' practical work; that undergraduate and postgraduate students in education and

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training will learn much from hearing about how to plan and prosecute lessons, or even how to manage class discipline.

It is surprising that research into initial teacher education (ITE) is very limited in most parts of the world. However, recent studies raise significant doubts about the effectiveness of existing ITE programmes (Maskill & Selles, 1995; Gustafson & Rowell, 1995; Orion & Thompson, 1996). Some believe that teaching should be learned by practice (a procedure biased towards training) and that theory has little to offer—the apprenticeship model of Ryle (1963). Others favour an approach in which teaching practice and its critical appraisal is accompanied by discussion of theoretical considerations (and the consequential offering of practical advice) from both university tutors and school mentors, the whole being set ideally in a local school context and a wider social view (Renshaw, 1971; Fleming & Thompson, 1996). This procedure is biased towards the education, rather than just the training, of true professionals.

Maskill and Selles (1995) claim that planners of ITE courses have, in the last decade, changed the balance of theory and practice, from heavily theoretical towards more practical approaches. While this is true for several countries (e.g. USA, England and Wales) there are many in which programmes are still theory-based.

Tamir (1991), in Israel, suggested that student teachers enter pre-service programmes with a high level of uncertainty. This was in contrast to studies in the USA which asserted that students entering teacher education programmes possessed definite ideas about teaching and learning (e.g. Hollingsworth, 1989). Orion and Thompson (1996) found that most student teachers entered the Postgraduate Certificate of Education (PGCE) programme in England and Wales with much uncertainty with respect to most aspects of science education and particularly the practical teaching of science, but with some definite ideas as well. However, it was also found that students possessed the same amount of uncertainty, but now in different areas of concern, after participating in the PGCE programme. These findings suggest that the objectives set by the tutors which related to these aims (Fleming & Thompson, 1996) do not correspond very well with the immediate needs of student teachers and, even more importantly, with their tenderfoot learning abilities.

Tamir (1991) wrote that 'previous research has shown that most pre-service education programmes ... tend to perpetuate the beliefs that pre-service teachers bring with them' (p. 239). The findings of Orion and Thompson (1996) in England refute this and suggest that throughout their teaching practices students pass through a dynamic process of transformation and that meaningful perceptual and attitudinal changes occur for almost all of them. This process, however, proved to be totally idiosyncratic and the influence of university tutors was effective only when their ideas provided students with useful practical teaching tools. Furthermore, ideas which were not recognized as 'useful' did not register and were too often referred to, and classified as, 'irrelevant'.

Orion and Thompson (1996) also pointed out a paradox. In order to produce educators rather than 'teaching technicians' student teachers should be introduced in a meaningful way both to practical and to theoretical (philosophical, historical, sociological, psychological and cultural) aspects of education. Alas, pre-service students are able only dimly to understand the relevance of many of these contexts and ideas. Moreover, these desirable but Utopian contexts cost time and money to introduce and discuss, which governments are loathe to fund. An alternative, now mandatory in England and Wales, is to increase greatly (to 66% of the course) the time spent in schools with school staff. A danger is that these measures may serve to perpetuate development in PGCE students

of the somewhat authoritarian day-to-day classroom management skills, strategies and approaches of the traditional parts of the teaching profession.

## The Purpose of the Study

The present study involved a comparison of the beliefs and attitudes of English–Welsh and Israeli pre-service secondary science teachers. The comparison focused on the amount and direction of the changes which occurred following their ITE programmes.

Since the two programmes were set in different cultures, where one (in England and Wales) accords the teaching profession a higher social and economic status, it is suggested that the findings of this study will have general implications for other countries and may encourage the development of more effective ITE science programmes worldwide.

This study had two main purposes: (a) To identify pre- and post-course differences in the preconceptions and attitudinal changes of students in England/Wales and Israel in relation to two individual ITE programmes. The rationale beyond this purpose was that such comparison might reveal, and stress, the advantages and disadvantages of each of the two programmes. (b) To identify similarities between the findings in each of two rather different cultures and the contrasting ITE courses. The rationale behind this was that such similarities might indicate general characteristics of pre-service secondary science students, i.e. those which are not related to a specific culture and programme.

In order to find any similarities and differences a series of questions was addressed. Are there any differences concerning:

(1) A 'general education through science'?
(2) Selected issues related to teaching science: the aims and goals of science education; classroom management skills; teaching schemes and instructional strategies?
(3) Their initial self-concepts as science teachers?
(4) Their initial self-confidence concerning teaching assignments which might be carried out in the classroom, in the laboratory and in the many out-of-school environments?
(5) Their expectations of the overall nature of purpose and directions of the teacher education and training programmes?
(6) The likely changes of preconceptions and attitudes in relation to the domains mentioned above in each group of students following their pursuit of two very different ITE science programmes?
(7) The extent to which teaching experiences of students, both as learners at school and as intending teachers who availed themselves of pre-course teaching opportunities, affect their attitudes towards different aspects of the ITE science programme?

### *The Two Education and Training Programmes*

Each of the programmes was quite typical for its country. A detailed description of the pre-service PGCE education and training programme of England and Wales, as exemplified at Keele, may be found elsewhere (Orion & Thompson, 1996; Fleming & Thompson, 1996). Table I highlights the main differences between the programme in England and Wales and the Israeli programme.

TABLE I. A comparative description of the two programmes

| | | The Keele model | The Israeli university-based model |
|---|---|---|---|
| The university component | Programme's duration | One year programme: 5 full days for 37 weeks | About 2 days a week over 2 years. |
| | The programme | The university staff work as a team. The programme was developed as a team effort and they have frequent regular staff meetings during the year as well as many meetings with the schools' mentors. The university staff members are appointed as a result of their long experience and reputations as exemplary science teachers. Likewise the choice of school mentors. | The programme consists of a conglomerate of individual courses and lecturers. There is no connection, co-operation or articulation between the lecturers and each course is delivered as a unique entity. Only a few of the university lecturers who teach the theoretical courses have experience as school teachers. |
| | Students' selection | There are criteria for accepting students to the programme. The students provide an application form together with a CV and, if their paper qualifications are suitable, they have to pass a searching oral interview. | There are no criteria related to the students' previous experiences which would evaluate their suitability or reasons for wishing to join the programme. No real selection process takes place. |
| | Students' status | Mostly postgraduates. They receive a bursary (financial support) for participating in a programme aimed at recruiting teachers of shortage subjects (e.g. science and mathematics). | Students join the programme in their third year of BSc studies. They have to pay an extra registration fee for joining the programme. |
| The school component | Practice versus theory | A school-orientated course. Two thirds of associates' time is spent in schools learning how to become professionals in a 'real life' context. The school provides a professional tutor (often deputy head) who supervises six to 12 students with respect to the consideration of theoretical educational issues as they are expressed in the school's policies. Many seminars are conducted in collusion with the education tutor from the university and in the presence of specialist school staff. In addition the science staff of the university visit the schools on at least four occasions in order to view, analyse and criticize students' lessons and liaise with the schools' science mentors who do likewise on many more occasions. | A university-orientated programme. Not more than a third of students' time is spent in schools. The university hires school tutors who collaborate with the lecturer of the methods course in overseeing the student's progress. There is no one model and each lecturer works with his school tutor group according to his own way. Some work closely with their school tutors while others do not invest much time or effort in visiting schools and viewing and criticizing lessons. |
| The assessment and evaluation of the students' progress | | There is an assessment and evaluation of the students during the course. This is carried out by university and school mentors acting independently in an equal partnership. At the end of the course a sample of students is assessed and evaluated by external university and school evaluators via an oral interview and by the scrutiny of their portfolio of coursework assignments. There is no end-of-course examination, this being considered to be an inappropriate way to assess and evaluate a professional teaching qualification. A great deal of emphasis is placed on jointly assessing the quality of the PGCE students' practical teaching competence. | The students sit a formal examination at the end of each of the courses. They have to attend the courses and pass these terminal examinations in order to receive the teaching certificate. The practical teaching experience of the students is not thoroughly assessed according to common criteria by the school or university. |

## Methods

*Sampling*

The English–Welsh sample included 38 postgraduates who completed a 1 year PGCE course at Keele during 1992–1993. This sample comprised 90% of the initial population (42 students) who started the programme. The Israeli sample included 30 students who started and finished the programme after 2 years (between 1992 and 1994) in one of the five universities in Israel that conducted such a programme. This latter sample comprised about 50% of the undergraduate population that started the programme. This large 'drop out' is another indication of differences between the two programmes. The distributions within the two samples in relation to gender, age, previous teaching experiences and scientific backgrounds are given in Table II.

According to tutors' judgements, the student groups were quite representative of other groups which have participated in science ITE programmes over the previous 10 years. The Keele course in 1992–1993 was very similar to that of other universities of England and Wales although all of them have changed rapidly since then. Although there were

TABLE II. The population distribution in relation to discipline, gender, age and previous teaching experience

Discipline and gender

| Major | Number (%) | | Male | | Female | |
|---|---|---|---|---|---|---|
| | B | I | B | I | B | I |
| Biology | 12 (31) | 12 (40) | 4 | 1 | 8 | 11 |
| Chemistry | 9 (23) | 6 (20) | 5 | – | 4 | 6 |
| Earth sciences | 8 (21) | 8 (27) | 7 | 3 | 1 | 5 |
| Physics | 10 (25) | 4 (13) | 8 | 4 | 2 | – |
| Total | 39 | 30 | 24 (61%) | 8 (27%) | 15 (39%) | 22 (73%) |

Age

| | British students | | Israeli students | |
|---|---|---|---|---|
| Range (years) | Number | (%) | Number | (%) |
| 20–25 | 22 | 56 | 8 | 28 |
| 26–30 | 9 | 23 | 15 | 50 |
| 31 < | 8 | 21 | 7 | 22 |

Previous teaching experience

| | British students | | Israeli students | |
|---|---|---|---|---|
| Previous experience | Number | (%) | Number | (%) |
| None | 22 | 56 | 4 | 14 |
| Limited | 15 | 39 | 17 | 57 |
| Quite a lot | 2 | 5 | 9 | 29 |

*Note:* B = British students, I = Israeli students.

some variations among the different Israeli courses, overall the programme under study was typical.

*The Instruments and the Structure of the Research*

The data were collected through a questionnaire and interviews which were conducted both during and at the end of the course. The questionnaire included an 'open' part and a 'closed' Likert-type part:

(1) The 'open' part involved views about education through science and included the following question: 'Besides the importance of pupils being acquainted with various aspects of subject matter, what in your opinion are the most important reasons for including science education in the National Curriculum?' (Please write short statements).

(2) The 'closed' Likert-type questionnaire included 65 items concerning seven categories:
- the purposes of science education;
- classroom management;
- teaching schemes and instructional strategies;
- their self-concept as a science teacher;
- their self-confidence in using selected teaching strategies; and
- their expectations of the programme.

The instrument used a seven-point scale. Most of the categories used an 'agree–disagree' scale as follows: 7 = strongly agree, 6 = agree, 5 = agree but not sure, 4 = not sure, 3 = disagree but not sure, 2 = disagree, 1 = strongly disagree.

The category involving the purposes of science education was based on a similar seven-point 'high–low' scale, while the category involving students' extent of confidence in teaching was based on a 'confident–diffident' scale. A detailed description of the validation and administration processes of the questionnaire is to be found in Orion and Thompson (1996).

Towards the end of the courses 18 British and 15 Israeli students were interviewed. The students were chosen randomly and interviews were conducted by means of a friendly and open conversation. The interviews started with a general discussion of the students' experiences and impressions of his/her programme. At some stage the student was asked direct questions about his/her responses to the pre- and post-questionnaires. They were provided with their original answer sheets and were asked to explain their views at the time. No notes were taken throughout the interviews in order to maintain the informal and open atmosphere of the conversation. However, a brief summary of the main points raised, and the paraphrasing of the enlightening comments which they offered, were written up immediately afterwards.

*Data Analysis*

The analysis of the 'closed' part of the questionnaire included frequency distributions, means and standard deviations, *t*-test and one-way analyses of variance (ANOVA) statistics. For the analysis the seven-point scale was merged into three categories: disagree = 1,2; not sure = 3,4,5; agree = 6,7.

The written responses were analysed and classified into categories in a three-stage process:

(a) classification and categorization of students' statements by the authors;

(b) classification by an external expert's judgement of the initial list of categories and their related students' statements. This process was conducted by eight science education researchers who were regarded as 'experts' with respect to their many (more than 10) years of experience in research and in visiting science lessons in schools. The experts were asked to evaluate the connection between each statement and its category. In a case of disagreement with the initial connection, they were asked to suggest a different category with which that specific statement should be connected;

(c) revision of the initial classification and categorization of students' statements by the authors following the experts' comments and suggestions. The final list of categories which was established enabled a pre-/post-test comparison of students' responses to be made that used four scales of analysis:
No change = the same reasons appeared in both the pre- and the post-test responses.
Minor change = only one change (in or out) appeared.
Moderate change = two or three changes were noted (in or out) and the change was less than 50%. If there were only three reasons and two of them were changed then it was accounted as a major change and not as a moderate one.
Major changes = more than three changes or more than 50% of changes.
The paraphrased answers compiled immediately after the interviews will be presented throughout the rest of this paper in explanation of some of the findings and conclusions.

## Results

*The Analysis of the 'Open' Questionnaire*

The analysis of the written replies of the British students to the pre- and post-questionnaires revealed 35 different sets of statements. Following the process described above, these statements were reclassified and collapsed into 18 different categories which served as the basis for the comparison of personal changes of opinion (Tables III and IV). The analysis of the Israeli replies revealed only 12 different categories.

The following observations emerged from a comparison of the replies:

(1) Both groups of students mentioned a wide spectrum of reasons initially for wishing to teach science. However, while the range of the British replies was enlarged after the course finished, the Israelis' spectrum diminished a little.

(2) In both groups only one, albeit different, reason for studying science in schools was mentioned by the majority of students. The British mentioned 'the role of science in our daily world' (about 60% in the pre-test and about 75% in the post-test), while the Israelis emphasized 'the development of cognitive skills' (68% in the pre-test and about 74% in the post-test).

(3) In both groups almost all of the students changed their views about science education and most of them exhibited major changes in their pre-test and post-test replies. The changes were in many directions and involved the acquiring of new ideas and the leaving aside of old ones. There were many swings of opinion in both directions by individual students at the personal level.

(4) Although the changes were mainly individual, it was possible to detect certain general changes within the British group. Their views about the importance of the role of science in our daily life, and in society generally, tended to increase. Such a direction and tendency to change was less obvious within the Israeli group.

TABLE III. A pre-post comparison of the reasons for teaching science in schools written by the same students (one to one). Data for the Israeli cohort are in bold

| List of reasons | Pre | Post | No change | Change In | Change Out |
|---|---|---|---|---|---|
| 1. The role of science in our surrounding: world we live in everyday (real) life, objects and personal body | 23 (61%) | 28 (74%) | 18 | 10 | 5 |
| | **8 (42%)** | **5 (26%)** | **3** | **2** | **4** |
| 2. Development of cognitive skills | 21 (55%) | 16 (42%) | 10 | 6 | 11 |
| | **13 (68%)** | **14 (74%)** | **10** | **5** | **3** |
| 3. The role of science in society aspects: environmental and/or technology awareness | 15 (39%) | 18 (47%) | 7 | 11 | 8 |
| | **3 (16%)** | **5 (26%)** | **1** | **4** | **2** |
| 4. Development of practical investigative skills | 13 (34%) | 9 (24%) | 3 | 6 | 10 |
| | **3 (16%)** | **5 (26%)** | **1** | **4** | **2** |
| 5. Progress and advancement of the: world/nation/humankind/industry | 11 (29%) | 5 (13%) | 5 | – | 6 |
| | **1 (5%)** | – | – | – | **1** |
| 6. Influence on future study and career | 9 (24%) | 5 (13%) | 3 | 2 | 6 |
| | **1 (5%)** | **2 (10%)** | – | **2** | **1** |
| 7. Enquiring state of mind | 6 (16%) | 5 (13%) | 1 | 4 | 5 |
| | **1 (5%)** | **2 (10%)** | – | **2** | **1** |
| 8. To provide basic education | 4 (11%) | 3 (8%) | – | 3 | 4 |
| | **2 (10%)** | **2 (10%)** | **1** | **1** | **2** |
| 9. The natural world | 8 (21%) | 6 (16%) | 3 | 3 | 5 |
| | **1 (5%)** | – | – | – | **1** |
| 10. The affective aspect: fun, enjoyment, interest | 4 (10%) | 5 (13%) | 1 | 4 | 3 |
| | **4 (21%)** | **5 (26%)** | **2** | **4** | **3** |
| 11. Study skills | – | 1 (3%) | – | 1 | – |
| | **1 (5%)** | **3 (16%)** | – | **3** | **1** |
| 12. Presentation skills | – | – | – | – | – |
| | **1 (5%)** | **1 (5%)** | **1** | – | – |
| 13. Social aspect (teamwork, co-operation) | 3 (8%) | 1 (3%) | – | 1 | 3 |
| | – | – | – | – | – |
| 14. Truth and objectivity | 2 (5%) | 2 (5%) | 1 | 1 | 1 |
| 15. Foster creativity | – | 2 (5%) | – | 2 | – |
| 16. A tool to involve all pupils in the lessons | – | 1 (3%) | – | 1 | – |
| 17. Knowledge of historical development in science | – | 1 (3%) | – | 1 | – |
| 18. To develop good discipline | – | 1 (3%) | – | 1 | – |
| 19. To develop self-control | – | 1 (3%) | – | 1 | – |
| | | Total | = 53 | + 57 | − 63 |
| | | | **= 19** | **+ 27** | **− 21** |

No change, similar reasons were given by the same students in both questionnaires.
In, reasons which appeared only in the post-test.
Out, reasons which appeared only in the pre-test.

(5) As shown by Table IV, there was a clear difference between the groups in relation to the size of the change which each of the students underwent. While the majority of the British students (63%) presented major changes, only 40% of the Israelis exhibited such a change.

In summary, these findings indicate that both student–teacher groups should be best described as holding individual opinions. However, there are differences between the groups in relation to the range of reasons which each holds before and after completing

TABLE IV. Amount of change in ideas about education through science revealed by the personal comparison of the pre- and post-questionnaires

| Criterion | Number of students | | Percentage of students | |
|---|---|---|---|---|
| | B | I | B | I |
| No change | 1 | 3 | 3% | 10% |
| Minor | 3 | 6 | 8% | 20% |
| Moderate | 10 | 9 | 26% | 30% |
| Major | 24 | 12 | 63% | 40% |
| Total | 38 | 30 | 100% | 100% |

No change, the same reasons appeared in the pre- and the post-questionnaire.
Minor, only one change (in or out) appeared.
Moderate, two or three changes (in or out) and the change was less than 50%. (If there were only three reasons and two of them were changed then it was counted as a major change and not as a moderate one).
Major, more than three changes or more than 50% of changes.
B = British students; I = Israeli students.

their programmes. These relate to the rating of the reasons (in terms of importance) and the existence of general changes of view. It is suggested that these differences indicate that:

(a) the British students hold what are generally regarded in the developed world as more 'progressive' ideas about the importance of learning science in schools; and
(b) that the science ITE programmes represented by those of England and Wales were more efficient in reshaping, widening and deepening the quality of students' original views (with respect to the standards espoused by the eight science education experts).

*Analysis of the 'Closed' Questionnaire: comparison of the opinions and characteristics of the two groups on entry*

Tables V and VI present the frequency distributions and means of the pre- and post-test data of the student groups, together with a *t*-test comparison.

Table V reveals that more differences of opinion exist between the two groups than similarities. Note that in many statements, even when the *t*-test analysis does not indicate a significant difference, such a tendency is detected by comparing the frequency distributions of the two groups.

The similarity between the groups appears mainly in the high degree of uncertainty that both groups hold upon entering their courses. This uncertainty is apparent in their responses to all the seven categories, but mainly in those relating to 'Teaching schemes and instructional strategies' and 'Self-concept'.

While students' views were found to be most definite in relation to several issues, other similarities are displayed which present the following encouraging characteristics of both groups:

- Neither group displayed gender bias or showed preferences for teaching the more able students. (The Israelis were significantly definite about gender, but this correlates with the fact, which may be significant, that most of the Israeli students were female);
- Both groups held progressive ideas about pupils being able to understand and question the nature, origin and future workings of the natural and man-made world, and media

TABLE V. A comparison of the post-questionnaires of the British (B) and the Israeli students (I), including both significant *t*-test analysis and frequency distribution. The original seven-point scale was merged into three categories: disagree = 1,2; not sure = 3,4,5; agree = 6,7. NS = not significant

| | Frequency (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Agree | | Not sure | | Disagree | | X (SD) | | | |
| Statements | B | I | B | I | B | I | B | I | *t* | *P* |
| *Views on teaching science* | | | | | | | | | | |
| 1. Teaching separate sciences up to 16 is best. | 36 | 61 | 46 | 33 | 18 | 6 | 4·5 (1·7) | 5·4 (1·5) | 1·9 | N.S |
| 2. Teaching science today is not very different from the way it was taught when I was a pupil. | 20 | 50 | 49 | 39 | 31 | 11 | 3·8 (1·6) | 5·3 (1·5) | 3·0 | 0·004 |
| 3. Teaching science could be very stressful for me. | 13 | – | 38 | 58 | 49 | 42 | 3·0 (1·5) | 3·0 (1·2) | 0·1 | N.S |
| 4. Less able pupils should be taught less science than the more able ones. | 15 | 16 | 23 | 16 | 62 | 68 | 3·0 (1·8) | 2·7 (1·8) | 0·4 | N.S |
| 5. Teaching broad balanced science is a greater challenge than teaching single sciences. | 56 | 16 | 39 | 47 | 5 | 37 | 5·3 (1·4) | 3·5 (1·7) | 3·7 | 0·0005 |
| 6. I expect more challenge and satisfaction in teaching science than in others jobs. | 79 | 42 | 21 | 47 | – | 11 | 6·0 (0·8) | 4·8 (1·5) | 2·7 | 0·01 |
| 7. Girls will be more difficult to teach than boys in science. | 3 | – | 25 | 10 | 72 | 90 | 2·1 (1·4) | 1·4 (0·7) | 2·4 | 0·02 |
| *Aims, goals and objectives* | | | | | | | | | | |
| 1. The purposes of science education should be derived from the needs of society. | 25 | 32 | 65 | 68 | 10 | – | 4·6 (1·3) | 4·8 (1·0) | 0·7 | N.S |
| 2. The purposes of science education should be derived from a knowledge of the ideas pupils already possess. | 13 | 16 | 67 | 52 | 20 | 32 | 3·7 (1·3) | 3·4 (1·6) | 0·8 | N.S |
| 3. The purposes of science education should be derived from the methodology and philosophy of science. | 15 | 17 | 77 | 83 | 8 | – | 4·3 (1·3) | 4·6 (1·0) | 0·8 | N.S |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4. The purposes of science education should be derived from the questions of the end of course examination papers. | 2 | 26 | 26 | 63 | 72 | 11 | 2·2 (1·4) | 4·8 (1·3) | 7·1 | 0·0001 |
| 5. The job of science teachers should be to encourage pupils to question the natural world around them. | 100 | 74 | – | 26 | – | – | 6·5 (0·5) | 6·3 (0·9) | 1·0 | N.S |
| 6. The job of science teachers should be to respond to the needs of society. | 41 | 5 | 46 | 84 | 13 | 11 | 4·7 (1·5) | 4·0 (1·1) | 1·6 | N.S |
| 7. The job of science teachers should be to satisfy the needs of the pupils. | 64 | 16 | 28 | 58 | 8 | 26 | 5·4 (1·6) | 4·0 (1·5) | 2·6 | 0·01 |
| 8. The job of science teachers should be to produce a life-long interest in science in the pupils. | 82 | 53 | 13 | 47 | 5 | – | 6·0 (1·3) | 5·8 (1·1) | 0·1 | N.S |
| *Management skills* | | | | | | | | | | |
| 1. The teacher should avoid grouping the class according to students' abilities. | 18 | 26 | 44 | 69 | 38 | 5 | 3·5 (1·6) | 4·5 (1·4) | 2·3 | 0·03 |
| 2. Developing a disciplinary role and the use of sanctions are very important. | 51 | 20 | 41 | 60 | 8 | 20 | 5·4 (1·3) | 4·0 (1·6) | 3·2 | 0·002 |
| 3. There should be separate classes for pupils of different abilities. | 43 | 10 | 44 | 65 | 13 | 25 | 4·9 (1·6) | 3·9 (1·5) | 2·0 | 0·05 |
| 4. As a teacher I would give encouragement to each of my pupils. | 97 | 75 | 3 | 20 | – | 5 | 6·7 (0·5) | 5·8 (1·1) | 4·1 | 0·0001 |
| 5. Gaining extensive feedback from many sources on the results of teaching is vital. | 94 | 90 | 3 | 10 | 3 | – | 6·3 (0·9) | 6·3 (0·8) | 0·0 | N.S |
| 6. Laboratory activities are not essential for teaching science. | 3 | 20 | 5 | 10 | 92 | 70 | 1·6 (1·1) | 2·9 (1·9) | 2·7 | 0·01 |
| 7. The computer is a vital educational tool for teaching science. | 41 | 65 | 49 | 30 | 10 | 5 | 4·9 (1·5) | 5·5 (1·4) | 1·2 | N.S |
| 8. I could teach science properly without even going outdoors. | 13 | 20 | 21 | 15 | 66 | 65 | 2·8 (1·7) | 2·8 (1·9) | 0·1 | N.S |
| 9. Pupils should get homework regularly in order to develop independent learning skills. | 67 | 60 | 25 | 35 | 8 | 5 | 5·4 (1·2) | 5·5 (1·4) | 1·4 | N.S |

TABLE V.—*Continued*

| Statements | Frequency (%) Agree B | Agree I | Not sure B | Not sure I | Disagree B | Disagree I | X (SD) B | X (SD) I | $t$ | $P$ |
|---|---|---|---|---|---|---|---|---|---|---|
| *My self-concept as a science teacher* | | | | | | | | | | |
| 1. I am confident in myself as a science teacher. | 48 | 70 | 49 | 30 | 3 | – | 5·3 (1·2) | 5·7 (0·9) | 1·4 | N.S |
| 2. I think I 'know my stuff' and will have few problems with teaching content/concepts. | 20 | 45 | 72 | 55 | 8 | – | 4·9 (1·3) | 5·4 (0·9) | 1·4 | N.S |
| 3. I will have few disciplinary problems with my pupils. | 8 | 10 | 79 | 90 | 13 | – | 4·0 (1·1) | 4·6 (0·8) | 2·1 | 0·04 |
| 4. A specialist science teacher is better respected than a general science teacher. | 13 | 5 | 43 | 75 | 44 | 20 | 3·5 (1·7) | 3·8 (1·2) | 0·6 | N.S |
| 5. Teaching science will be life-long career for me. | 44 | 35 | 53 | 55 | 3 | 10 | 5·2 (1·2) | 4·3 (1·5) | 2·6 | 0·01 |
| 6. I am apprehensive about developing appropriate relationships with science classes. | 31 | – | 41 | 35 | 28 | 65 | 4·2 (1·6) | 2·6 (1·1) | 3·9 | 0·0003 |
| 7. I am apprehensive about developing sound personal relationships with every student. | 18 | 10 | 51 | 45 | 31 | 45 | 3·9 (1·5) | 3·1 (1·4) | 1·9 | N.S |
| 8. I will be able to act out the role of the best science teacher who taught me. | 15 | 21 | 60 | 74 | 25 | 5 | 4·1 (1·7) | 4·6 (1·3) | 1·4 | N.S |
| 9. I expect to have to earn the respect of my pupils. | 100 | 65 | – | 30 | – | 5 | 6·3 (0·5) | 5·5 (1·4) | 2·6 | 0·01 |
| *Teaching schemes and instructional strategies* | | | | | | | | | | |
| 1. Individual teachers should decide the teaching scheme for each science class. | 15 | 40 | 62 | 45 | 23 | 15 | 4·0 (1·6) | 4·5 (1·5) | 1·0 | N.S |
| 2. Teachers must cover all the topics in the science syllabus. | 44 | 30 | 48 | 65 | 8 | 5 | 5·1 (1·5) | 4·9 (1·3) | 0·1 | N.S |
| 3. Heads of science should control the curriculum which is taught by individual science staff. | 23 | 35 | 64 | 55 | 13 | 10 | 4·6 (1·4) | 4·7 (1·3) | 0·1 | N.S |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4. The external examination in practice determines the course of science which is taught. | 64 | 55 | 33 | 35 | 3 | 10 | 5·7 (1·1) | 5·2 (1·7) | 1·0 | N.S |
| 5. The needs of the industry and other influencing bodies should be reflected in what is taught. | 46 | 45 | 44 | 45 | 10 | 10 | 5·1 (1·4) | 4·7 (1·5) | 0·9 | N.S |
| 6. Teachers should not spend much time on development of teaching materials; there are good materials to buy. | 8 | 10 | 43 | 35 | 49 | 55 | 2·8 (1·4) | 2·8 (1·7) | 0·1 | N.S |
| 7. What is taught should be chosen for its potential to interest students. | 33 | 25 | 54 | 55 | 13 | 20 | 4·5 (1·6) | 4·0 (1·8) | 1·1 | N.S |
| 8. Individual teachers should decide how to teach each topic in science syllabus. | 62 | 56 | 35 | 44 | 3 | – | 5·5 (1·1) | 5·6 (0·7) | 0·0 | N.S |
| 9. Few behavioural and safety problems arise when teachers direct learning closely. | 26 | 30 | 66 | 65 | 8 | 5 | 4·7 (1·0) | 4·6 (1·1) | 0·5 | N.S |
| 10. Chalk-and-talk is still the best way of teaching science. | 10 | 15 | 41 | 60 | 49 | 25 | 3·1 (1·6) | 3·6 (1·5) | 1·3 | N.S |
| 11. Small group practicals are better than individualized practicals. | 38 | 26 | 52 | 73 | 10 | – | 4·8 (1·4) | 4·7 (1·0) | 0·2 | N.S |
| 12. Individualized learning tasks, monitored by the teacher, should be commonplace. | 28 | 60 | 67 | 40 | 5 | – | 4·8 (1·1) | 5·5 (0·9) | 2·3 | 0·04 |
| 13. Students learn best if they have to work out things for themselves rather than being told or shown what to do. | 38 | 30 | 54 | 55 | 8 | 15 | 5·0 (1·5) | 4·5 (1·4) | 1·2 | N.S |
| 14. When working with slow learners, teachers should focus on developing minimum competencies. | 10 | 21 | 59 | 63 | 31 | 16 | 3·6 (1·5) | 4·1 (1·5) | 0·9 | N.S |
| *Expectations of the pre-service programme* | | | | | | | | | | |
| 1. The science methods course will be the most important one for me this year. | 18 | 65 | 69 | 35 | 13 | – | 4·3 (1·3) | 5·5 (1·1) | 3·2 | 0·002 |
| 2. I expect that the programme will supply me with all skills needed to become a competent science teacher. | 20 | 20 | 60 | 55 | 20 | 25 | 4·3 (1·6) | 4·0 (1·6) | 0·4 | N.S |
| 3. I believe that my ideas about education will change significantly during the programme. | 46 | 10 | 51 | 75 | 3 | 15 | 5·0 (1·4) | 4·1 (1·3) | 2·3 | 0·03 |

TABLE V.—*Continued*

| Statements | Frequency (%) Agree B | Agree I | Not sure B | Not sure I | Disagree B | Disagree I | X (SD) B | X (SD) I | $t$ | $P$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 4. I expect to find the teaching profession to be enthusiastic. | 46 | 25 | 46 | 75 | 8 | – | 5·0 (1·3) | 4·9 (0·9) | 0·4 | N.S |
| 5. The training programme should be based on experience in schools which is complemented by work in the university. | 90 | 60 | 10 | 40 | – | – | 6·3 (0·7) | 5·5 (1·2) | 3·0 | 0·006 |
| 6. Developing a worthwhile science educational philosophy will be an important task of my postgraduate year. | 61 | 42 | 31 | 47 | 8 | 11 | 5·4 (1·3) | 4·9 (1·3) | 1·5 | N.S |
| 7. The teaching practices will be the most important part of the training programme. | 79 | 60 | 28 | 35 | 3 | 5 | 6·0 (1·1) | 5·5 (1·4) | 1·8 | N.S |
| 8. The course on educational issues (history, philosophy, sociology and organization of teaching) will be very important to me as a science teacher. | 54 | 15 | 36 | 70 | 10 | 15 | 5·1 (1·5) | 4·1 (1·3) | 2·4 | 0·02 |
| *Extent of confidence in teaching* | | | | | | | | | | |
| 1. Introducing a topic by interactive discussion. | 49 | 58 | 51 | 42 | – | 2 | 5·4 (1·1) | 5·6 (1·0) | 0·3 | N.S |
| 2. Running a practical. | 54 | 60 | 38 | 40 | 8 | – | 5·4 (1·3) | 5·8 (0·8) | 1·6 | N.S |
| 3. Discussing and interpreting the results of a practical. | 69 | 70 | 31 | 30 | – | – | 5·8 (0·9) | 5·9 (0·9) | 0·9 | N.S |
| 4. Helping pupils to plan an investigation of their own. | 38 | 50 | 62 | 50 | – | – | 5·2 (1·1) | 5·6 (1·2) | 1·6 | N.S |
| 5. Helping pupils to create hypotheses/conjectures to test. | 36 | 60 | 61 | 40 | 3 | – | 5·1 (1·1) | 5·6 (0·9) | 1·6 | N.S |
| 6. Helping pupils to control variables. | 59 | 60 | 41 | 40 | – | – | 5·5 (1·1) | 5·6 (0·9) | 0·3 | N.S |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 7. Using audio-visual aids. | 72 | 90 | 28 | 10 | – | – | 6·0 (0·8) | 6·2 (0·7) | 0·8 | N.S |
| 8. Organizing and introducing a museum visit. | 64 | 75 | 36 | 25 | – | – | 5·6 (1·1) | 5·9 (0·9) | 0·7 | N.S |
| 9. Organizing and introducing an industrial visit. | 64 | 40 | 36 | 55 | – | 5 | 5·6 (1·1) | 5·3 (1·2) | 0·8 | N.S |
| 10. Organizing and introducing a field experience in a natural setting. | 54 | 70 | 43 | 30 | 3 | – | 5·4 (1·4) | 6·0 (0·8) | 1·9 | N.S |

TABLE VI. Pre- and post-comparison in terms of Israeli students' frequency distribution, means and standard deviations of their replies to the pre- and post-questionnaires and *t*-test analysis. The original seven-point scale was merged into three categories: disagree = 1,2; not sure = 3,4,5; agree = 6,7

| | Frequency (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Agree | | Not sure | | Disagree | | X (SD) | | | |
| Category and statement | Pr | Po | Pr | Po | Pr | Po | Pr | Po | *t* | *P* |
| *Views on teaching science* | | | | | | | | | | |
| 1. Teaching separate sciences up to 16 is best. | 36 | 24 | 46 | 54 | 18 | 22 | 5·4 (1·5) | 4·2 (1·6) | 1·9 | 0·01 |
| *Aims, goals and objectives (High–Low scale)* | | | | | | | | | | |
| 11. The purposes of science education should be derived from the questions of the examination papers. | 2 | 12 | 26 | 24 | 72 | 64 | 4·8 (1·0) | 4·2 (1·4) | 2·0 | 0·03 |
| *Management skills* | No differences | | | | | | | | | |
| *My self-concept as a science teacher* | No differences | | | | | | | | | |
| *Teaching schemes and instructional strategies* | | | | | | | | | | |
| 35. Teachers must cover all the topics in the science syllabus. | 44 | 46 | 48 | 46 | 8 | 8 | 5·1 (1·1) | 3·9 (1·3) | 3·6 | 0·01 |
| *Expectations of the pre-service programme* | | | | | | | | | | |
| 48. The science methods course (will be)* was the most important one for me this year. | 18 | 30 | 69 | 45 | 13 | 25 | 5·4 (1·2) | 3·5 (1·9) | 3·2 | 0·003 |
| 53. Developing a worthwhile science educational philosophy (will be)* is an important task in my postgraduate year. | 61 | 59 | 31 | 38 | 8 | 3 | 4·8 (1·4) | 3·7 (1·3) | 0·9 | 0·03 |
| *Extent of confidence in teaching (High–Low scale)* | No differences | | | | | | | | | |

* The wording of the 'pre' questionnaire is given in brackets. Pr, pre; Po, post.

comment on such, through the knowledge and skills acquired in their science education;

- Both groups displayed progressive ideas in relation to classroom management and teaching strategies, e.g. the importance of extensive feedback and of using a variety of learning environments including the library, the laboratory, computers and the outdoors. However, the British students were significantly more definite about the importance of the laboratory whilst the Israeli students were more definite in relation to the potential use of computers. (Recall, however, that all this relates to 1992–1994.)

The differences discovered indicate that, in general, the British students expressed viewpoints about science teaching and education which, on a worldwide basis, are considered to be progressive, whilst the Israeli students expressed more progressive social viewpoints.

Differences relating to British students appear mainly in the categories 'Views on teaching science' and 'Aims, goals and objectives'. The following are the major differences between the groups:

- The significant differences appear in statements 2, 5 and 6 of the category 'Views on teaching science'. They indicate that, whilst most of the British students chose to enter the programme for 'positive' or 'right' reasons (challenge and satisfaction), only 42% of the Israelis came for these reasons.
- The significant *t*-test differences, and differences in frequency distributions, appear in statements 4, 5, 6, 7 and 8 of the category 'Aims, goals and objectives' and statement 4 in the category 'Management skills'. These replies indicate that the British held a more pupil-oriented approach in relation to the purposes of teaching science and the management skills which they imagined would be needed in order to be successful.

The more progressive social attitudes of the Israeli students are expressed by statements 1, 2 and 3 of the category 'Management skills'.

The analysis of the two categories 'My self-concept' and 'Extent of confidence in teaching' reveals that both groups expressed an overconfidence and an underestimation of the complexity of the skills needed to be a successful truly professional science teacher. However, the Israeli students entered the programme with a significantly higher self-image.

Although significant differences emerged in four statements concerning expectations, both groups generally expected a predominantly practical bias in their courses. As intending teachers, they expected that their school experiences would be the central and most important part of the course. Whilst the British expected a close relationship between their experiences in school and the slant of their university courses, the Israelis expressed much less confidence in the efficiency of their university courses in this regard.

In summary, the common profile of a student teacher in England–Wales and Israel upon entry to his/her PGCE courses appears to include the following characteristics: practical expectations; a questioning outlook towards studying the natural world; a wish to use a variety of learning environments; overconfidence and underestimation of the complex nature of the professional skills needed in teaching. The differences between the two groups were that:

- The British students held more positive attitudes towards the teaching of science as a profession and a career.
- The British students were more motivated.
- The British students were more pupil-oriented.

- The Israeli students were more sceptical about the efficiency of their course in delivering an appropriate professional outcome.
- The Israeli students held what is commonly regarded as a more 'progressive' approach to the socializing aspects of education.

It is suggested that all these differences have cultural origins. The first four appear to relate to the lower status in which the teaching profession is held in Israel compared with England and Wales. This difference reflects in the degree of professionalism which underpins the structure and content of the ITE programmes in both countries. It is hypothesized that this last difference is related to the hierarchical structure of society in England and Wales which, though ever-evolving, is considered to be much more disciplined than Israeli society.

*Students' Opinions and Characteristics upon Leaving the Courses*

The results of the post-questionnaires clearly indicate differences in the responses of the groups to their programmes. The differences are expressed in the degree of uncertainty with which each of the groups left the programme and by the number of significant changes reported. Both groups left their courses in an uncertain mind in relation to many statements in Table V. However, the British left their course with opinions which were a great deal more certain than those of the Israelis in relation to all the categories. The number of statements about which the majority of the British students were uncertain upon entering their course was 22 but this was reduced to only 14 upon leaving. The majority of the Israelis were uncertain with respect to 27 statements on entering but this was only reduced to 22 at the end.

Table VI reveals that the Israelis recorded significant changes following their programme in only five statements pertaining to three of the seven categories. A similar analysis of the British group revealed significant changes in 18 statements of six of the seven categories (Orion & Thompson, 1966).

It is suggested that the results noted in the 'closed' and the 'open' questionnaires are consistent in relation to both groups. It seems that the Israeli group underwent small changes (if any) of their attitudes and perceptions of science teaching and education following their ITE programme. The findings in relation to the British group, however, reveal a pattern and direction of change towards the development of very down-to-earth practical views. In particular, the British emphasized, following their course, issues which make the work of a science teacher in the laboratory more effective and may be easier: the development of a strong pupil-oriented constructivist approach; a greater emphasis on the development and implementation of disciplinary rules and sanctions; a tendency to prefer homogeneous rather than mixed-ability classes and a preference for teaching the more able students.

Table VII indicates the significant differences between the groups which were revealed both by a *t*-test comparison and by statements where more than 25% of difference in students' frequency distribution were obtained. The comparison of the findings of Table VII, together with the pre-questionnaire findings (Table V), indicates that, in general, most of the initial differences remained and in some cases even expanded in relation to the three first categories. For example, statements 2, 5, and 6 of 'Views on teaching science'; statements 4, 6, and 7 of the category 'Aims, goals and objectives'; statements 1–4 and 6 of 'Management skills' highlight the main differences. The significant difference which emerged in relation to statement 8 of 'My self concept' might again

indicate a cultural difference, but might also reflect a difference in academic qualifications of pre-service science teachers in both countries. The differences which emerged in relation to 'Teaching schemes and instructional strategies' emphasize the inclination of the British students towards more pupil- and discipline-oriented approaches.

The significant differences that emerged in relation to statements 6 and 7 of the category 'Expectations of the preservice programme' only serve to indicate some of the advantages of the English-Welsh programme in general; the central contribution of the co-ordinated university and school-based partnership and the extensive practical teaching experiences in particular. It is stressed that the Keele partnership involves theoretical inputs, translated as practical 'educational issues', being delivered through seminars (not lectures) for groups of 6–12 students held in both university and school. The students comprising a seminar are selected from a variety of faculties: arts-humanities, social sciences and sciences. The seminars are led by experienced tutors (entitled Education Tutors) many of whom are recently retired headteachers and deputy heads as well as university staff. These seminars take place over protracted periods each week in both the university and in schools. In the latter case, theoretical issues are discussed in the context of reigning school policies and in the presence of both a university tutor (the same Education Tutor), the school's co-ordinator (named the Professional Tutor—usually a deputy head) and representatives of the school staff responsible for creating, co-ordinating and prosecuting the policies. In this way, the topics dealt with, having philosophical, psychological, sociological and historical dimensions, and relating to mainstream academic disciplines, are rendered 'practical' and are closely related to impending and ongoing teaching practices (in two separate schools). The topics include: the nature of knowledge, the shape of the whole curriculum, the history and philosophy of subjects (especially science and technology), cross-curricular co-ordination and integration (e.g. within and outside science); theories and styles of learning, differentiation according to achievement and ability, progression from year to year, special needs (physical and mental); classroom management, discipline, reward and punishment; homework and marking policies; extra-curricular activities (including perhaps a sports' policy), relations with society in the locality, relations with parents, the organisation and administration of the education system locally and nationally, etc. The provision of course booklets, annually updated, on most of these topics for students and tutors in both schools and university ensures some degree of common experience and approach to seminars across both institutions. The course materials serve as distance-learning materials for those hard-pressed members of the profession who join the ranks of the tutors at short notice after long periods attending to other priorities.

In addition to these seminars, the development of school-based partnerships involves the establishment of regular meetings at least three times per year between university 'methods of teaching' tutors and the 30 or so science teachers in schools (termed science mentors) who act as role models and lead their colleagues and student teachers in fulfilling the professional aims of the course. Science mentors serve on rota in the selection of suitable applicants from the many who aspire to be accepted for ITE courses. Release of science mentors for full or half days represents a considerable financial commitment which government was sadly unwilling to fund; the costs had to come out of schools' and universities' existing budgets. It is important that the group of science tutees assigned to a school be two or three strong and have academic qualifications in very different science disciplines so that they are able to teach, counsel and influence each other on a daily, sometimes hourly, basis and so rapidly augment each others'

TABLE VII. A comparison of the replies in the post-questionnaires of the British (B) and the Israeli students (I), including a significant *t*-test analysis or more than 25% differences in the frequency distribution. The seven-point scale was merged into three categories: disagree = 1,2; not sure = 3,4,5; agree = 6,7

| | Frequency (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Agree | | Not sure | | Disagree | | X (SD) | | | |
| Statements | B | I | B | I | B | I | B | I | *t* | *P* |
| *Views on teaching science* | | | | | | | | | | |
| 2. Teaching science today is not very different from the way it was taught when I was a pupil. | 24 | 60 | 19 | 35 | 57 | 5 | 3·1 (1·9) | 5·4 (1·2) | 5·5 | 0·0001 |
| 5. Teaching broad balanced science is a greater challenge than teaching single sciences. | 68 | 40 | 23 | 40 | 9 | 20 | 5·4 (1·7) | 4·5 (1·9) | 1·8 | N.S |
| 6. I expect more challenge and satisfaction in teaching science than in others jobs. | 79 | 35 | 21 | 60 | – | 5 | 5·5 (1·4) | 4·8 (1·4) | 1·9 | N.S |
| *Aims, goals and objectives* | | | | | | | | | | |
| 2. The purposes of science education should be derived from a knowledge of ideas pupils already possess. | 35 | 20 | 54 | 65 | 11 | 15 | 4·7 (1·6) | 3·8 (1·4) | 2·1 | 0·05 |
| 4. The purposes of science education should be derived from the questions of the end-of-course examination papers. | 12 | 20 | 24 | 65 | 64 | 15 | 2·5 (1·7) | 4·2 (1·4) | 3·9 | 0·0002 |
| 6. The job of science teachers should be to respond to the needs of society. | 35 | 5 | 57 | 85 | 8 | 10 | 4·7 (1·3) | 4·1 (1·1) | 1·7 | N.S |
| 7. The job of science teachers should be to satisfy the needs of the pupils. | 68 | 30 | 29 | 60 | 3 | 10 | 5·5 (1·1) | 4·6 (1·3) | 2·5 | 0·01 |
| *Management skills* | | | | | | | | | | |
| 1. The teacher should avoid grouping the class according to students' abilities. | 8 | 10 | 38 | 70 | 54 | 20 | 3·1 (1·6) | 4·0 (1·4) | 2·1 | 0·04 |
| 2. Developing a disciplinary role and the use of sanctions are very important. | 83 | 25 | 17 | 35 | – | 40 | 6·2 (0·8) | 3·7 (1·8) | 6·1 | 0·0001 |
| 3. There should be separate classes for pupils of different abilities. | 63 | 10 | 32 | 30 | 5 | 60 | 5·4 (1·4) | 3·6 (1·5) | 4·4 | 0·0001 |
| 4. As a teacher I would give encouragement to each of my pupils. | 97 | 95 | 3 | 5 | – | – | 6·8 (0·5) | 6·2 (0·7) | 3·5 | 0·001 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6. Laboratory activities are not essential for teaching science. | 5 | 20 | 11 | 20 | 84 | 60 | 2·0 (1·3) | 3·0 (2·0) | 2·2 | 0·03 |
| 7. The computer is a vital educational tool for teaching science. | 27 | 60 | 57 | 35 | 10 | 16 | 4·4 (1·5) | 5·4 (1·5) | 2·4 | 0·02 |
| 9. Pupils should get homework regularly in order to develop independent learning skills. | 81 | 40 | 16 | 50 | 3 | 10 | 5·9 (1·0) | 4·9 (1·4) | 3·0 | 0·005 |
| *My self-concept as a science teacher* | | | | | | | | | | |
| 4. A specialist science teacher is better respected than a general science teacher. | 24 | 5 | 41 | 80 | 35 | 15 | 3·8 (1·8) | 3·7 (1·1) | 0·1 | N.S |
| 8. I will be able to act out the role of the best science teacher who taught me. | 19 | 35 | 43 | 60 | 38 | 5 | 3·5 (1·6) | 5·0 (1·1) | 4·0 | 0·0002 |
| 9. I expect to have to earn the respect of my pupils. | 83 | 55 | 12 | 35 | 5 | 10 | 5·8 (1·4) | 5·1 (1·7) | 1·6 | N.S |
| *Teaching scheme and instructional strategies* | | | | | | | | | | |
| 2. Teachers must cover all the topics in the science syllabus. | 46 | 10 | 46 | 70 | 8 | 20 | 4·9 (1·4) | 3·9 (1·3) | 2·6 | 0·01 |
| 13. Students learn best if they have to work out things for themselves rather than being told or shown what to do. | 68 | 20 | 29 | 75 | 3 | 5 | 5·6 (1·2) | 4·8 (1·1) | 2·4 | 0·02 |
| 14. When working with slow learners, teachers should focus on developing minimum competencies. | 19 | 35 | 63 | 40 | 18 | 25 | 4·2 (1·5) | 3·9 (1·8) | 0·7 | N.S |
| *Expectations of the pre-service programme* | | | | | | | | | | |
| 4. I found the teaching profession to be enthusiastic. | 44 | 15 | 29 | 75 | 27 | 10 | 4·3 (1·8) | 4·4 (1·1) | 0·3 | N.S |
| 6. Developing a worthwhile science educational philosophy was an important task of my postgraduate year. | 59 | 16 | 38 | 68 | 3 | 16 | 5·4 (1·2) | 3·8 (1·4) | 4·2 | 0·0001 |
| 7. The teaching practices was the most important part of the training programme. | 92 | 65 | 8 | 20 | – | 15 | 6·4 (0·9) | 5·3 (1·9) | 2·9 | 0·005 |
| *Extent of confidence in teaching* | | | | | | | | | | |
| 8. Organizing and introducing a museum visit. | 24 | 65 | 65 | 35 | 8 | – | 4·6 (1·2) | 5·8 (1·1) | 3·9 | 0·0004 |
| 10. Organizing and introducing a field experience in a natural setting. | 38 | 65 | 48 | 30 | 14 | 5 | 4·9 (1·5) | 5·7 (1·3) | 2·1 | 0·04 |

Pr, pre; Po, post.

professional development. Indeed, they are required to act as teachers to each other the moment they start the course.

The two differences which emerged in relation to statements 8 and 10 of the category 'Extent of confidence' only result from the significant decrease in the British students' attitudes and not from any increase in those of the Israelis.

*Interviews*

Interviews were conducted with 18 British and 15 Israeli students in order to augment their responses to the questionnaire. A comparison of the responses offered reveals a common pattern in relation to four general issues:

An Israeli spoke thus concerning this issue:

> ... The general courses were quite shallow, badly taught and do not contribute much to my science teaching ...
> ... In my opinion there are many courses ... that are not relevant to teacher training since their content is too broad and does not relate to the teacher in the classroom with the student. The 'methods of teaching' course was the only relevant, needed and desirable part of the programme ...
> ... The courses on sociology and psychology of education did not contribute much to my training ... The methods courses enlighten me with respect to the problems and the beauty of teaching science ...
> ... The level of the general education courses was much below the standards of our scientific studies ...

Two British students expressed this attitude somewhat extremely and naively:

> ... I expected that the methods course would prepare me to teach the same topics I had to teach later with my classes, but instead they just gave us broad ideas and some examples; they were not concrete enough.
> ... I don't know exactly ... but sometimes I couldn't follow them (the tutors), they spoke on too high a level for me ... I couldn't detect the relevance of their ideas for my teaching.

*The role of the practical teaching experiences.* There was general agreement about the pre-eminence of these in relation to other parts of the ITE courses. However, most Israelis, in contrast to their disappointment with other parts of the programme, expressed a very positive attitude towards their teaching practice:

> ... I don't want to waste too many words. It was just a waste of time. I did not extract any use from my certification studies. It was boring, with no challenges. Only the practical experience was interesting and effective ...
> ... My practical experience was the most successful part of the course for me, since I had a very good mentor. Unfortunately, all the other courses were definitely unnecessary ...

*The role of the school science mentors in the success of the practical experience.* Both groups emphasized the central and most positive influence of their school mentors in relation to their development of worthwhile skills and attitudes. However, both provided instances where their mentors failed to encourage them or provide them with an appropriate role-model. A British student expressed her experiences as follows:

> ... The practical experience was important in providing me with practical knowledge of teaching but its efficiency depended totally on the specific mentor that worked with me.

An Israeli spoke thus concerning this issue:

> ... In my first year of practice I had an awful mentor ... a waste of time. In the second year I was lucky to move to another tutor. The love and care that she expressed for the profession were the only reasons that convinced me to stay in the programme in spite of all ...

*The attitudes of students who came to the courses with previous teaching experiences.* Two of the Israeli interviewees came to their course with 5 years' informal, unqualified, teaching experience. Their responses were very similar to those of their British counterparts.

> ... The courses in psychology and teaching strategies improved my teaching ability enormously ...
> ... The most important parts for me were the courses which dealt with general educational aspects (e.g. psychology, philosophy etc.) ...

The British student who entered the course after a few years of unqualified school teaching used the term 'gold' to express his feeling about the 'methods of teaching science' courses taught in the university. For him, they were the highlights of the whole programme:

> ... I remember at the beginning of one session about classroom management ... For me it was 'gold', every example of common mistakes that the tutor raised, I used to do as a teacher.... After the lesson I was very excited and went to thank the tutor.... The others just sat there with bored expressions ... they had no idea what I was so excited about.

He added:

> ... What I learned here in 1 year, I couldn't learn even in 10 years of school teaching.

Some clear differences between the groups emerged from the interviews:

(a) The Israelis were more adversely critical about their programme and most of them expressed very strong dissatisfaction and disappointment.
(b) The Israelis suggested a link between the quality of the teaching profession in schools and its social status. They referred to the haphazard way that the ITE programme was organized and delivered in the university. Mainly they pointed out the destructive effects of the lack of a selection and appointment system with respect to both intending teachers and the employment of university staff from several academically distinct departments who deliver the courses. As in schools, co-ordination is difficult to achieve across departments. For university staff experience of working in the primary and secondary (junior and senior high) school system is rarely guaranteed.

The following are but a few examples of Israeli students' responses which led us to the above conclusions:

> ... I apologize for being so outspoken and straightforward, maybe even rude, but I feel that the low status of the teaching profession that we are talking about so much starts here in the Teacher Education Department. All the courses given in the university including the sociology of schools, the psychology of education, the foundations of education and even the methods courses, were taught by lecturers who have been disconnected from the reality of schools for too many years. It is absurd!
> ... Some university teachers did not provide as good a model of a teacher that any educational system deserves. I think that a teacher education and training

> programme should be based on, and exemplify, much higher standards of teaching ...
> ... I am disappointed at the quality of the students who completed the course. I doubt if there is any chance of improving the image of the teaching profession in a situation where just anyone can choose to enter the programme and ... there is no selection ('weeding out') process as the programme unfolds ...

The huge difference between the two sets of experiences presented above illustrates the paradox of any ITE course. On the one hand, in order to develop *professional educators* rather than 'teaching technicians', university courses in many countries tend to include and emphasize the theoretical and philosophical aspects of education and teaching. These are greatly appreciated by students with any substantial teaching experience. On the other hand, the majority of inexperienced student teachers cannot understand, at this stage, the relevance of such aspects. They are trying to learn from concrete teaching experiences and, in some cases, they are even seeking 'tips for teachers' which they can immediately implement in their own classroom/laboratory challenges.

## Summary, Discussion and Conclusions

The study investigated perceptions and attitudes of intending teachers before and after taking science ITE programmes in 1992–1994 in two widely different cultures. The results throw much light upon present procedures and call for many changes in future practice. Besides several similarities shared by the groups, there were also clear differences. The latter related to: (i) to students' characteristics before entry; (ii) the programmes themselves; and (iii) the perceived degree of success or failure of the courses.

### *Initial Characteristics of the Groups*

It is conjectured that many differences, and in consequence the courses themselves, are culturally derived. That the British students hold more positive attitudes towards teaching as a professional career; are more motivated and pupil-oriented; have more faith in the effectiveness of their course, are likely to be due to the traditionally high status of the profession in England and Wales. That Israelis hold a 'more progressive' social approach to education is explained by the less disciplined nature of society compared with the hierarchical, class-based structure in England and Wales. That teaching has a lower status in Israel is supported by the gender distribution: females *c.* 40% of the British, but *c.* 75% of the Israeli sample. This difference derives from the perception of teaching in Israel, as in many countries, as an appropriate one for mothers who need to arrive home around lunch time in order to take care of the housekeeping. The perception is also related to the lower salary scales which provide only a second wage for the subsidiary supporter of the family.

### *Differences between the Programmes by End of 1994*

The differences reflected a relationship between the social status of teaching and the quality of delivery and effectiveness of the ITE programme. British culture perceives teaching as important and finances a 1 year professional programme with clear standards of selection and organization, and high standards of assessment before certification. Grants for the courses have existed for over 50 years. However, extra payments (bursaries) were offered from 1993 to entice students of 'shortage' subjects (like math-

ematics and all science disciplines) to enter courses. Israeli culture perceives teaching less professionally and expects intending teachers to pay for courses. Such a programme requires minimum investment and almost no selection system with regard to the initial scientific and personal qualities of would-be teachers. Nor does it require at the end the demonstration of high standards of professional skills, techniques and attitudes or critical awareness of the wide range of societal problems which may be usefully addressed by schools. The modest outcomes of the Israeli model, and the negative attitudes of many students, can be largely explained by this cultural background. The Israeli situation, in 1994 and since, is that of dozens of societies characterized by the low status of teaching. Contacts in many countries suggest that most so-called teacher training programmes are based mainly on heavily theoretical courses delivered in teacher training colleges and universities. Teaching is a low-paid gender-biased vocation, rather than a high-status profession; thus our findings have much wider meaning and validity.

*The Perceived Success or Failure of Courses*

Our results indicate the disadvantages and inefficiency of theoretical academic courses. The advantages of the English–Welsh model derive mainly from its post-1990 development of, and emphasis on, school experience and specified professional skills, competencies and attitudes (DES, 1992, now replaced by DfEE, 1998). The cornerstone is the concept of an equal partnership between the university and a large group of schools, in the Keele case selected by mutual interest in improving ITE in both institutions. However, there are other fundamental factors. Whilst British students spend a year (at least 37 weeks largely between school vacations) concerned solely with ITE, the Israeli programme is dispersed episodically over 2 years whilst students fulfill degree studies and take other jobs.

Our findings, however, show that the English–Welsh model has room for significant improvements. Two problems exercise both university and school tutors. University tutors, although well qualified and experienced, possibly because they are so experienced, often fail to remember their own feelings as beginning students, and do not recall the narrow practical stances of students which alienate them from theoretical aspects. Newly appointed school science mentors, on steep learning curves as they add a teacher education dimension to their portfolio of professional skills and attitudes, tend to perpetuate students' craving for a 'technical teaching approach' based on the acquisition of laboratory management skills, the honing of traditional strategies and the pursuit of containment rather than self-discipline. They find it difficult to set the course in a wide historical, social, psychological and philosophical context despite the analysis of such issues in frequent seminars held at each school (co-chaired by a university education tutor and the school's professional tutor).

It is significant that both programmes are very effective for those with prior teaching experiences. This indicates that developers of both courses have too much ignored the 'first low of constructivism: taking into account initial attitudes, perceptions and expectations of the vast majority of students. This suggests the need for co-ordinated programmes of 2–3 years' length, covering both pre-service and early years of service (the latter called the induction period in the UK) wherein students progress gradually and spirally from 'practically biased' starting points towards an ever-widening but relevant 'theoretically biased' background whose essence is shown to be incorporated in every school's policy documents. The finding substantiates Orion and Thompson's (1996) idea that, amongst serving teachers there will occur, after a period of initial experience, a

ripening time prior to readiness for further professional development, during which they are very susceptible to reflecting on the teaching styles developed up to that point. National policies aimed at professional development should provide statutory opportunities for these truly educational needs to be fulfilled by appropriate in-service education (INSET) (not training). The largely in-school INSET (5 days per year) administered when pupils do not attend school, as in the UK, is often an inadequate form of professional development for those new to the service.

*Similarities between the Two Groups*

In spite of cultural differences and the totally different courses, similarities were found:

(1) Students entered courses with many uncertainties *vis-à-vis* most aspects of science education and the practical teaching of science, but with some definite ideas as well.
(2) Throughout teaching practice, almost all students underwent a dynamic transformation involving considerable changes of perceptions and attitudes about science education.
(3) The influence of university tutors was often effective only whilst students believed that their discussions and ideas provided useful and practical teaching tools. Students only dimly understood the relevance of many theoretical and philosophical ideas presented by tutors.
(4) Student teachers are best described as a group of individuals. They hold wide-ranging perceptions of science education on entering courses; they undergo idiosyncratic conceptual changes; they complete courses whilst still holding a wide range of differing perceptions.

*The Future: a model*

These common factors serve as good starting points for the evolutionary development of a constructivist ITE programme. They indicate that any course should start from the immediate practical needs of the intending teacher, but should evolve thereafter. The fulfilment of basic needs and reduction of initial anxieties should be the starting point for the development of a solid philosophical and theoretical basis. This process requires longer than 1 year; we think of professional development as a 3 year process, i.e. ITE followed by 2 years' induction. The programme should show a carefully managed balance between initial concentration on practical teaching skills and a slow development of a wider theoretical basis.

The existing national models represent different cultures: one perceives teaching as an activity of low status; the other seeks a higher, professional, status. Such a profession should prove attractive to well-qualified persons of either gender who aspire to belong to a group which might be entrusted, on behalf of society, to form a General Teaching Council which would control entry to, and seek ever higher standards within, its area of expertise. The rapidly evolving English—Welsh model is still not effective enough. In light of the costly long-term process required to achieve conceptual changes in serving teachers who are contributing as mentors to the teacher education process, greater priority should be given to ITE and induction as a co-ordinated seamless process. Attention should first be invested in devising more effective ITE programmes in order to establish a solid basis for constructivist teaching and learning.

The changes should be placed in the hands of the science education community whose energy and actions should be invested in three main directions:

(a) intensive research into ITE and induction as a co-ordinated process;
(b) ensuring that investment and policy decisions by politicians and civil servants lead to a structure which is constructivist rather than prescriptive;
(c) ensuring that university education departments form close and equal working partnerships with their 'teaching schools' in the effective selection, appointment, education, training and assessment of both university staff and school-based professional tutors and science mentors. This means that only well-qualified, experienced, battle-hardened, yet visionary teachers will be employed. They serve as model teachers who actively involve students in developing their own philossphies and styles of good practice in teaching. Each student teacher will teach independently under supervision for protracted periods in two schools (e.g. at least 15 weeks in total) before interim certification is allowed and a further 2 years in a first post before induction is completed and full qualification granted.

Since the study was completed in 1996, changes in the UK have been rapid (see Barber, 1996, for a review from a Keele perspective), whilst science has remained a core, i.e. protected school subject. Meanwhile Prime Minister Blair (1997) has seen the future of the UK in terms of 'Education ... Education ... Education ...'. For many years this political goal was expressed as an increase in control by central government. Pressure on ITE institutions and schools has been constant and has shown itself in many ways, mainly as the imposition of accountability and the assessment of quality in teaching and research. Government has specified many aspects of ITE: the length of courses; teaching competences (skills and attitudes); the nature of the partnership with schools; the length of ITE experience spent in schools (at least 66%); lengthier teaching practices in several schools; school mentors to contribute to the selection, guidance and assessment of students. Would-be teachers are required to present initial qualifications in at least two traditional Advanced level science subjects (achieved mainly at ages 16–19 years) and, subsequent to gaining a first degree, to fill in gaps in their understanding of science appropriate to teaching students up to age 16 years across all science disciplines. For established staff, a recent circular (DfEE 1998, p. 16) requires heads and teachers to take responsibility for their own professional development, based on keeping up-to-date with educational research. Added to all this, there has been a greater frequency of inspection of ITE courses by OFSTED (the Office for Standards in Education). Even novice teachers on their first teaching practices have their tenderfoot prowess assessed using the same criteria as those used for experienced teachers. The publication and discussion of the results of inspections as league tables (so beloved by the media) has led to accusations that bullying of heads and staff, rather than a co-operative recognition and solving of professional problems, is taking place. These measures were no doubt intended further to professionalize ITE, but so many powers of decision have been removed from university departments and tutors and school mentors, that deprofessionalization can be alleged to have resulted. In terms of our findings, the pendulum has swung towards pavlovian training in the competencies of teaching rather than the pursuit of balanced, open-ended, constructivist *education*, based on the needs of both learners and local societies. A fine line is to be drawn between providing a worthwhile governmental framework of desirable aims and imposing and inspecting a detailed behaviourist check list which acts as a straightjacket.

Much the same judgement might be made with regard to several other initiatives taken by government: the establishment of the Teacher Training Agency (TTA), the TTA's

over-hasty consultations for a national curriculum for ITE, for its professional development schemes (involving induction and INSET for long-serving teachers); even in their proposals for a General Teaching Council to adjudicate in disputes, in the manner of the lawyers and the doctors. Universities have been forced into a competitive market with respect to using their modest funds to pay schools a fee for each student who is accepted by the latter as part of a partnership agreement. Some schools have shown a mercenary, rather than professional, face in this regard. Many problems alluded to relate to the economic pressures on schools and government in the face of a rapid expansion of higher education. Many changes are seen by us as a retreat from a commitment to treat ITE in a truly professional manner. Little wonder that high-quality teacher recruitment in science, always problematical, is in greater difficulty than hitherto and that there has been a rush of science teachers to retire early. Maintenance grants for entrants to ITE have been held constant, i.e. have diminished in value; bursaries to entice possible entrants to courses in science and mathematics are still provided, albeit they are offered in different ways in 1998. One bright spot might be the recent proposals, after inspection of individuals by OFSTED, to offer substantially increased salaries to gifted laboratory teachers. One wonders, however, how much this is justified when success depends largely on the context of the immediate economic and social conditions of a neighbourhood and the administrative abilities, organization, discipline and support of colleagues in any department and school.

Since 1994, there have been no significant changes in Israel in the arrangements for educating and training science teachers.

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