

Chemistry Teachers' Training in Ireland



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ABSTRACT

There is considerable provision of Initial Teacher Education in Ireland via a variety of programmes in a number of institutions, which are in the main State-funded. These programmes are in demand as evidenced by the above average entry requirements. Initial and In-service Teacher Education is managed by the Government Department of Education and Skills Teacher Education Section. There is also a structured Professional Development Service for teachers to provide on-going options for in-service training and continuous professional development. However, in-service teachers are currently coping with cutbacks in salary, increased pupil-teacher ratios, on-going problems with lack of laboratory assistance and technical support, funding cutbacks, preparation for implementation of new syllabi and curricula at junior and senior cycle, as well as all the other day-to-day issues involved in teaching at a professional level. Primary teachers have to implement a science subject for which many of them have felt underprepared. In the background for Chemistry teaching at secondary school level is the on-going debate about concurrent versus consecutive undergraduate training programmes and the impacts these may have on subject content knowledge and pedagogical skills. Newly Qualified Teachers are required to undergo induction and/or probation to become registered by the Teaching Council. This report summarizes the national situation on teacher training and attempts to align it with initiatives in ICT supports for the curricula. It also attempts to introduce the new language around in-service and pre-service training of teachers.

1. National Situation on Teacher Training

1.1 Initial Teacher Education

The Irish Government Department of Education and Skills [1] established in April of 2004 the Teacher Education Section (TES) [2], which incorporates the work of the former In-Career Development Unit (ICDU) and includes a remit for initial teacher education, which was previously the responsibility of the Colleges Section. TES was formed to reflect the Department's view of teacher education as a continuum from initial teacher education (ITE), to induction and continuing professional development (CPD). The rationale provided for the changes was that they would ensure cohesion in teacher education policy and practice in a way that would best support teachers and school leaders in the 21st Century. The work of the Section embraces policy formulation, co-ordination, general direction and management, quality and financial control in supporting the provision of education and continuing support for teachers and school leaders throughout their careers.

In Ireland, initial teacher education programmes for primary and secondary teachers are facilitated through a range of concurrent (undergraduate) and consecutive (postgraduate) programmes. There are nineteen state-funded and three private providers of initial teacher education, with some forty programmes in primary and post-primary teaching. All of these programmes have undergone revisions in recent times.

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 learning course. Undergraduate programmes for primary teachers were 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.

In the concurrent model, student pre-service teachers complete a four year B.Ed. degree which includes professional studies in education, teaching practice and science. All students graduate with a competence to teach two subjects to Leaving Certificate level as well as Junior Certificate Science. Up to seventy students graduate from these courses each year, with the University of Limerick being a major provider.



For secondary teachers, the consecutive 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 the newly renamed Professional Masters in Education (PME), previously called the Postgraduate Diploma in Education (PDE). This was formerly known as the Higher Diploma in Education (H.Dip.Ed.) and entry requirements include a degree in at least one subject which meets the criteria for registration with The Teaching Council. [3] At the moment, PDE programmes are one year in duration, although this will be extended to two years, with effect from September 2014. The courses include pedagogical studies as well as approximately 100 hours of teaching practice over the year, but no further science. The teaching practice is now being renamed Student Placement. The majority of approximately 100 graduates specialize in Biology, which reflect the demand for Biology at second level. There is no real shortage of Chemistry teachers at secondary level but the reality is that in many schools, because of cutbacks, Chemistry may be taught by a teacher who has not majored in Chemistry.

At post-secondary (further education) level, a teacher education qualification will be a requirement from 2013, and new programmes are currently being designed to meet the particular needs of that sector. All teacher education programmes in Ireland that lead to registration must have professional accreditation from the Teaching Council.

All initial teacher education programmes, be they undergraduate or postgraduate are in demand and there is a high level of competition for places. The majority of undergraduate entrants apply for their place through the Central Applications Office [4] and they are awarded courses depending on their results in the Leaving Certificate examination. This examination is scored on a points system, with the maximum points based on six subjects at 625 points total. Applicants must be at least 16 years of age by 15 January of the year in which the application is made (15 January 2013 for entry in autumn 2013). The Minimum Academic Requirements in the 2013 Leaving Certificate Examination for entry into primary teacher education were: Grade C3 on a Higher Level paper in not less than three subjects and Grade D3 in three other subjects in accordance with the Rules and Programme for Secondary Schools. Essential Subjects were Irish: Grade C3 Higher Level; English: Grade C3 Ordinary Level or D3 Higher Level and Mathematics: Grade D3, either Ordinary or Higher Level. In other words a science subject is not mandatory. Applications for postgraduate training are through the Postgraduate Admissions Centre.[5]

1.2 Funding and other issues

A new online only student grant application system has been in place since 2012. Applications are to be made online through the single awarding authority, Student Universal Support Ireland (SUSI).[6] The grants are awarded based on income of the student's parents or guardians (or personal income in the case of mature applicants. Where a student has access to income in excess of the maximum to qualify for a grant, they will be eligible to pay registration fees. In 2013 the annual student contribution/registration fee for undergraduate programmes is in the region of €2,500 – 2,800.

Teaching requires mandatory certification of Fitness to practise. Before a College can complete a student registration, the Colleges require that all incoming teacher education students undergo a process of Garda (Police) vetting in order to establish whether they have any convictions or criminal charges pending. Where this process confirms the existence of such, the matter is referred to a Vetting Committee within the College which decides whether the student can continue with his/her programme of study. The Colleges require that all incoming teacher education students complete a medical information form, indicating whether they have any significant on-going illnesses or disabilities which might adversely impact their capacity to meet the requirements of the course, including School Placement. Entrants who declare health conditions, disabilities or psychological conditions will be assessed on an individual basis to evaluate whether, with reasonable accommodations, they would have the ability to undertake the demands of the programme. Individuals will not be excluded on the grounds that they possess a particular condition or disability if it is deemed likely that it would be possible for that person to fulfil the requirements of the course with reasonable accommodation(s). The Colleges will advise students as to the procedure to be followed in this regard.

The colleges and their concurrent and consecutive routes that are relevant to a review of training in Science or Chemistry education are summarised in the tables which follow. These do not represent all teacher training courses, but only those relevant to Science. For example, Primary science pre-service training varies from one



institution to another, although all primary school children should be studying science as part of their Social Scientific and Environmental Education curriculum.[7]

College	Qualification
Mary Immaculate College, Limerick	Bachelor of Education
Mary Immaculate College, Limerick	Bachelor of Education with Psychology
Froebel College of Education / NUIM	Bachelor of Education (NEW)
Colaiste Mhuire, Marino	Bachelor of Education
Church of Ireland College of Education	Bachelor of Education
St. Patrick's College, Drumcondra	Bachelor of Education

Table 1: Colleges offering concurrent teacher training at Primary level

College	Qualification
St. Patrick's College, Drumcondra	Graduate Diploma in Education
Froebel College of Education	Higher Diploma in Education
Hibernia College	H. Dip in Arts in Primary Education
Colaiste Mhuire, Marino	Higher Diploma in Education
Mary Immaculate College, Limerick	Graduate Diploma in Education
St. Patrick's College, Drumcondra	Graduate Diploma in Education

Table 2: Colleges offering consecutive teacher training at Primary level

2. Primary Teacher Education

2.1 Initial Primary Teacher Education

Primary school teachers must be qualified to teach the range of subjects to children aged 4 to 12 years. Primary school teachers must satisfy the Department of Education and Skills (DES) that they can not only teach the Irish language but also teach the range of primary school subjects through Irish. In order to gain full recognition as a primary school teacher, applicants must pass the written, aural and oral parts of the Scrúdú Cáilíochta sa Ghaeilge and provide certification that they have completed an approved three-week course in the Gaeltacht.

Before being certified as fully qualified teachers, graduates of the colleges of education have to complete a probation period after they satisfy the Irish language requirement. This is generally a one-year period during which an inspector from the DES evaluates the teacher's work. If the Inspector is satisfied by the teacher's performance, they will be awarded the DES Diploma which certifies that they are a fully qualified national school teacher.

As far as training for primary teachers is concerned, all pre-service teachers must have some training in science to enable them connect with the science curriculum at primary level. Chemistry is embedded in the Primary curriculum in a stream of Social Environmental and Scientific Education, which was formally introduced in 2003/4. The curriculum is presented in two sections: a skills section and a content section. The skills section supports children in working scientifically and in developing their designing and making skills, encouraging them to learn by investigating: observing, asking questions, suggesting explanations, predicting outcomes, planning investigations or experiments to test ideas and drawing conclusions. Chemistry is inherent in the *Materials* and *Environmental Awareness and Care* strands. The word 'Chemistry' is not evident in any of the curriculum booklet sections [7].

Teachers should be trained to guide their pupils in learning about *Materials*, which involves the exploration of different everyday materials, their characteristics and the processes by which materials are changed and *Environmental awareness and care*, which outlines how science and geography can foster the child's appreciation of environments and his/her responsibility for their conservation and enhancement. The curriculum is based on a spiral approach, in which some aspects of the natural and physical environment may be explored at each class level. The titles of the strands and the strand units are almost identical at each class level. However, the knowledge and understanding presented and the range of process skills that children are encouraged to use in scientific investigations will be developed and extended at each class level. This means that the pre-service training of the teachers should give them both the confidence and competence to work with this spiral curriculum and deliver the topics in an inquiry-based approach.

2.2 In-service Primary Teacher Training

There is considerable anecdotal evidence that teachers who have not received any science pedagogical training pre-service are less confident and competent with implementation of the science curriculum. A major initiative to redress this issue has been the highly successful Discover Primary Science and Maths programme.[8] The latter is a flagship project of the Discover Science and Engineering (DSE) awareness programme.[9] It facilitates teacher training in general primary science, and provides teachers with useful online resources – that can also be used by parents and students – and classroom activity packs.

Just over 3,100 primary schools and their teachers are currently participating in activities which include hands-on induction days which are hosted throughout the country in colleges of education, institutes of technology, universities and education centres. Limerick Institute of Technology participated in this programme, in the first instance undergoing training as trainers and then facilitating training sessions with teachers in the region. The idea was that each primary school would nominate one teacher to participate in the training sessions and then s/he would go back to train other teachers in her/his school.

The Professional Development Service for Teachers (PDST) [10] also offers opportunities for in-service training in Science. The PDST was established in September 2010 by Teacher Education Section (TES) of the Department of Education and Skills (DES) following a re-conceptualisation of support and continuing professional development (CPD) for teachers in primary and post- primary schools. Currently PDST encompasses the supports previously supplied by other support services and programmes, including Primary Professional Development Service (PPDS) and Second-Level Support Service (SLSS). The aim of PDST is to provide high quality professional development and support that empowers teachers and schools to provide the best possible education for all pupils /students. Its mission is to support teachers as reflective practitioners by promoting teacher learning, collaboration and evidence-based practice. Supports and CPD available to principals and teachers include Subject-specific and curriculum support, Teacher Professional Networks (TPNs), online learning and support and In-school support in a range of areas to support learning and teaching. Current training is focussing on Literacy and Numeracy, but there is on-going work in integration of ICT for subject support. [11]

The National Centre for Excellence in Maths and Science Teaching and Learning (NCE-MSTL) [12] at the University of Limerick has provided in-service training opportunities for primary teachers. Typically these have been half-day workshops presenting ideas and sharing methodologies for introducing science to primary level students. This author has participated in presentation of these training sessions, which were well-attended largely by experienced teachers. [13] One of the Chemistry is all Around Us Associate partners, Dr Maeve Liston, is the Science Education Tutor in Mary Immaculate College Limerick and has done considerable work

in revamping the science curriculum and also reporting research findings on different innovative approaches to primary science, e.g. in the use of Concept Mapping [14] and Puppets [15] in science teaching.

One study has shown that many primary school teachers have insufficient content and pedagogical knowledge of science. [16] This lack of knowledge can often lead to a lack of confidence and competence in teaching science. It explores the impact of a year-long science methodology (curriculum science) course on second year Bachelor of Education (B.Ed.) students' conceptual and pedagogical knowledge of science and on their attitudes towards teaching science in the primary classroom. A questionnaire, containing closed and open questions, was administered to students at the beginning and end of their science methodology course. The findings revealed that the science course had a positive impact on developing students' scientific content knowledge. While the students were positive about the prospect of teaching science, insufficient scientific content knowledge was a concern for many of them, as were concerns over various teaching methodologies and classroom management issues in teaching science. The findings of this study are worrying, as it is likely that high percentages of these students will enter the teaching profession with similar inaccurate conceptions of science as the students they will be teaching. The theme of misconceptions has become a recurring one across many of the activities and discussions that have been component of the Chemistry is All Around us project.

3. Secondary Teacher Training

3.1 Initial Teacher Education in Chemistry/Science

Post primary teachers are normally required to teach at least one subject which they have studied to degree level. They may also be required to teach other subjects which they have not studied to degree level but in which they have developed expertise. Post-primary teachers do not need to have a qualification in the Irish language unless they are employed by a Gaeltacht school or a school where Irish is the medium of instruction. Qualification is usually achieved by gaining a primary degree from a recognised third level institution and the degree must include at least one subject from the curriculum for post-primary schools for the Leaving Certificate Programme. The primary degree is followed by a postgraduate qualification in education such as the Professional Diploma in Education (PDE).

Another path to qualification is gaining a degree which is awarded by a recognised third-level institution on the basis of a concurrent course of academic study and teacher training. The concurrent and consecutive routes to qualifying as a science teacher for secondary level are summarised in the tables that follow. Typical programmes are outlined for two institutions in Appendix 1 and 2.

College	Qualification
University College Cork	Bachelor of Science in Education
National University of Ireland, Maynooth	BSc. In Science Education
Dublin City University	BSc. In Science Education
Dublin City University	Physical Education with Biology
University of Limerick	BSc. Physical Ed.
University of Limerick	BSc.Ed. in Physics and Chemistry
University of Limerick	BSc.Ed. (Biological Science with Chemistry and Physics)
St. Angela's College	B.Ed. (Home Economics with Biology)

Table 3: Colleges offering concurrent Science teacher training at Secondary level

College	Qualification
University College, Dublin	Professional Diploma in Education
University College, Cork	Professional Diploma in Education
National University of Ireland, Galway	Professional Diploma in Education
National University of Ireland, Galway	Professional Diploma in Education (Irish)
National University of Ireland, Maynooth	Professional Diploma in Education
Trinity College, Dublin	Professional Diploma in Education

Table 4: Colleges offering consecutive Science teacher training at Secondary level

One research project has shown the value of mentoring for the student teachers: The mentor is an experienced science school teacher in a partner school linked to the University of Limerick (UL). The teachers are trained in the University in two consecutive summer schools where upon completion they graduate as Lucent Mentor Teachers (LMTs).[17] The mentor is assigned a student teacher during the mentees' teaching practice placement (dictated by the geographic preferences for schools indicated by students). Continuous evaluation of the mentoring programme indicates the mentors play a key role in the training of the student teachers by guiding, coaching, challenging, planning and reflecting with their mentee during their placement. Unfortunately the Lucent Mentoring Initiative was discontinued due to lack of funding.

3.2 Professional Registration

All teachers must be registered by the Teaching Council. A member of staff from the Teaching Council will visit all colleges or universities to provide information about the role of the Council and on teacher registration to final year students. At this information session, they will be required to fill in a form which authorises the college or university to transfer your contact and exam result details to the Teaching Council. Like primary teachers they will also be required to complete a Garda vetting form during the visit. The result of the Garda vetting will be issued to the student as soon as the result is returned to the Teaching Council, along with a personalised application form. If the form is completed correctly and the student's qualifications are in order, the Council will then confirm registration. Currently, there is no charge applied when a new graduate is added to the Register of Teachers. New graduates will be granted conditional registration until they have successfully completed a process of induction (for post-primary teachers) or probation (for primary teachers).

In order to be admitted to the Register of Teachers as a post-primary teacher an applicant must hold a suitable degree and teacher education qualification. A suitable degree is defined as an award from a State-recognised university or similar third-level college, which enables the holder to teach at least one curricular subject to the highest level within the Post-Primary schools curriculum. For most subjects, this is Leaving Certificate Higher Level. The programme must be comprised of at least three years of full-time study or equivalent, carrying at least 180 ECTS credits and be equivalent to at least a Level 7 award on the Irish National Qualifications Framework (NQF).[18] With effect from 1 April 2013 the minimum requirement has become Level 8 on the NQF.

A suitable initial teacher education qualification is defined as a qualification from a State-recognised university or similar third-level college, incorporating three specific elements:

- Foundation Studies
- Professional Studies
- School Placement

and which is directed towards the 12 to 18 age range (First year to Sixth year). The programme must extend over at least one year of full-time study or equivalent. With effect from September 2014, postgraduate

programmes of initial teacher education accredited by the Teaching Council will be extended to two years full time study or 120 ECTS credits.

The most common initial teacher education qualification in Ireland is the Professional Masters in Education (previously known as the Postgraduate Diploma in Education / Higher Diploma in Education). This is awarded on successful completion of a one-year full-time course.

The Teaching Council is sponsoring research and development to reinforce the idea of the continuum of teacher education in Ireland across all subjects and levels. A number of policy documents, some generated from speeches, are available on the Council website.[19]

3.3 Subject Criteria for Professional Competence

The Teaching Council provides details of the individual subject requirements (subject criteria) for all post-primary curricular subjects. Applicants applying under Regulation Four (Post-primary) must hold a qualification which meets the requirements for at least one of these subjects. The Teaching Council also maintains a list of degrees which have in the past been deemed to meet the requirements for named curricular subjects. Given degree programmes and elective modules within degrees can change over time, it is important that this list should only be considered as a guide and applicants should in the first instance ensure that they satisfy the criteria for at least one curricular subject and be verified by Council staff.

Applicants must provide officially certified evidence of satisfactory achievement in primary degree studies (or equivalent) as outlined hereunder: The candidate must have studied Chemistry as a major subject in the degree extending over at least three years and of the order of 30% at a minimum of that period. Details of the degree course content must show that the knowledge and understanding required for teaching Chemistry to the highest level in post-primary education has been acquired. In addition, details of degree course content where the studies involved modular or applied subject content or where studies were in a related subject area will require specific assessment to determine equivalence. The Council will also require details of course and practical work content completed during the degree programme together with teaching/tutorial times, list of experiments and practicals, as well as explicit details of standards achieved in degree studies in Chemistry with at least an overall Pass result in the examinations in Chemistry.[20]

Recognition to teach Chemistry also confers recognition to teach Science in the Junior Certificate programme. The Council has approved new guidelines for school placement (formerly Teaching Practice) for student teachers. The new term, "school placement" encompasses the sense that the student teacher is expected to engage in the whole life of the school as they progress through their initial teacher education. This progression culminates in a single block of 10 weeks in the second half of the programme.

4. Continuous Professional Development

In its document *The Continuum of Teacher Education*, the Teaching Council refers specifically to Continuing Professional Development (CPD), stating that 'Continuing professional development (CPD) refers to life-long teacher learning and comprises the full range of educational experiences designed to enrich teachers' professional knowledge, understanding and capabilities throughout their careers'.[21] Further information on the provision of continuing professional development in Ireland and internationally is available in the Council's background document, *Teacher Education in Ireland and Internationally*. [22]

The Teaching Council's Policy on CPD is underpinned by the three pillars of innovation, integration and improvement and the Council's generic principles of good teacher education. In addition, the following principles, which are specific to CPD, are significant:

CPD is a right for all registered teachers. In that context, an allocation of time for individual and/or staff group CPD should be built into teachers' scheduled non-teaching time. The allocation of time should be significant and should reflect the importance of CPD for effective professional practice. CPD should be based on teachers' identified needs within the school as a learning community. CPD is a responsibility of all registered teachers. In that context, a registered teacher should take reasonable steps to maintain, develop and broaden the professional knowledge, skill and capabilities appropriate to his or her teaching.

Effective CPD provision requires the adoption of a coherent national framework that is informed by international and national research evidence and that caters for individual teacher, school and system needs. The national framework should identify ways in which professional development can be resourced and facilitated both within and outside school time, within a school and/or within a cluster of schools. A key

challenge will be to take account of different categories of need and address current shortfalls while recognising the integrity of the school year and the need to minimise disruption to student learning.

There should be a partnership approach to policy development and planning involving all the key stakeholders. This is particularly evident in the ethos and rationale of the Professional Development Service for Teachers.

4.1 Professional Development Services for Teachers

The aim of the Professional Development Service for Teachers (PDST) is to provide high quality professional development and support that empowers teachers and schools to provide the best possible education for all pupils/students. Our mission is to support teachers as reflective practitioners by promoting teacher learning, collaboration and evidence-based practice. PDST operates under the remit of Teacher Education Section (TES) and is hosted by Dublin West Education Centre (DWEC).

PDST collaborates with the Education Centre network to provide continuing professional development (CPD) to post primary teachers through various models and in a range of settings depending on the needs of schools and teachers. PDST provides a range of supports across the secondary school system:

- Subject-specific: there is a team for each subject of Trainers who are experienced teachers who have been seconded to training posts. The Chemistry team includes teachers and associates from the Irish group in the Chemistry is All Around Us Network.
- Programme-specific including Junior Certificate Science.
- Teacher professional networks (TPNs) support
- Online learning and support
- In-school support in a range of areas to support learning and teaching

PDST advisors, associates and local facilitators, supported by Education Centre bases, respond to the professional development needs of teachers by working flexibly within and across a number of teams. The Science/Chemistry base is at the Limerick Education Centre, but the members of the teams are available for training throughout the country.[23]

An example of a current programme is described here: The Induction Course for Chemistry Teachers is facilitated by experience PDST trainers. [24]This course is 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 practicals 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 will also be covered on the day. Teachers are provided with an extensive range of chemistry resources and useful websites. The Mandatory CD is distributed to attendees on Day 1. The Schedule for this year includes two days of training in September and December at the University of Limerick, two alternative days at NUI Maynooth or two days at University College Cork.

4.2 Education Centres

The principal activity of the nationwide network of Education Centres (originally Teachers' Centres) is to organise the local delivery of national programmes of teacher professional development on behalf of the Department of Education and Skills. [25] Centres also organise a varied local programme of activities for teachers, school management and parents in response to demand. Among their activities is the delivery of the National Induction Programme for Newly Qualified Teachers.[26] The National Induction Programme for Teachers (NIPT) supports the induction of newly qualified teachers (NQTs), both primary and post-primary, into the teaching profession in Ireland. The main objective of induction is towards promoting the professional development of NQTs by way of systematic support in their first year of teaching, thus laying the foundations for subsequent professional growth and development. Wong, (2004) describes induction as: 'a comprehensive, coherent, and sustained professional development process aimed to train, support and retain new teachers and represents the first part of a lifelong professional development programme'. [27]The NIPT provide five pillars of support, the NQT workshop programme, website support, school-based support, school visits and professional support groups.

The Limerick Education Centre provides the administrative support pillar for the Maths and Science PDST teams. Education Centres are statutory bodies and are managed by voluntary management committees elected annually. There are 21 full-time and 9 part-time education centres. They are organised into an Association of Teacher Education Centres of Ireland (ATECI).

4.3 Irish Science Teachers Association

The Irish Science Teachers' Association (ISTA), Eol Oidí na hÉireann, is the Professional Association for the Teachers of Science in the Republic of Ireland. [28] It is one of the largest voluntary subject associations in the country with branches in the following areas: Cork, Donegal, Dublin, Galway, Kerry, Kildare, Kilkenny, Limerick, Monaghan, Midlands (Athlone), Sligo, Tipperary, Waterford and Wexford. ISTA was founded in 1961 and has almost 1200 members from all sectors of education in fourteen Branches nationwide.

The ISTA functions as a body dedicated to the professional development of its members and the advancement of science teaching. Membership is open to teachers of science and others involved in science education. The Association works to develop co-operation between teachers of science at all levels. It aims to keep members up to date with changes in their subjects and with new ideas in teaching, learning and assessment. The ISTA helps members to promote a positive attitude amongst their students towards science and technology in society. It also offers support sessions to Professional Diploma in Education and Newly Qualified Teachers.

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 Annual Conference in the Spring of each year with a very broad programme of interest to people in different areas of Science education. These conferences offer unique CPD opportunities for teachers across all sciences. The ISTA has close affiliations with ASE UK and Scotland and is also a member of the International Council of Associations for Science Education (ICASE)

4.4. Royal Society of Chemistry

The Royal Society of Chemistry (RSC) education team aims to support chemistry teachers and enable them to inspire their students into pursuing a future in the chemical sciences.[29] There is a Royal Society of Chemistry Education Division Ireland committee of which the author is a member. Following its global strategy of electronic access, the RSC has put together a comprehensive platform called Learn Chemistry that enables Science and Chemistry teachers all over the world to access fantastic free resources. [30] Aside from resources, teachers can look for supports by communicating with colleagues. Teachers can find out which resources other educators are finding useful by asking on the new chemistry teacher forum (Talk Chemistry) on myRSC which is free to join. [31]

In Ireland, Dr. Angela McKeown, based in Queen's University Belfast, has been the most recent education executive, who has given fantastic support to chemistry teachers' CPD throughout the island. The RSC has amassed its local members as Chemistry ambassadors within their communities. These members go out to schools to give talks to students about careers in Chemistry. The RSC has offered some free Teacher CPD throughout Ireland this year - including "Learn Chemistry CPD" sessions on "the mole" and "redox chemistry" in Galway and Dublin and in Limerick at this year's ChemEd conference.

Chemistry for Non-Specialists [32] course is aimed at teachers currently teaching chemistry in a secondary school but holding a specialism in a different subject. This affordable, high quality training programme is designed to provide teachers with the confidence, flair and enthusiasm to teach chemistry at and is specifically aimed at those who are not chemistry specialists. It is delivered by experienced chemistry teachers, trained by the RSC. Courses have been provided in Ireland this year, and there was a waiting list of applicants to attend.

4.5 ChemEd Ireland conference

The annual ChemEd Ireland conference runs for one day in October and is dedicated to CPD issues for Chemistry teachers.[33] In 2013 ChemEd-Ireland returns to Limerick (hosted by Limerick Institute of Technology) and features a number of talks and workshops to give new ideas for chemistry teachers. These include new information about the changes to the current Chemistry syllabus, new methods of utilising ICT in Chemistry and new perspectives for Junior Certificate and for exams.



4.6 Chemistry in Action!

This magazine for chemistry teachers is produced three times a year and is circulated to individual Irish chemistry teachers on a mailing list.[34] Some 700 teachers are on the named mailing lists and they are encouraged to share the ideas with their colleagues, especially the Newly Qualified Teachers – although some of these would already be familiar with the publication through the student subscription facility availed of by some Teacher Education departments. It includes reports on new initiatives, teaching tips and recommendations for resources. In 2013 the 100th issue will be published. Teachers utilise it as a support for their on-going CPD.

4.7 National Centre for Excellence in Maths and Science Teaching and Learning

This centre is based at the University of Limerick and is another associate partner of the Chemistry is All Around Network. The National Centre for Excellence in Mathematics and Science Teaching and Learning (NCE-MSTL) [35] was established in 2008 under the aegis of the Shannon Consortium with funding from the HEA for an initial three year period (Phase 1). During Phase 1 the Centre has become a nationally recognised hub for research, policy and leadership in mathematics and science teaching and learning. It has established a research base, an impressive suite of programmes, projects and collaborations, and a solid foundation for the implementation of medium to long-term strategies to address national priorities in science and mathematics teaching and learning. It is particularly significant that major stakeholders, both industrial and public sector, are increasingly recognising the importance of the National Centre and are seeking to work with it. In addition the Centre has recorded major successes in the following areas through its activities of direct relevance to Chemistry CPD, including: Building capacity in Science and Mathematics education research, Informing national policy in mathematics and science education, Raising general awareness of Science and Mathematics in schools and the community and Supporting national initiatives.

It is recognised internationally that the problems associated with mathematics and science teaching and learning have their source mainly in the teachers' subject content knowledge and pedagogical content knowledge rather than in generic pedagogy or in any aspect of generic educational theory. A fundamental guiding principle driving the work of the National Centre is that good teaching in mathematics and science is based on good content knowledge in mathematics and science. All the academic and professional activities of the Centre are based on deep subject knowledge in mathematics and/or the sciences. Consequently, all its programmes are characterised by a strong emphasis on science and/or mathematics content integrating associated pedagogical content knowledge. Good practices in mathematics and science teaching have to be identified, carefully adapted for local use, and monitored in use before they are generally adopted. Research supports approaches to improved pedagogy through better subject knowledge. The work of the centre is project-led within the following themes in science and mathematics education: Fourth and Third levels, Second level, Primary Education, Mathematical and Science literacy. Projects address important issues such as adapting good practices in mathematics and science teaching and learning for use in Ireland by research interventions in schools and other institutes and piloting such practices. These are then disseminated through CPD events organised by the Centre and all materials are made available on the NCE-MSTL website.

The work of the Centre is strongly focussed on translating research into practice so that research findings impact on science and mathematics teaching in Irish classrooms. The Centre has evolved a three-pronged strategy to make this happen: best practice solutions are identified or developed through evidence-based research; solutions are piloted in appropriate interventions and evaluated; CPD materials are developed and disseminated through CPD events and the NCE-MSTL website. The Centre supports an annual week long workshop for Chemistry Demonstrations. Its resources for Chemistry include Classroom activities, concept maps and lesson plans.

4.8 Other providers of CPD opportunities

In Dublin City University, a team that includes chemists as well as pedagogical skills practitioners has established CASTeL, the Centre for Advancement of Science and Mathematics Teaching and Learning, which offers CPD opportunities.[36] For example in Summer 2013 Inquiry workshops were held at DCU for 4 days. This workshop focussed on the teaching and learning of science, in particular **chemistry** and **biology** through an inquiry approach. Materials and resources shared will be suitable for **Junior Cycle science**. Participants



were invited to participate in the following: Interactive workshops, A European Community of Practice, On-line sessions and a Digital Learning Course.

DCU also initiated the Science and Mathematics Education (SMEC 2012) "Teaching at the heart of learning" will took place on the 7-9th June 2012, in DCU, Dublin. It was the fifth in the series of biennially international Science and Mathematics Education Conferences that have been hosted by CASTeL.[37] The purpose of this conference series is to provide an international platform for the educators of DCU and SPD, of Ireland, and beyond to discuss issues arising in teaching mathematics and science.

This year we are focusing the attention on teachers as we believe for any improvements in classroom practice that research (science and mathematics education) can suggest it is the teachers who are crucial in bringing these theories and principles to fruition; they are the agent for change.

In Cork the EUREKA Centre, which has considerable industry sponsorship has also offered invaluable CPD for teachers.[38] A one-day course for Chemistry Teachers was held in the Eureka Centre UCC on the assessment of practical work in the revised Leaving Certificate Chemistry syllabus. This Summer School for Chemistry Teachers was first run last year and was so popular with teachers that it was repeated on a second day. Due to the emphasis on laboratory practical work, the number of teachers attending each day was limited to 24. These are only a limited sample of events to give an idea of what is possible for teachers and to illustrate that CPD is available regionally.

5. The Impact of the Chemistry is All Around Us Project on Teacher Training

On May 28th 2013, a workshop on teacher training involving nine teachers, five experts and one associate was held in Limerick Institute of Technology. A discussion based on the following was engaged within the working group under the following headings and within an Irish context

Consecutive Vs Concurrent training of student teachers: It was felt that both had a significant importance in the education and training of effective science /chemistry teachers. This was significantly dependant on several key factors including the student; the particular philosophy of the department or third level institute; the delivery mode (and the 'lecturer') and the motivation or students perception of what is a chemistry teacher. Of the specifics of consecutive versus concurrent training it was felt that there were advantages and disadvantages to each method and that a blend of both was ideal but difficult to get the correct balance based on the 'dependant' key factors. However, content knowledge was identified as possibly lacking in some instances. The teachers present included graduates from both typologies, and indeed one of the group members had trained through the non-state-funded route.

Pre-service and In-service training: To date pre service training for primary school teachers has not been evident. However Dr Maeve Gleeson of Mary Immaculate College Limerick (an associate partner of the network) informed that this is currently being addressed at undergraduate level but the benefits of which may not be seen for four years i.e. graduates of 2017. In-service training in the Irish context is not a mandatory requirement for teachers at either primary or secondary level. [39] However, the uptake of such training where available was significant by teachers in Ireland despite it usually being outside of 'normal' working conditions with no recognition by the education department nor incentive.

Probation and Induction: This is not undertaken in Ireland specific to Science/Chemistry teaching. However, the approach is a well-established in the Irish system for any teaching role within a primary, secondary or tertiary education level. The group felt that a science mentor either within a school or locally among community of schools would be of huge benefit to teachers. The potential for a third level lecturer to be engaged in such roles was a positive contribution but in need of much exploration. The Lucent Mentoring project was cited as a good example that unfortunately no longer exists because of funding. Two of the workshop participants had trained as Lucent science teacher mentors and enjoyed the experience of the training as well as the actual mentoring role.

Continuous Professional Development; In the context of second level teachers of science/chemistry CPD was well catered for with courses run on a regular basis. However, notable of teachers commitment to CPD and the need for it is evident in that fact that the courses are oversubscribed and that waiting lists exist. One of the teachers in the Irish group has recently been appointed as a PDST trainer for Chemistry, Science and ICT-based initiatives. Dr Maria Sheehan has also been involved in the delivery of the Chemistry for Non-Specialists Course.

Discussion regarding the group's reviews of papers and publications on the portal site (the European context for teacher training) took place. There was broad discussion of the reviewer's experiences regarding the papers. It was felt that there were significant issues with the communication of information as a result of poor translation with regard to some of the papers. Issues with regard to quality and relevance to the stated aims and objectives of the project in year two were raised. It was felt that a stricter peer review process prior to up loading on the portal may benefit in a positive way in the future of the project. Papers that were contributing to the debate were in some instances based on what should be done in that particular European country and not on the current situation.

A brief outline of the Irish papers which were selected for the Irish context was given. The issue of publications over ten pages in length (some being books) was observed as being impractical to review. The main issues which emerged during the course of the discussion in the European context were centred on the 'Misconception' of primary information attained by student's teachers and the continuation of the misconception being continued on in the chain to the secondary level students. This was acknowledged as a possible situation in the Irish context too but with no firm evidence.

The issue of the use of ICT was discussed in the context of one of the reviewed publications and this was discussed in the Irish situation. It was felt that while the future of the teaching of science/chemistry was most definitely with ICT given the prevalence of it in everyday life that there must also be a focus on the technique of blended learning to include traditional teaching methods. How this balance could be achieved was discussed with no firm conclusions.

A number of topics were discussed with regard to potential future activities:

Methodologies to teach specific topics – The used of various media and ICT as tools for teaching which are either available as packages or a group based project e.g. where students using as a core of a Chemistry themed song to develop an accompanying 'stills shot' video which visually explains the science of the song: the example given by Dr Maria Sheehan is currently on *you tube*.

While other examples of such initiatives were discussed the constraints of such methods were examined and it was felt that such teaching was often time consuming and was too liberal as a method when the syllabus is so well defined. It was also felt that both students and parents are focused on the exam process and the final grade as opposed to the topic of chemistry. The system as it is in the Irish context is very constricting and that the emphasis for the students is the final examination process. To that end it was felt that such a project style using blended learning should be incorporated into the learning through the contribution of such work to a continuous assessment grade which would be incorporated in the final grade.

The importance of training science teachers to keep up to date with the continuous progress of research was dictated by the recommended texts for the subject. Time constraints are a continuous factor with many of the more motivated teachers engaging in extra circular activities for their students such as SciFest and the BT young scientist competition. It was felt that CPD also has a role to play here. At the very least financial support for in-service training requirements should be sine non qua.

The use of simulations had a major drawback regarding cost and relevance to the syllabus. While there were many resources available the detail and relevance did not always match the syllabus learning outcomes and had limited used either being too detailed and in depth or not enough. There may be a possibility to develop such resources specifically for the Irish situation and this is something to consider for future work. Simulations do have a role in a blended learning environment but they may come at a cost. It was also noted that such learning resources are taxed at 23% in Ireland and possibly to a similar extent in Europe – The current project may be a good vehicle on a European level to repeal such taxes?

5. Conclusions

The biggest issue with teacher training in Ireland at the current time is the flurry of change that is happening in curricula and syllabi, length of training, specifications for placement and indeed the names of the various departments and qualifications. There seems to be a whole new vocabulary around the profession, which is in itself confusing for all involved.

There are restrictions on the full use of ICT in Chemistry teaching where the teacher is fortunate enough to be teaching this practical subject in a laboratory base classroom, since mobile phones are typically not allowed in the proximity of volatile solvents. Where computers or PCs are available they may be outdated, or the internet connection may be unreliable in some parts of the country. However, simulations do offer a support



opportunity without being a replacement for traditional practical experiments. The difficulty for many in-service teachers is not lack of supports or CPD opportunities but lack of time because of all the other preparation and administration duties which are the remit of the modern-day teacher in Ireland. To up-skill and utilize ICT requires dedication and commitment. One of the difficulties possible end-users of the project portal have identified is the need for more interaction on the portal as well as more categorization of the portal resource links.

In an opinion piece published in September 2013, Sean Duke writes, *'These developments (in the Irish education system, such as the publishing of school 'league tables') have had a devastating impact on teacher training. Unlike in times past, trainee teachers in the classroom are assessed by a number of standard listed criteria, as if they were a new car rolling off the assembly line. There is little room for aspiring teachers to be different, or creative in their approach, even if they are so inclined. Neither is there much room for teaching inspectors to judge trainee teachers as individuals with their own style – rather they are forced into a box ticking exercise largely akin to the role of the quality assurance inspector on the factory floor.'* [40] If a teacher's creativity is stifled pre-service there is little hope that they will flourish creatively in-service.

Another opinion piece, in the national broadsheet, The Irish Times, on September 19th 2013 is entitled 'Teaching of science must be recalibrated'. It says, *'According to the country's science teachers, there are significant challenges in second-level education that should pose concerns for science, technology, engineering and mathematics. Of the approximately 50,000 Leaving Cert students in 2013, only 4,832 took higher-level physics and 6,756 took higher-level chemistry. "This is very worrying," says Mary Mullaghy, chairwoman of the Irish Science Teachers' Association. "These are key subjects required by our high-tech industries." The key to solving this problem, she says, is for greater government support of continuing professional development programmes for teachers. The Teachers' Professional Network, funded by the Department of Education and Skills, is "an excellent system as it provides funding directly to the subject associations to organise continuing professional development", says Ms Mullaghy. "Unfortunately, many of the activities that the members of our organisation request are not deemed suitable for [Teachers' Professional Network] funding," she added.* [41] The columnist went on to quote figures for financial support for the organisation's CPD activities which amounted to a total of €212,494 in the seven years since 2013. As a member of the committee of a local branch of the ISTA this author can vouch for the fact that qualification for TPN funding has become more difficult in the current fiscal situation especially. Less than quarter of a million Euros over a period of seven years seems a small enough sum to ensure quality and availability of CPD for science teachers.

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Appendix 1: Typical concurrent course outline

Concurrent B.Sc.(Education) with Physics and Chemistry at the University of Limerick
Source: <http://www3.ul.ie/courses/PhysicsAndChemistryEducation.php>



In common with other teacher education programmes at the University of Limerick, the B.Sc.(Ed) in Physics and Chemistry is based on the concurrent model. Academic and professional studies proceed together throughout the course and modules in the core science subjects are taken.

The first two years of study provide a foundation in Chemistry, Physics, Biology, and Mathematics in addition to Education and Pedagogics.

In the third and fourth years, you will continue to study Chemistry, Physics and Mathematics at a more advanced level along with further modules in Education.

In the final year, you will undertake a project which may be in the area of Physics, Chemistry, Science Education, or Educational Theory. As part of this work you are required to demonstrate abilities in research, literature review, analysis, synthesis and interpretation of research findings as applied to the selected topic.

There are two periods of teaching practice placement during the course. The first, of six weeks, occurs in Year 2, and the second, of ten weeks, occurs in Year 4. During teaching practice, you will be supervised by an academic staff member and undertake assigned coursework.

To find out more, go to www.ul.ie/~physics

Year 1	Semester 1	Semester 2	Summer
BY4001	Biology 1	BY4002	Biology 2
CH4701	General Chemistry 1	CH4202	Inorganic Chemistry 1
EN4031	Becoming a Teacher: Identity and Communication	EN4012	How Young People Learn
MA4601	Science Mathematics 1	MA4602	Science Mathematics 2
PH4131	Mechanics/Heat/Electricity/Magnetics	PH4102	Waves/Light/Modern Physics
	Optional		
EN4021	Life Skills		

Year 2	Semester 3	Semester 4	Summer
CH4303	Analytical Chemistry 1	BY4004	Horticulture
PH4041	Optics	EN4024	Planning for Teaching and Learning 2
PH4717	Mechanics	SE4014	Teaching Science 1



EN4023	Planning for Teaching and Learning	SE4024	Teaching Science 2
CHXXXX	Fundamental Organic Chemistry	BY4004	Horticulture

Year 3	Semester 5	Semester 6	Summer
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CH4253	Inorganic Chemistry 2B	CHXXXX	Physical Chemistry
EN4006	Curriculum Studies	EN4016	Responding to Diversity in Education
MS4613	Vector Analysis	CH4304	Analytical Chemistry 2
BCXXXX	Biomolecules	PH4072	Electromagnetism
PH4013	Earth Science	SE4006	Science Teaching 3

Year 4	Semester 7	Semester 8	Summer
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EN4017	Understanding Schools	CH4017	Chemical Nanotechnology
SE4007	Project 1	EN4008	Teacher as Professional
TP4007	Teaching Practice 2	PH4042	Thermal Physics
		PH4132	Modern Physics
		SE4008	Project 2

Appendix 2: Typical Consecutive course outline

Professional Diploma in Education at Trinity College Dublin: The Professional Diploma in Education (PDE) is a one-year, full-time (60 credits), intensive programme of study for the preparation of post-primary school teachers. The course is recognised and accredited by the Teaching Council of Ireland, the regulatory body of the teaching profession in the Republic of Ireland. The course is composed of two main elements: teaching placement and university experience. Students teach in schools on Monday mornings, Thursdays and Fridays and attend lectures, tutorials and workshops in the university on Monday afternoons, Tuesdays and Wednesdays throughout the academic year. It is the responsibility of the student to secure a teaching placement and schools must be within a 25 km radius of Trinity College. The PDE is a required qualification for persons wishing to work as post-primary teachers in the Republic of Ireland and is a recognised teaching qualification within the EU.



Course Overview

We seek to develop in our students: knowledge and appreciation of the discipline of education; a sense of the broad context of Irish education as part of society as a whole; an appreciation of the complicated nature of the teacher's role and of the function[s] of schools in society; knowledge of a range of models of instruction, with the ability to choose between them and to apply them in classrooms, laboratories and elsewhere; the ability and willingness to act as reflective practitioners, adopting critical insights into practice as appropriate.

The course is staffed by a combination of full-time and part-time lecturers and tutors, the former being Trinity lecturers who have wide research interests and experience in teaching in schools and higher education, the latter typically being current or recently retired teachers who bring extensive classroom experience.

Please note that nationally all PDE courses were designated at level 8 and renamed as Professional Diploma in Education starting in the academic year 2011/2012.

Applicants must be university graduates with a primary degree that includes, as a substantial component, at least one subject from the list of those taught at Leaving Certificate level in Ireland.

All applications are made on-line between September and December of the year prior to the course beginning and selected applicants will be called to interview in Spring as part of the selection process. The intake of the Professional Diploma in Education at TCD is approximately 135 students with a quota applied for each of the pedagogy subjects offered on the course which include Chemistry.

An Induction course is held over one week in August/September. Its aim is to provide a general overview of the programme and to equip students for their introduction to teaching in the classroom. There is an emphasis on classroom teaching methods and survival skills.

Teaching Practice (TP): takes place for the full school year from September until June. It is the responsibility of the student to secure a teaching placement and schools must be within a 25 km radius of Trinity College. In certain circumstances staff in the School of Education can offer help and advice in organising TP but this is not normally the case. Students are required to be present in their Teaching Practice School on Monday mornings, and on Thursdays and Fridays. Students must teach 6-8 hours per week with the majority of hours in their major subject.

College-based courses: Lecture courses are given in the following areas: Educational Philosophy and Theory; Applied Psychology in Education; History of Education; Special Education; Sociologies of Education; Introduction to Assessment & Examinations.

Courses in pedagogy of teaching subjects are offered in Chemistry among other school subjects. The purpose of the courses in pedagogy is to introduce students to the theoretical and practical aspects of teaching as a subject. Teaching in each subject is shared by a team of full-time members of the School and part-time staff, some of whom are also practising teachers, and one of whom will coordinate each subject. Students must choose two pedagogy subjects, a major and a minor. The major subject is the subject for which the student applied. The second (minor) subject should be chosen from a range of possible subjects that do not clash with the student's major on the course timetable. The minor pedagogy course will not be assessed and you will not be supervised if you teach that subject. Science and Modern Languages count as double pedagogy subjects. Majors in these subjects do not have to choose a minor pedagogy programme. However, students taking either of these subjects as minor must also have a major.

Each pedagogy team aims, in its own way, to develop in students:

- [a] the ability to reflect on and evaluate their own practice;
- [b] a working knowledge of relevant research into pupils' learning and an appreciation of the importance of pupils being actively engaged in their own learning;
- [c] an appreciation of the importance of developing positive relationships with pupils, based on principles of equity and inclusiveness;
- [d] a rigorous approach to planning, combined with the ability to make considered choices from a range of teaching methods and resources;
- [e] a knowledge of the content of their subject[s] as required for the Junior Certificate and Leaving Certificate examination syllabi.

A course in ICT (Information and Communication Technology) and elective courses in some or all of the following will also be available:

Civic, Social and Political Education;
Drama in Education;
Classroom Practice and the Hidden Curriculum;
Inquiry Learning;
Language and Literacy across the Curriculum;
Depth psychology for teachers;
Gender and Identity;
Education Research in Practice.

