

Initiatives in Chemistry Teacher Training in Ireland

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In Ireland, under the governance of The Teaching Council, there is a clear structure to Initial Teacher Education by one of two mechanisms, concurrent or consecutive, both of which have come under critical review in recent times. Chemistry at upper secondary school is a minority subject and Chemistry teachers generally will be timetabled to teach other subjects as well. In some cases budgetary and other logistical requirements within a school means that Chemistry may be taught by a non-specialist. Balancing Subject Content Knowledge with Pedagogical Skills Training requires skilful manoeuvring to ensure that teachers are not disadvantaged in their own Initial Teacher Education. They should be qualified and confident in their attempts to teach what is perceived to be a difficult and abstract subject and to motivate their students to study Chemistry. However, Chemistry teachers in Ireland are fortunate that they have access to skills development initiatives and sharing of expertise with experienced teachers and trainers, both in subject content and in pedagogical supports. The Professional Development Service for Teachers has evolved subject specific support teams, drawing on the state-of-the-art in educational theories and practice. There are several other sources of information, support and in-service training for Chemistry teachers. This paper summarises the current options for Initial Teacher Education in Chemistry and also for In-service Training, as well as the requirements for Induction Training of newly qualified teachers. It provides an overview in terms of the Conference on Initiatives in Chemistry Teacher Training since practitioners in the field will also share their work and views in greater depth.

Introduction

In the words of the Sahlberg Report to the Irish Higher Education Authority in July 2012: 'In order to advance further in its national teacher education system, Ireland needs to invest more in the continuous improvement of the quality of teaching, the role of research in teacher education, and international cooperation in all of its teacher education institutions'. [1] The report adds that the review panel 'reiterates that the key characteristics of internationally recognised teacher education systems include high quality instruction on both pedagogy and pedagogical content knowledge, a strong focus on research as a basis of teaching and learning, a close and systematic engagement with schools'. The Sahlberg Report has given the impetus for The Minister for Education and Skills, Ruairí Quinn T.D., to proceed with radical plans to overhaul the provision of initial teacher education (ITE). The purpose of the report, requested by the Minister, was to identify new possible structures to improve teacher education in Ireland so that it is comparable with the best in the world. The main recommendation in the review by an international panel of education experts is that teacher education be provided in six "centres for teacher education". [2] The Chair of the panel of experts, Pasi Sahlberg, is a Finnish educator and scholar who has worked as a schoolteacher, teacher educator and policy advisor in Finland and has analysed education systems and reforms around the world. His book "Finnish Lessons: What can the world learn from educational change in Finland" won the 2013 Grawemeyer Award, and interestingly he has now been commissioned to chair a review of Initial Teacher Education in Northern Ireland. [3] An evaluation of the success of the Finnish education system shows that it relies on high-quality, well-trained teachers, with strong academic qualifications and master's degrees, who are drawn to the profession by its compelling societal mission and its conditions of autonomy and support, unlike the rapid entry strategies of short-term training and high teacher turnover advanced in countries in Western Europe and the US. Teacher training across all subjects and school levels in Ireland is currently achieved via one of two mechanisms: *concurrent* training for a qualification which combines the study of one or more subject disciplines with teacher education professional studies, foundation studies and school placement and have a minimum 240 ECTS credits; and *consecutive* training which involves the completion of an undergraduate degree, with a minimum of 180 ECTS credits, which enables the holder to teach at least one approved curricular subject followed by the completion of a programme of initial teacher education, with 60 ECTS

credits, geared towards the post-primary age range of typically 12-18 years. The requirements for qualification and registration of a teacher are monitored by the Teaching Council.[4] The Teaching Council's role with respect to initial teacher education in Ireland is provided for in Section 38 of the Teaching Council Act (2001) which gives statutory powers to the Council to: review and accredit the programmes of teacher education and training provided by institutions of higher education and training in the state, review the standards of education and training appropriate to a person entering a programme of teacher education and training, and review the standards of knowledge, skill and competence required for the practice of teaching.

In Ireland there are nineteen state-funded Higher Education Institutions that are providers of Initial Teacher Education (and three non state-funded) offering more than forty college programmes in primary and post-primary (secondary) teaching. There are five state-funded Colleges of Education which offer programmes of teacher education for primary teachers through a concurrent (undergraduate) programme leading to a Bachelor of Education (B.Ed.) degree. Four of the colleges offer a Graduate Diploma in Education (GDE). The latter is also offered by a private college as an online, blended course. Currently, undergraduate programmes for primary teachers are three years in duration, although this has been extended to four years, with effect from September 2012. Post-graduate programmes for primary teaching are currently offered over 18 months, and this will be extended to two years with effect from September 2014.

For secondary teachers, the concurrent route to a teaching qualification is offered for a wide range of programmes, typically those with practical, laboratory and workshop elements. The secondary consecutive route is via the Postgraduate Diploma in Education (PDE). Entry requirements include a degree in at least one subject which meets the criteria for registration with The Teaching Council. [4] All teacher education programmes in Ireland that lead to registration must have professional accreditation from the Teaching Council. Currently, PDE programmes are one year in duration, although this will be extended to two years from September 2014. The locations and qualifications offered have previously been documented.

2. Pre-service Training in Science/Chemistry Education in Ireland

In September 2012 the Minister for Education announced plans for a radical overhaul and rationalisation of pre-service training provision. The purpose of the report, requested by the Minister, was to identify possible new structures to improve teacher education in Ireland so that it is comparable with the best in the world. Thus we are in a state of transition. This comes at a time when there is proposed reform of science and chemistry curricula at secondary school, as well as new Chief Examiners for Science and Chemistry.

2.1 Pre-service training in Primary School Science

Chemistry is implicit in the Primary curriculum in the *Materials* and *Environmental Awareness and Care* strands of Social Environmental and Scientific Education (SESE), which was formally introduced in 2003/4. [6] The National Council for Curriculum and Assessment (NCCA) [7] is responsible for development of subject curricula and has stated one aim of the SESE curriculum was to make the Science more dynamic, interactive and scientific. *'An experimental and investigatory approach to science in the primary school can make a unique and vital contribution to the holistic development and education of the child.... at the same time developing and using scientific ways of investigating and exploring the world'*. Initial Teacher Education programmes at primary level have modified to include SESE studies.

2.2 Pre-service training in Secondary School Science/Chemistry

Science at lower secondary level is currently presented as a single Junior Certificate subject with three distinct sections, one of which is Chemistry. Teachers qualified to deliver upper secondary courses in Chemistry, Physics or Biology typically would also teach the integrated Science at junior secondary level. For logistical and resource reasons the reality is that a science teacher may be expected to deliver the whole Junior Certificate syllabus, not just those sections for which they are fully qualified. In other words, the Chemistry may be taught by a teacher who is primarily a Physicist or Biologist. The Junior Certificate Science curriculum guidelines [8] offer suggestions for classroom practice that can facilitate students in developing their knowledge, understanding, skills and attitudes in relation to science. However, they advise that *'teachers should choose an appropriate teaching methodology for the achievement of the aims, objectives and learning outcomes specified in the syllabus'*. The support of the Junior Certificate Science Support Service [9] has been invaluable in aiding teachers dealing with subjects outside their specialities. The aims of the service include, assisting teachers to work together effectively in school, assisting non-subject specialists, and helping teachers to integrate ICT in science teaching and learning. Anecdotal evidence suggests that uptake of Science subjects at senior cycle can be very much influenced by the teacher at junior cycle.

2.3 Pre-service training in Secondary School Chemistry

Science graduates going into teaching have traditionally been sought after, and have had a strong chance of securing full-time employment. Science is a subject that is constantly changing and evolving. If teachers are unable to appreciate and adapt to this, their students may be left with an unrealistic view and understanding of the value and use of science in our everyday lives. [10]

Leaving Certificate Chemistry is offered at two levels, Ordinary (OL) and Higher (HL), which creates a difficulty in classroom management as both levels are typically taught in the same classes. In addition some schools have been under-resourced with regard to technical support and equipment issues. Not all science classes are taught in laboratory settings. However, as Showalter said 'if you have a well-stocked laboratory but a poorly trained teacher' pupils will not benefit. [11]

As at primary Initial Teacher Education level, so too at secondary level Ireland has both concurrent and consecutive models of secondary science teacher training. Whichever mode is employed, the development of adequate subject matter knowledge in pre-service teachers is imperative. A number of studies have shown that teachers who have misconceptions about chemical concepts pass these on to their pupils. [12,13] There have always been question marks about the efficacy of the concurrent model in linking pedagogical and content knowledge, with some calls to phase out the model entirely. The Teaching Council has supervised a review of these programmes to increase the subject content and copper fasten the placement and pedagogical skills training. The Council's professional accreditation function is distinct from the process of academic accreditation which programmes already undergo. Academic accreditation is based on the suitability of a programme for the award of a degree/diploma; whereas professional accreditation is a judgement as to whether a programme prepares one for entry into that profession. In 2009, the Council began reviewing programmes, including the concurrent programmes and recommendations were made specifically in relation to subject content in balance with pedagogical content. All review reports have been published on the Teaching Council website.

2.4 Qualification to teach Chemistry

In order to meet the registration requirements set down in the *Teaching Council [Registration] Regulations 2009* (Regulation 4) in respect of the curricular subject of Chemistry, an applicant must meet all of the following criteria: Applicants must hold a degree level qualification (or equivalent), with Chemistry studied up to and including third year level (or modular equivalent); The qualifying degree must be equivalent to at least Level 8 on the Irish National Qualifications Framework (NQF) and with a pass result in all examinations pertinent to the subject of Chemistry; The qualifying degree must carry at least 180 ECTS (European Credit Transfer System) credits (or equivalent) with the specific study of Chemistry modules comprising at least 60 ECTS credits (or equivalent) with not less than 15 ECTS credits (or equivalent) studied at third year level (or modular equivalent). The study of Chemistry during the degree must show that the holder has acquired sufficient knowledge and understanding to teach the Chemistry syllabus to the highest level in post-primary education. To meet this requirement the degree must include the study of all of the following: Organic Chemistry, Inorganic Chemistry, Physical Chemistry and Analytical Chemistry. Laboratory practical work in chemistry must have been completed throughout the degree programme. [14]

2.5 Subject Criteria Declaration Forms

In order to fulfil the Teaching Council's documentary requirements for applying for a teacher education programme, the applicant must complete a detailed declaration form customised to each curricular subject. In completing this declaration form it is expected that the applicant will link the specific criteria with the appropriate modules or study blocks on their examination transcripts and produce course handbooks in support of their declaration where necessary. This is a change from the previous system whereby a particular course was summarily accredited and all graduates were eligible to apply for teacher training. [15]

3. Newly Qualified Teachers: Probation and Induction

In order to gain full registration as a Post-Primary teacher, all teachers must complete a period of Post-Qualification Employment (PQE). This involves providing evidence of 300 hours' teaching experience in a recognised school which is verified and signed by the school principal. A minimum of 200 hours of the approved teaching experience must relate to the teaching of a recognised curricular subject to a class of at least 14 students. Up to 100 hours of the approved teaching experience may be carried out in a learning support, special needs, language support, or guidance counselling role. A maximum period of three years is

permitted to meet this requirement. This is moderated by the Teaching Council.

The National Induction Programme for Teachers (NIPT) consists of ten workshops, which take place in the late afternoon or evening time for two hours each. They take place in education centres and/or outreach venues around the country. Newly Qualified Teachers will be required to attend all workshops within three years of their date of registration. Once all the workshops have been completed, the Education Centre Network will provide participants with a Certificate of Attendance and notify the Council of same. The condition will then be removed and the teacher's registration status will be updated on the Register of Teachers. [16] The work of the Teaching Council is grounded in the values of professionally-led regulation, shared professional responsibility and collective professional confidence. These values have informed the introduction of a new model of induction and probation for primary and post-primary teachers on a pilot basis over the next two years. Central to this new model is a period of post-qualification professional practice called *Droichead* (the Irish for bridge), which is designed to reflect the importance of the induction phase on the teachers' lifelong learning journey. It marks the point where the new teacher is formally welcomed into the profession of teaching having qualified following the initial teacher education (ITE) phase. *Droichead* is grounded in the belief that the people best placed to conduct that formal welcome are experienced fellow professionals who know what is involved in teaching and learning in their school, and who will be exemplary mentors for the newly qualified teachers. These serving teachers will themselves be supported through the provision of a range of structures and resources.[17]

4. In-service Training and Supports for Chemistry Teaching

4.1 Continuous Professional Development

Chemistry teachers have been excellently supported for some time by the Second Level Support Service (SLSS), which is now under the umbrella of The Professional Development Service for Teachers (PDST).[18,19] This offers induction and continuous development training at a local and national level. The PDST Chemistry trainers are in-service or seconded teachers of considerable experience. Just a sample of the courses offered in the past twelve months are: Chemistry for non-specialists, Hands-on science enquiry activities, Science-based enquiry through computational thinking, *Schoolology* workshops. In addition workshop participants also receive the annual PDST DVD of resources for chemistry teaching.

4.2 PDST Chemistry Induction Course

The PDST has developed this course for teachers of chemistry who are new to the profession or new to the revised chemistry syllabus. It focuses on good classroom teaching and learning practices as well as giving participants a hands-on experience to master the skills required in carrying a number of experiments. A detailed summary of the syllabus is provided with particular emphasis on the Leaving Certificate questions. Organic laboratory practical experiments are included with the emphasis on safety and following the correct procedures as outlined in the Mandatory Experiment CD. Teachers get an opportunity to set up and prepare organic compounds under the watchful eyes of their demonstrators. Safety tips, techniques tips and exam questions related to the experiments are also covered on the day. Teachers are provided with an extensive range of chemistry resources and useful websites. The Mandatory CD is made available on Day 1. The workshops are held over two days in three different locations, and pre-booking is essential.

4.3 Chemistry for non-Specialists

This is training programme designed by the Royal Society of Chemistry and adapted for the Irish curriculum. The aim is to provide teachers with confidence, flair and enthusiasm for teaching chemistry and there is an emphasis on gaining hands-on experience with the use of relevant and interesting experiments and demonstrations to illustrate key ideas and phenomena. It addresses the issues of teachers who are qualified to teach subjects other than Chemistry to Leaving Certificate level but who have to teach the Chemistry as part of the Junior Certificate Science curriculum. The course identifies the topics that challenge students' conceptual understanding of chemistry and provides the teacher with strategies to tackle them. Participants receive resources to assist them with their chemistry teaching including a course book that provides guidelines on over 80 experiments. The two day course is free of charge and there is a follow-up workshop to clarify any issues that remain. [21]

4.2 Other supports for continuing professional development

There is a community of practitioners in Ireland who are providing excellent support to science teaching in general or chemistry teaching in particular. The Irish Science Teachers Association (ISTA) [22] is the Subject

Association for teachers of Science in the Republic of Ireland, with over 1,200 members. Branches hold frequent meetings of interest to Science teachers, and the Association has had representation on the various syllabus committees which drew up the revised programmes in the various Science subjects. The Association has several Sub-Committees which do valuable work in the various subject areas. The ISTA holds an AGM in the spring of each year with a very broad programme of interest to people in different areas of Science education. Trainee teachers are included in membership and all activities of the ISTA.

The National Centre for Excellence in Maths and Science Teaching & Learning (NCE-MSTL) [23] was developed to address issues in the teaching and learning in science and mathematics by conducting best practice, high level evidence-based research into teaching and learning in mathematics and science - incorporating all learning environments - formal, non-formal and informal. It is collaborating and sharing information with all universities and institutes in order to formulate strategies that enhance mathematics and science teaching and learning from primary school, through secondary school to third level and fourth level. In addition it aims to translate existing research into effective best practice in mathematics and science teaching and learning, and to achieve this through designing, informing, advising and delivering nationally recognised evidence based CPD programmes. It currently has a cohort of postgraduate researchers, many of whom are carrying out research relevant to modifying and enhancing teacher training.

The ChemEd-Ireland annual conference is an annual one-day conference held to provide an opportunity to share ideas and resources relevant to teaching chemistry and science in Ireland. [24] It is attended by both pre-service and in-service teachers and includes a mixture of interactive talks and workshops. The theme of the 2013 conference is *New Perspectives for Chemistry Teaching* and the conference proceedings will be published in *Chemistry in Action!* in Spring 2014. For example, one of the talks in 2013 will demonstrate the usefulness of mobile phones and apps in the chemistry classroom.

Conclusion

The Sahlberg Report emphasises the importance of a connection with a strong focus on research as a basis of teaching and learning. One Comenius Project STIMULA (Stimulating Science and Technology Competences Through Innovative Means for Teaching and Learning) addresses the emergence from the Bologna Process of the identification of competence development as a key priority if teacher in science and technology subjects is to be improved. To this end McGeown *et al* have developed a competence profile through the STIMULA Project.

The key objectives of the competence profile for prospective Science and Technology teachers in post-primary initial teacher education (ITE) are to outline the essential core values and areas of competence necessary for preparing teachers to work in Science and Technology post-primary education. These core values and areas of competence are to be developed during ITE, but then used as a foundation for later professional development and to identify a framework of core values and areas of competence in Science and Technology education which are applicable to any Initial Teacher Education (ITE) programme focusing on post-primary education. The profile is proposed as a tool for reflection to support the professional development of student teachers and also for practising post-primary teachers to identify personal priorities for continuous professional development activities. The authors acknowledge the interface between what may be regarded as generic competences and those which are specific to Science and Technology, but they highlight the necessity for teachers to have an understanding of and ability to implement what may be described as the '21st Century Skills' framework which would include the necessity to communicate effectively; think critically; collaborate with others; display creativity and imagination; connect learning; problem-solve; and innovate.

The reality for Chemistry teachers is that they must have sufficient subject content knowledge, confidence in their practical ability, pedagogical skills and be at the heart of development of 21st century skills for themselves and their learners to. Graduating as a Chemistry teacher is not an end point but a step towards the continuum of learning and excellent professional practice.

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