STRANMILLIS UNIVERSITY COLLEGE
A College of Queen's University Belfast

Primary Science Teaching Trust

Stranmillis Project

A model for excellence in primary science in Initial Teacher Education

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Project Overview

Stranmillis College in Belfast developed their Stranmillis Primary Science Accreditation programme to recognise pre-service teachers' innovative practice in primary science. The programme aims to serve as a 'Community of Practice' for student teachers with respect to primary science and establish mind-sets and dispositions to professional development which will be sustained throughout their professional careers. The programme encourages student teachers to develop their science teaching skills and to engage in professional development activity. Successful completion of the programme enhances their professional profile and their future employability.

Stranmillis have produced a full report to outline the theory and rationale that underpin this accreditation programme. This is found on pages 3-27.

They have also written a guide to support other initial teacher education providers to develop similar initiatives in their own settings. This is found on pages 28-33

Stranmillis has carried out significant research into other areas of primary science education. These include playful approaches, use of iPads, coteaching and microteaching. For further details about these developments please see their website.

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why & how?
PRIMARY SCIENCE TEACHING TRUST

Aspiring for excellence in primary science:

A model for initial teacher education

Dr John McCullagh & Dr Andrea Doherty
Stranmillis University College Belfast

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FOREWORD AND INTRODUCTION

Foreword

The work that colleagues at Stranmillis College have done to engage teachers with science right from the start of their career is excellent.

Their initial teacher education accreditation scheme provides a thorough and manageable way for student teachers to widen their experience and develop their expertise in teaching, learning and leading primary science. I encourage other initial teacher education providers to draw on this work and to develop similar enrichment initiatives in their own institutions.

Professor Dudley E. Shallcross,
CEO, The Primary Science Teaching Trust

Introduction

How can we ensure that all children's classroom experiences of primary science are as stimulating and enriching as possible?

As initial teacher educators who have worked collaboration with the Primary Science Teaching Trust we believe that high quality initial teacher education (ITE) can go a long way to achieving this aim and that the very principles and theories which underpin best practice in the classroom are just as important within the seminar rooms and lecture theatres of the ITE campus. As is the case for primary education, student teachers present with a range of abilities, experiences and conceptions about science and science education. It is the task of the teacher educator to ensure that all pre-service teachers fulfil their potential to become the best teachers they can be, and that they continue to develop their expertise throughout their teaching careers.

Graduating or achieving qualified teacher status should not be perceived as the end of a period of training but as the beginning of a journey of professional development growth and innovation. Therefore we feel that it is important that pre-service teachers' experience of science goes beyond daily lesson plans and classroom teaching, and includes wider issues relating to school science provision and curriculum development. In this respect pre-service teachers have much to offer the school community and partnerships between schools and colleges can prove most advantageous to all stakeholders. Whilst the model presented here is based on the experiences and practices developed within one initial teacher education college we hope that it will be of use to colleagues in other teacher education institutions and the wider science education community.

John McCullagh & Andrea Doherty

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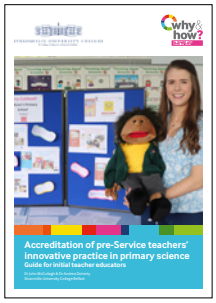

The research and development underpinning this report was supported by funding from The Primary Science Teaching Trust.

A short guide for initial teacher educators in how to set up a similar accreditation programme in their own context is available **here**

RATIONALE

Perspectives on initial teacher education

The need for more research into what constitutes an effective initial teacher education programme has been made frequently (Hiebert et al. 2007; Darling-Hammond, 2010) Burn & Mutton, 2015; Philpott, 2014; Carter, 2015; Tatto & Furlong,2015; Menter ,2016). Menter (2016) identifies the relationship between theory and practice and the sites of professional learning among six enduring themes within teacher education which require greater research. Recent policy changes in the UK have led to a greater use of 'school-led ' teacher education with pre-service teachers spending more time than ever in school settings and less time attending college based seminars. This represents a shift in the philosophy of policy makers regarding the very nature of teaching itself "teaching is a craft and it is best learnt as an apprentice observing a master craftsman or woman. Watching others, and being observed yourself as you develop, is the best route to acquiring mastery in the classroom" (Murray, et al. 2011, p273).

This view of the teacher as an expert in delivery, and the mind-set that learning to be a teacher merely involves the acquisition of a number of skills, is not new. Schon (1983) makes a distinction between 'major' professions, such as medicine, with stable knowledge bases and 'minor' professions, suffering from 'shifting ambiguous ends and unstable institutional contexts of practice' (p.23).His rejection of such a 'technical rationale' model of applied theory gave rise to the notion of the teacher as a reflective practitioner and a view of teaching as a problematic enterprise through which skills, knowledge, and ability are developed over time, through reflecting on experience (Korthagen 2001). Philpott (2014) argues that at a time of increased debate regarding where teacher education takes place, ie. either in schools or on campus, it is more pressing to establish the 'how' of teacher education rather than the 'where'.

Hiebert et al (2007) proposes an approach where pre-service teachers learn how to teach from actually teaching with the aim of developing pre-service teachers' ability to evaluate their teaching by working through a clearly defined analysis framework to explore how their actions, or lack of them, may support or restrict pupil learning. However the assumption that pre-service teachers learn from school placements and that this experience 'melds theory into practice' is challenged by Santagata (2007,p.124). She cautions that unstructured classroom observation can prove ineffectual and poorly planned school placements can 'expose students to a limited repertoire of strategies and to a narrow and unrepresentative sample of students.' Kenny (2010,p.1268) cautions that in relation to the amount of time pre-service teachers spend in school, 'more is not necessarily better'. The key determining factor of pre-service teachers' learning in school is the quality of the mentoring. Hobson and Malderez (2013) present empirical data which identify problems at each of the levels of the mentoring process- the relationships between mentors and mentees, the selection and training of mentors and the efficacy of collaboration between ITE institutions and schools. Burn and Mutton (2015) suggest that increasing the proportion of time student teachers spend in school may well imply a rejection of research-based knowledge, rather than a concern to integrate it more effectively with professional knowledge.

A key recommendation in Carter's (2015) review of teacher education in England is to commission a sector body to develop a framework of core content for initial teacher education. In his review he prescribes that pre-service teachers have the opportunity to:

- observe good and outstanding teachers
- understand the importance of observation and how to observe effectively
- come together in peer groups
- experience school as early as possible in the programme

RATIONALE

Carter (P.21) further recommends that 'effective programmes give careful consideration to how trainees' learning experiences are structured..... effective integration between different types of knowledge and skills trainees need to draw on in order to develop their own teaching and don't privilege 'theory' or 'practice' but integrate them in an environment where trainees have access to the practical wisdom of experts and can engage in a process of enquiry, in an environment where they are able to trial techniques and strategies and evaluate the outcomes.'

Developments in Educational policy in the north and south of Ireland also challenge the current provision of initial teacher education. The development of partnerships between schools and universities is at the heart of the Irish Teaching Council's 'Guidelines on School Placement' (2013). The Irish Teaching Council calls for 'new and innovative school placement models...using a partnership approach, whereby Higher Education Institutions and schools actively collaborate in the organisation of placement' (p.3). The recent introduction of a two year Professional Master of Education degree as the only post-graduate route into teaching in the south of Ireland, also brings with it an extension of the proportion of time which pre-service teachers will spend in placement schools. This Council's placement model seeks to address some of the current issues within initial teacher education as identified in the Council's 'Policy on the Continuum of Teacher Education' (2011, P.8) such as 'education must be reconceptualised so that it is fit-for-purpose in preparing 21st century teachers and interfaces appropriately with the induction stage,' and 'many current programmes are overloaded and are based on somewhat outdated models of provision where there is much emphasis on contact hours and assessment. This leaves insufficient time and space for the meaningful initiation of the development of teachers as reflective, enquiry-oriented, life-long learners.' The Teaching Council's view of teacher education as a continuum requires that pre-service teachers are supported in developing the skills, habits and disposition for professional development and lifelong learning at the very early stages of their teacher education experiences.

In the north of Ireland the importance of reflective practice is a fundamental premise of the General Teaching Councils' Competence Framework. Whilst the development of student teachers' reflective thinking is a key objective within all initial education programmes, Hagan (2013) proposes that here in Northern Ireland the emphasis on reflective practice is particularly strong. The General Teaching Council for Northern Ireland's publication 'Teaching: the Reflective Profession' (2007) states that 'one of the principles which underpin the Council's concept of competence is the centrality of reflective practice.... (and that) competence is developed through reflection on practice and through dialogue with others,' (p.13). The recent report on initial teacher education in Northern Ireland (Sahlberg et al., 2014, p.11) recognises the importance of school placement experiences where, 'beginning teachers observe and analyse their own and other people's teaching, undertake progressively more demanding teaching episodes with learners, and begin to come to terms with the way of life of schools.'

In summary an effective pedagogy for 21st century initial teacher education should;

- Provide opportunities for pre-service teachers to learn about teaching through teaching in a supportive, progressive and theory-rich environment.
- Forge stronger partnerships with schools in the joint exploration and creation of new forms of practice.
- Adopt collaborative forms of learning and conceptualise teacher education as a continuum.

RATIONALE

Primary science in the UK

Concerns have been raised that Science and Technology has become less of a priority in schools in England, Wales and Scotland, with too little teaching time set aside for this area of the curriculum (CBI 2015). The report (p.15) states that 'half of those surveyed said that science had become less of a priority at primary school over the last five years... science is being "squeezed out with numeracy and literacy pressures". The Welcome Trust's State of the Nation Report of UK Primary Science Education (2017) examined leadership and management of science, the delivery of science, and teachers' confidence in teaching science.

LEADERSHIP

- 51% of science leaders get specific release time to lead science.
- 30% of schools' senior leadership teams think science is very important (83% for English and 84% for Mathematics).
- 60% of schools report that science is included in their school development plan.

DELIVERY

- 75% of schools deliver science lessons on a weekly basis to all year groups.
- On average science is taught weekly for an average of 1.4 hours, with lower year groups receiving less than older groups.
- 65% of teachers agree or strongly agree that they feel supported by their school to teach science.

CONFIDENCE

- 79% of teachers agree or strongly agree that they feel confident in teaching science.
- Schools where there is a science leader are more likely to have confident teachers.

Ofsted (2019) identified weaknesses in science provision in comparison to English and mathematics. *'Science has clearly been downgraded in some primary schools.'*

Primary science in Northern Ireland

In Northern Ireland there are also concerns about the profile of science and technology within the primary school curriculum. The merging of Science and Technology with History and Geography under the Area of Learning called 'The World Around Us' has been reported (Johnson, 2013) to have reduced its profile in the primary school, with '90% of teachers spending less time teaching science than four years ago [prior to curricular reform], and over 50% saying it had decreased substantially, leading to a reduction in science content and topics being taught" (p.9).

The Education and Training Inspectorate's survey (2015) of science and technology provision within the 'World Around Us' considered that Science and Technology was underdeveloped in 54% of schools sampled and that 'provision focussed on low-level factual learning within isolated topics and lacked purposeful investigative experiences for children' (p.37). The most alarming statistic was that 28% of teachers sampled in NI did not feel confident teaching Science and Technology (ETI 2015), in contrast to only 5% for History and 4% for Geography. The report highlights the lack of professional development for teachers in science and technology and the focus on Numeracy and Literacy as contributing factors. The report's recommendations refer to all science education stakeholders bar initial teacher education institutions. Parry et al's (2019) recent article 'Where has all the science gone?' also proposes.

RATIONALE

Student teachers' experience and confidence in teaching science

A recent survey (Lowry, 2017) of final year undergraduate student teachers within an ITE institution in Belfast found that they lack experience and confidence in teaching primary science. Of the 66 students surveyed two thirds had taught less than 6 science lessons throughout the four years of their B.Ed degree and 11% of the students had never any taught science. The factors which restricted the amount of science taught were personal confidence in their ability and the direction from the host teacher. The most frequently cited means by which student teachers felt their confidence could be increased was the opportunity to observe science lessons other than during placement (70%), the opportunity to teach science lessons other than during placement (55%), and having more time within the ITE programme for primary science (60%). There therefore seems to be an appetite amongst student teachers to experience primary science beyond the context of their annual school placement. In addition to overcoming the challenge of finding space for science in an already busy school day, the opportunities to teach science outside of school placement may encourage students to take risks and opt for more pupil-centred hands-on practical activities.

Any decline in the quantity and quality of science being taught in primary classrooms will in turn impact negatively on the quality of future teachers given that school experience is a key component of all initial teacher education programmes. The shift towards school-based models of initial teacher education may magnify the problem. If pre-service teachers' experience of science during school placement is quite limited then their own current and future science practice is in turn likely to be undeveloped. A possible 'cycle of decline' (Figure 1.) could therefore result as future teachers experience less and less science during their training. A similar 'Catch-22' scenario relating to science education in Australia has been described by Kenny (2010), where in-service teachers lacking in confidence are less likely to model best practice for observing pre-service teachers let alone encourage or support them to teach science during their placements. It is therefore vitally important that initial teacher education institutions strive to break this potentially reductive cycle by providing on-campus learning activities which encourage and support pre-service teachers through their early attempts at teaching primary science.

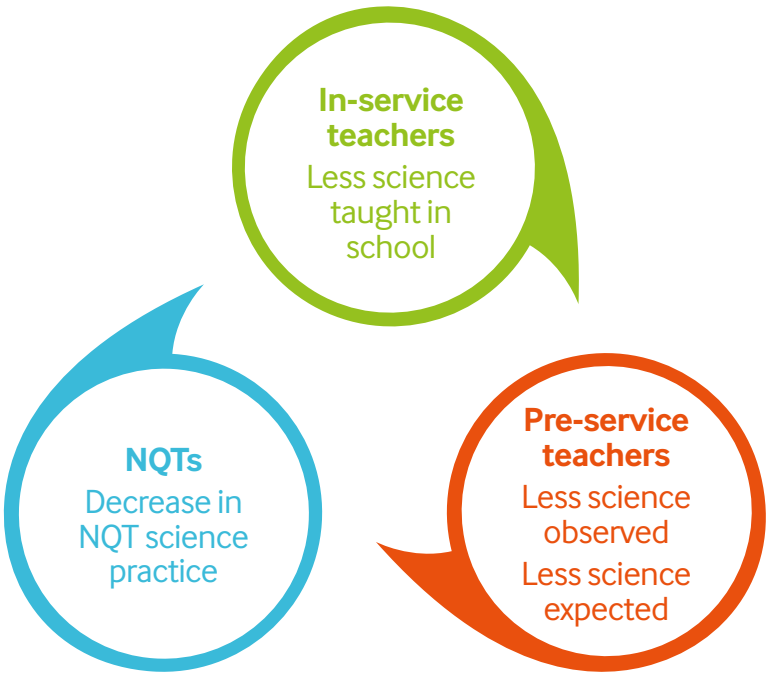

Figure 1. The potentially disastrous 'cycle of decline' for primary science.

RATIONALE

Making time for science

The starting point for producing teachers and future subject leaders of quality is initial teacher education. However as the prescription of what should be included within an initial teacher education programme continues to grow, the time and capacity for primary science can be marginalised; mirroring the decline of science in primary schools. In recent years we have noticed a decrease in the number of in-coming students choosing primary science as their subject specialism within the B.Ed course, possibly reflecting a perception that science is a less important area of the curriculum. We therefore sought a means by which the profile of primary science could be enhanced across the whole College, so that more students might engage with it during the course of their four years at the College and hopefully be more inclined to teach science during their placements in school and in their future practice. It was also our aim to promote a culture of sharing and exchanging ideas and resources relating to the teaching of primary science. Our 'Stranmillis Primary Science Accreditation' (SPSA) scheme was inspired by the PSTT's 'Primary Science Teacher College' and aims to recognise and promote excellence amongst student teachers. The accreditation scheme requires our students to actively promote primary science and engage with a range of activities which demonstrate their commitment to developing the practice of themselves and others.

DEGREE ENHANCEMENT ACCREDITATION SCHEME

Aims of the accreditation

A central feature of our curriculum development and research is the involvement of pre-service teachers. Our projects initially involved only student teachers specialising in science. As this proved to be effective with respect to both ITE and CPD we sought a mechanism whereby we could provide opportunities for all pre-service teachers to become involved. This way we could impact on the practice of more pre-service teachers and a greater number of schools.

In adopting this approach we aim to:

- Support in-service teachers' professional development by bringing innovative pedagogies into schools and classrooms, for example through coteaching, placement projects and dissemination events.
- Enhance the profile of science education within initial teacher education programmes and inspire and empower the next generation of primary educators.
- Establish a culture among student teachers of peer dissemination of best practice and create a structure and mechanism for enhancing student agency and professionalism.
- Establish a blueprint for use by other similar academic collaborators or any initial teacher education institution.

The SPSA should serve as a 'Community of Practice' for student teachers with respect to primary science and establish mind-sets and dispositions to professional development which hopefully will be sustained throughout their professional careers. The SPSA aims to nurture the skills and professional qualities of future subject leaders in science.

DEGREE ENHANCEMENT ACCREDITATION SCHEME

Accreditation criteria

To maximise engagement across all year groups and to ensure progression and continuity the accreditation is available at two levels, Silver (B.Ed Years 1 and 2) and Gold (B.Ed Years 3 and 4)

SILVER ACCREDITATION

To become an accredited member of the SPSA at Silver Level students are required to submit a portfolio of evidence containing all of the following:

1. Evidence of excellent classroom teaching in primary science throughout the course of a project or school placement- (to include lesson plans/ notes, units of work, teaching resources, and examples of pupils' work). A minimum of five lessons is required.

2. Evidence of having taken part in a peer dissemination event such as the annual science student conference or a presentation seminar within the B.Ed programme. This may take the form of photographs or the programme for the event.

GOLD ACCREDITATION

To become an accredited member of the SPSA at Gold Level students are required to submit a portfolio of evidence which meets the criteria for Silver and also contains the following:

3. Evidence of having contributed to the development of primary science outside the College, for example contribute to staff development in a school, organise an after-school science club or science education event. This takes the form of a short 'Impact on Practice' report completed by the partner school.

4. Evidence of having engaged critically with research or policy regarding science education, eg, essays or reflective accounts of practice (Minimum word count 500 words.)

DEGREE ENHANCEMENT ACCREDITATION SCHEME

Accreditation activity

TEACHING

The science lessons may relate to:

- Classroom teaching during annual school placement. (This encourages and provides a further incentive for pre-service teachers to teach science during school placement. The lessons can be related within a topic or be stand-alone.)
- Lessons taught within a science specialist module or curriculum development project. (Science specialist modules involve a placement in a partner school where pre-service teachers co-teach in pairs or with in-service teachers to develop and evaluate a particular form of science teaching or resource, such as 'Playful Approaches To Science', Teacher Assessment in Primary Science-TAPSNI; 'Digital Enquiry in Primary Science', developing reflective practice in science teaching.)
- An after-school Science or STEM club. (This can take place over lunch or after school and involve pupils across all year groups.)
- Working with pupils in preparation for a science competition, event or school display. (eg, RDS Science Blast; RSC funded 'Chemistry of the elements' workshop.)

PEER DISSEMINATION

This can take the form of a formal presentation or a display to peers describing and evaluating recent science practice. The presentation may be part of a taught module or within a bespoken science sharing seminar. Responding to questions and discussion is also encouraged.

IMPACT ON SCHOOLS

To fulfil this criteria pre-service teachers must submit a document, completed by the host school, which describes the science activity within the school and evidences the impact and influence the work will have on the science practice within the school.

ENGAGEMENT WITH THEORY AND POLICY

This is a written reflective account that evidences the pre-service teacher's ability to contextualise their practice within current science education policy and demonstrates how their understanding of practice is informed and guided by theory.

DEGREE ENHANCEMENT ACCREDITATION SCHEME

The Stranmillis Primary Science Accreditation (SPSA) conference

Each year all pre-service teachers are invited to contribute to or attend a primary science education conference in Stranmillis. The conference consists of a series of short presentations by pre-service students on a range of topics and a keynote talk delivered by a recent graduate who is now leading science in their school. The conference also includes a display of pre-service teachers' work and interactive demonstrations.

Nurturing future subject leaders

The criteria for accreditation is informed by the qualities and skills desirable in a future subject leader. In fulfilling these pre-service teachers develop their capacity in each area as shown in Table 1 below.

Effective leadership requires:	Pre-service teacher activity
Followership	Aspiring to be role models
Vision	A focus on 'next' rather than current practice (Department of Education 2016, p.8)
Communication	Good communication skills
Professional Learning	Engagement with research and policy Positive disposition to growth
Collaboration	Interaction with a range of stakeholders
Organisation	Curriculum mapping
Monitoring and Evaluation	Reflection on teaching and learning Observations and Assessment

Table 1. How the qualities of a subject leader relate to accreditation activities.

The CBI's (2015) 'Tomorrow's World; Inspiring Primary Scientists', report includes as a key recommendation that primary schools should ensure that professional development for science is of a high standard and that all schools should have a subject leader for science in place to drive a continual focus on the subject. The 'State of the Nation Report' found that the having a science subject leader enhanced the school's science provision. Lawrence (2011) points out that new subject leaders may have had few opportunities during their initial teacher training or early professional career to observe and learn from good practice in primary science teaching and leadership and cautions that subject leadership training can be limited to generic courses which do not address the subject and pedagogical knowledge needed to support colleagues. The published vision for teacher professional development in Northern Ireland, 'Learning Leaders: A strategy for professional development' (Department of Education, 2015), identifies 'building Leadership Capacity' (p.5) as one of its key areas and includes, as one of its 12 policy commitments, that 'leadership skills will form an integral part of all competence development from ITE and throughout a teacher's career.' The skills and competences required of a subject leader (summarised in Figure 2) are addressed within the criteria of the accreditation scheme.

DEGREE ENHANCEMENT ACCREDITATION SCHEME

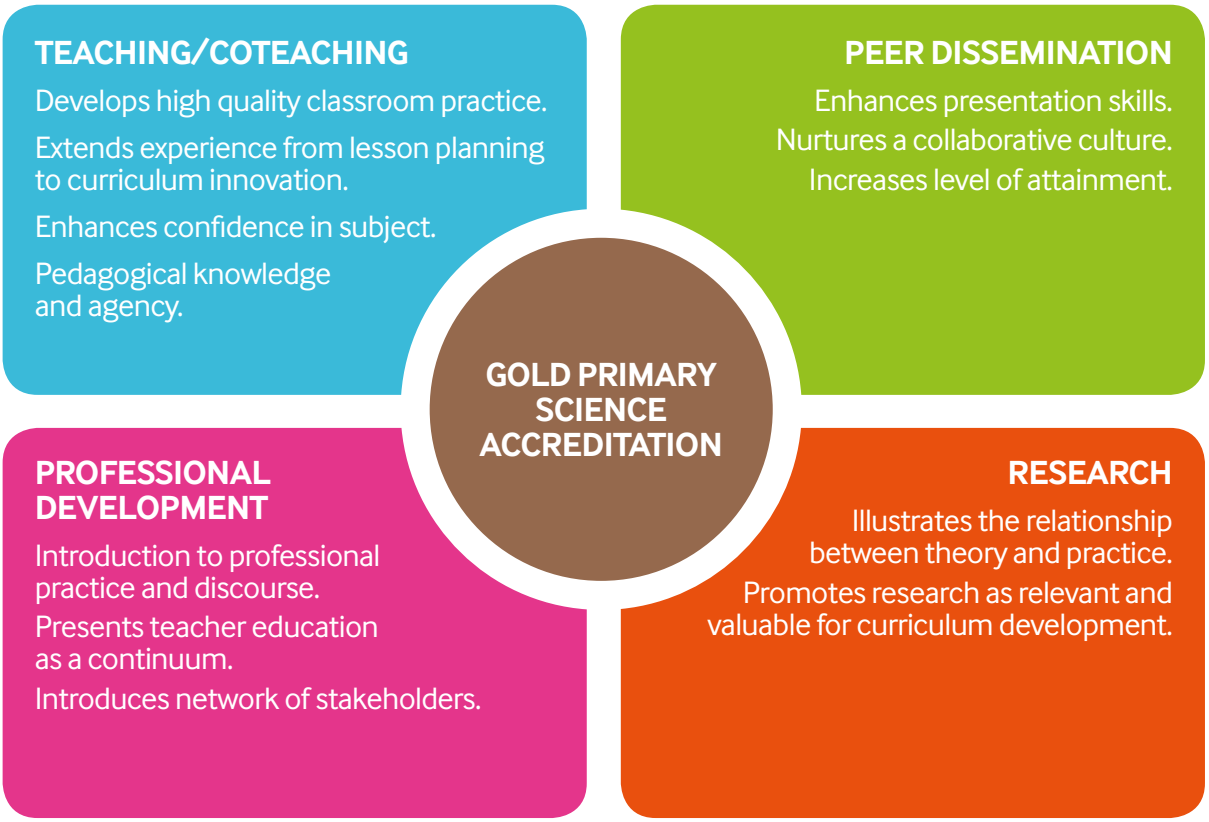

Figure 2. The strands of accreditation nurture future leadership potential.

Early career exposure to leadership can be advantageous. Roden (2003) showed how pairing newly qualified teachers with science subject leaders significantly enhanced the science practice across a number of primary schools. She argues that combining the NQT's fresh knowledge of the science curriculum with an experienced curriculum planner is beneficial to the school, the pupils, and the NQT themselves. We propose extrapolating this approach back to the initial stage of teacher education. Being a subject leader requires a positive disposition to change and growth. Knight (2013) points out that from the very beginning of their teacher education courses students are more receptive and positively disposed to exploring the relationship between practice and theory than is generally believed. Initial teacher education should ensure that the future leaders of science education possess the necessary skills and competences to become critical and reflective exchangers of best practice and curriculum innovation. The programme should include opportunities for student teachers to develop an appreciation of the value of collaboration and ensure that they have sufficient confidence and sense of agency to inform their own and other's practice. All subject leaders should possess a deep belief that change is possible and a lived experience of having played an active role in bringing it about. This may be a big ask, especially during the early years of a teaching career, but to miss this opportunity during the formative years of a teacher's career makes little sense.

DEGREE ENHANCEMENT ACCREDITATION SCHEME

Research related practice

Perceived 'gaps' between theory and practice (Korthagen, 2010) and insufficient continuity between student teachers' learning experiences on campus and in the school setting, have been the subject of much discussion within initial teacher education literature. The importance of attending to this possible learning dichotomy is given added significance by the recent growth of school-based models of initial teacher education. As Donaldson (2014) cautions, more time in school doesn't necessarily result in better teaching. The Carter review and international evidence (Sahlberg et al., 2014) take the view that in high quality initial teacher education programmes 'theory and research need to be seamlessly linked with practice'(Carter,2015,p.28). The British Educational Research Association (BERA, p.3) highlights the importance of inducing their teachers 'in the use, assessment and application of research findings and that schools should be research-rich environments'... with 'relevant research embedded at every level.' Engaging with practice related research also shifts students' thinking about learning to teach and, as Korthagen et al.(2006) put it ,'requires a view of knowledge as a subject to be created rather than as a created subject' (p1027). Providing all students with school placements where a thorough examination of the interplay between theory and practice can be facilitated and supported is not always possible given the large number of students and the decrease in the number of schools willing to accommodate student teachers during placement (Hurd, 2008). In addition there is the concern that the placement setting may not expose the student teacher to best practice (Santagata, 2007). Through their participation in curriculum development projects from within the theory rich environment of an initial teacher education programme, our students' understanding and appreciation of the importance of research is extended. By setting theory-related research within practice, students may be less likely to consider the college-based theory driven components of the initial teacher ITE programme to be less valuable than the practice-led placements (Hobson, et al.,). Student teachers should be better placed to appreciate how research can not only help explain the present, but should inform and shape the future.

These experiences can provide our students with the theoretical grounding as well as the skills, agency and disposition to develop and lead new practice in their future careers. The Teacher Training Agency (1998,p.6) states that 'subject leaders should have knowledge and understanding of how evidence from relevant research and inspection evidence and local, national and international standards of achievement in the subject, can be used to inform expectations, targets and teaching approaches.' Our dual roles of initial teacher educators and working in collaboration with the Primary Science Teaching Trust have enabled us to adopt a research-led approach to our pedagogy which can inform the practice of our students and potential future subject leaders.

Within their portfolio of evidence our students must demonstrate that they have critically engaged with theory within their practice, particularly their evaluations and reflections, and show an awareness of how theory is situated and rooted within their teaching. During their annual school placement our students spend the majority of their time teaching numeracy and literacy and therefore have only limited opportunities to teach science. In addition to reducing the quality of pupils' learning experiences, limited time for science during school placement can significantly compromise student teachers' capacity to explore the links between theory and practice. For example when adopting an enquiry-based approach to learning it is important to spend sufficient time to explore pupils' ideas and provide opportunities which may challenge and test their thinking and plan activities which encourage and support pupils in discussing their ideas and emergent theories. In addition to developing the student teachers' general teaching skills, this additional time for science enables the students to fully appreciate the merits and dynamics of pupil-centred pedagogy and engage with learning theory such as social constructivism. Through curriculum development projects or self-initiated work with a partner school, our students can plan new or modified approaches in line with a particular resource or their emergent ideas based on theory or policy. Through the analysis of nascent practice our students can be more critical and honest in their evaluation than when following a host school's particular scheme during placement. Rather than always attempting to repeat and emulate the practice of others, they now have the opportunity to begin to explore and develop their own approaches. However exploring new approaches involves taking risks. As school placement is very much driven by assessment students will often stick with a 'safe' lesson and be disinclined to teach outside their comfort zone. We must therefore look beyond the traditional form of school placement if we are to truly provide our students and future leaders with the opportunity to examine current theory and policy and challenge them to try and enact it in their practice.

DEGREE ENHANCEMENT ACCREDITATION SCHEME

Impact on pre-service teachers

Feedback indicates that the programme greatly enhances the quality of participants' science practice and their confidence and enthusiasm for teaching science. Many graduates go on to lead science in primary schools and continue to collaborate with Stranmillis by supporting curriculum development projects or as guest speakers within taught science education modules.

Thematic analysis of feedback from pre-service teachers identified the following:

- The accreditation programme enhances confidence in teaching primary science.
- As a result of the accreditation programme pre-service teachers teach more science during school placement.

> **"During my recent placement I taught more science than ever and included more practical activities. This was because I felt more confident and could manage everything better."**

- The additional experience of primary science increases the quality of science teaching

> **"My tutor commended me on my science lessons. I was able to teach a full investigation during the tutor's visit and felt in control. The positive report really gave me a boost."**

- Getting ideas and hearing about other pre-service teachers' experiences at the conference was very beneficial.
- Displaying their work and explaining it to peers enhanced pre-service teachers' professional identity.

> **"I was really thrilled that so many other students felt interested in my work and thought it was good. The positive feedback made me feel I had something to offer as well."**

DEGREE ENHANCEMENT ACCREDITATION SCHEME

Impact on schools

All partner schools report that the pre-service teachers make a significant impact on their science provision. This takes the form of:

- New ideas for science lessons.
- Lesson plans and units of work for science topics.
- Support for science activities which the teacher may not have felt sufficiently confident to carry out.
- Experience of the latest science education resources such as data-loggers, easi-scopes, electricity kits.
- Enthusiasm and passion for primary science.

Sample feedback from the vice-principal of a large primary school in south Belfast.

1. How has working with the Stranmillis students developed science in your school?

- Allowed us to refocus our attention on the more investigative/practical elements of science.
- Stranmillis Students come with a passion, subject specific knowledge which they share with the class teacher and pupils – reignites interest and motivates our staff.
- Teachers get to see a subject area being taught with fresh eyes and a different perspective.
- The activities trialled within a given class are then modelled by the class teacher to the other teachers in their year group – sharing of good practice and capacity building, cascading of skills and knowledge amongst staff.
- Termly and half termly planners are being revised to include these activities – redressing the balance of science within the WAU.

2. What do you consider the benefits of teacher training institutions and schools working on curriculum development together?

Benefits are:

- Much more collaborative approach – both parties are very much in touch with each other, positively impacting on shaping the practice of what the other does – everyone has a vested interest which is why it has been such a success.
- Win - win for everyone involved.
- Trainee teachers – get to share their enthusiastic, knowledge of a specific area under the direction and with the support of their mentors whilst gaining valuable experience within a classroom teaching and learning experiences within a school benefit from this expertise- empowers and inspires both adults and children 'free CPD'.
- Opportunity for team teaching: science students teaching together alongside the class teacher – safety element. Staff are more willing to engage, less inhibited or self-conscious as the 'session is being led by trainee students'.
- Delivering a curriculum that is current, relevant and evolving – kept very much in touch with technology, up to date resources.
- Science partnership – very different to the traditional hosting of students – a much more tailored set up which is very much in line with our school's development plan in addressing the school's needs and in helping us raising standards for all. Not something that has been imposed upon us like lots of initiatives or partnerships. Personally feel the way teaching practice placements should be carried out.
- Even the cycle of plan, teach and reflect – the fact that the teaching sessions are filmed to allow the students to reflect on their session with their tutors. This efficient feedback tool allows the students to recognise their strengths and areas of development – meaning that the competency and confident of the students develop very quickly – a huge benefit to the class teacher and her pupils - content/skills are taught in an effective purposeful way.

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

Initial teacher education differs from other forms of 'professional education' (Grossman et al, 2009) such as training for working in the health or social services in that pre-service teachers bring with them a lived experience of up to 14 years as a pupil, a so called 'apprenticeship of observation' (Lortie, 1975). This presents both challenges and opportunities for initial teacher educators who may only have a matter of months to challenges tacit assumptions and reconfigure thinking and conceptualisations. Therefore initial teacher education programmes must engage pre-service teachers in practices and activities which may alter and shape their interpretations of what teaching is and who teachers are. McDonald and Rook (2015: 21) describe teaching as both a culture and a cultural activity and propose that the 're-enculturation of pre-service teachers into new ways of seeing and understanding teaching practices through their close examination of teaching' (p.22) to be the ultimate goal of initial teacher education. As the pace of curriculum reform shows no sign of slowing down and developments in communication technology accelerate, the gap between the pre-service teacher's experience of how they were taught in school and the particular forms of pedagogy appropriate for the current time can only grow.

The importance of exploring pre-service teachers' values and thoughts on teaching are particularly important within science. Lowry (2017) found that three quarters of a cohort of graduating pre-service teachers agreed that their personal experience of science whilst a pupil would influence their future teaching of science. The same study reported that only half of the cohort described their experience of school science as good or better.

Activities which access and challenge pre-service teachers' understanding of the science curriculum and their role in enacting it are vitally important. Their personal and professional interpretations of the curriculum and their role as a teacher will greatly influence how much science they teach and how they teach it, for example the balance between developing subject knowledge and developing science skills. The importance placed on enquiry in primary science may be at odds with pre-service teachers most recent memories of science at GCSE or A level. ITE learning experiences must therefore enable pre-service teachers to develop their own understanding and meaning of what it is to be an effective teacher of primary science and allow for the progression and growth of their practice throughout the programme. Teaching programmes must also attend to any concerns or anxiety pre-service teachers may have regarding their subject knowledge and the classroom management of practical activities. Therefore the pedagogy of science teacher education should attend to both the cognitive and affective needs of pre-service teachers and be;

• Collaborative • Supportive • Progressive • Experiential • Motivating • Authentic

Achieving teaching excellence through coteaching

Coteaching involves student teachers and in-service teachers sharing equally in the planning, teaching and evaluation of new classroom approaches. This takes place during the course of curriculum development projects which focus on a particular aspect of pedagogy or the trialling and evaluation of a new approach or resource. The experience is quite different from the students' block placement where time for science can be restricted and students often do not get sufficient teaching time to meaningfully follow through a complete cycle of reflection for science (Jones, 2008). This form of ITE pedagogy accommodates a collaborative approach to action research and is in line with Carter's (2015) call for student teachers to develop their own teaching 'in an environment where trainees have access to the practical wisdom of experts and can engage in a process of enquiry, in an environment where they are able to trial techniques and strategies and evaluate the outcomes.'(p21.) As is often the case, the in-service teacher may also have responsibility for leading science in the school or may be a curriculum leader for another area or Key Stage. This provides the student teacher with an experience of planning and curriculum mapping way beyond what would be possible during traditional school placement. In Years 1 and 2 of their programme pre-service teachers coteach with peers. As expertise develops in Years 3 and 4 the pre-service teachers coteach with in-service teachers. Progression is also ensured by focussing on a particular aspect of curriculum development, such as 'Playful Science', or 'Teacher Assessment in Science Northern Ireland(TAPSNI) project.

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

Although there is a range of forms which coteaching may take (Murphy, 2016 ; Murphy et al., 2014), a typical pattern involves three phases; co-planning, coteaching and solo practice. During co-planning, pre and in-service teaching pairs attend a number of workshops and seminars at Stranmillis University College relating to the focus of a project, for example Playful Approaches to Science and Technology or Digital Story-telling in Enquiry-based Science. The workshops provide the co-teachers with the opportunity to discuss the new resources or approaches, explore the theory which underpin the pedagogy, and then incorporate these approaches as they put their ideas and plans into action back in the classroom. We also include a session which focuses on the practicalities of this new form of practice and how to make the most of the opportunities provided by coteaching as well as strategies to overcome any challenges this new approach may present. Co-planning allows our students to work as an equal alongside an experienced teacher and therefore builds their confidence, teacher identity and agency. We consider the creation of new practice to be an essential feature of coteaching as now both parties are equal partners embarking on a new learning journey. This provides a very different learning dynamic to the traditional school-based placement where the student is considered to be the 'novice' and expected to conform and replicate the current practices of the 'expert' host teacher. The Northern Ireland Department of Education's latest publication 'Learning Leaders: A Strategy For Teacher Professional Development' calls for a focus on 'next' as well as 'current' practice (2016, p8). Our students get first-hand experience of planning, adopting and assessing new teaching practices. We find that a synergy is created by the experience and situated knowledge of the in-service teacher and the fresh ideas and innovation of the student teacher. Teaching alongside an experienced teacher can be invaluable to the development of classroom practice. Our students feel privileged by the opportunity to simultaneously take part and evaluate a teaching episode from 'within' the lesson itself.

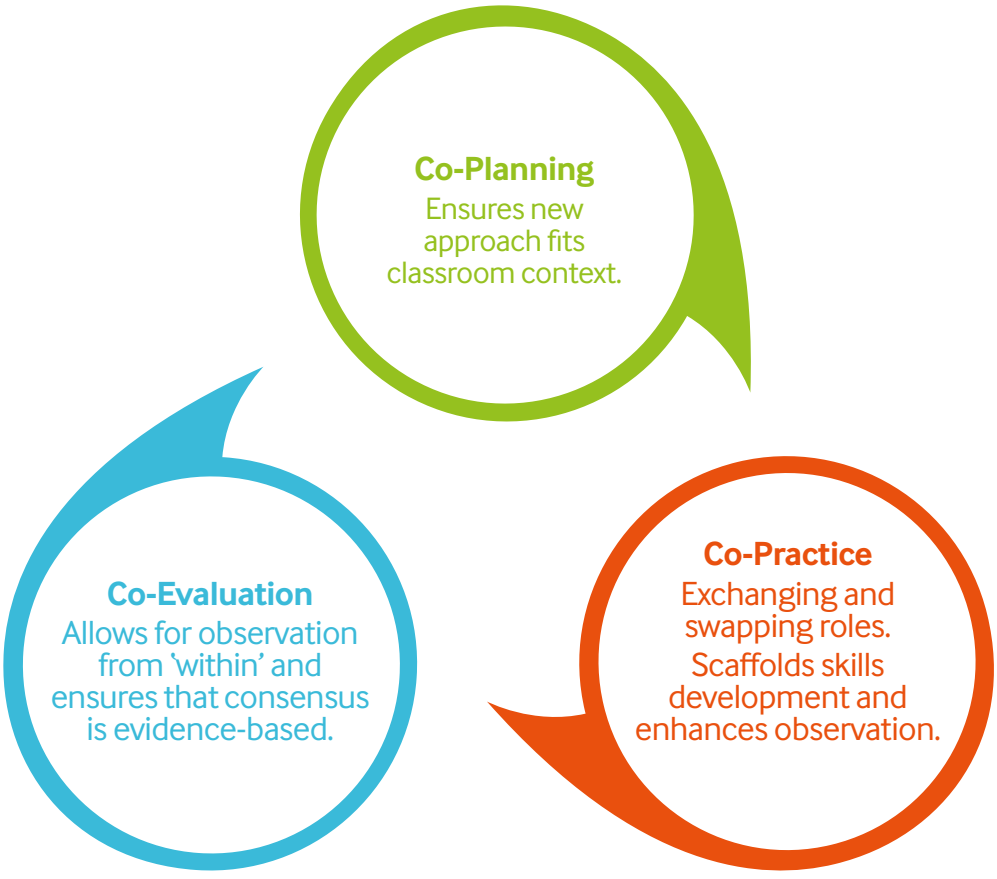

Figure 3. How coteaching enhances the practice of both participants

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

As roles are shared and swapped during the course of the lesson, both parties are better placed (physically as well as intellectually!), to evaluate the effectiveness of the curriculum innovation under study. This 'double experience' provided by coteaching extends the evaluative and critical thinking skills of our students. Learning from classroom incidents is much more profound and leads to a deeper understanding when the various incidents and scenarios have been personally experienced by both co-teachers during the classroom activity and then critically analysed during post-lesson evaluation. Judgements and emergent theories regarding the various strengths or areas for further development within an aspect of the lesson can be validated or reconfigured through this discussion.

The added meaning which coteaching brings to the task of lesson evaluation must surely go some way to developing (on the part of the student) and possibly realigning (on the part of the teacher) the practitioner's disposition to the concept of reflection. It presents reflection as manageable, valuable and powerful. We have noticed that students who have experienced coteaching usually attain higher grades during their subsequent school placements. This is particularly true for students who may have initially struggled to cope with the full demands of classroom life. They find that coteaching is much more supportive than solo practice. It also allows higher achieving students to continue to develop and refine their skills and to challenge themselves that little bit further. As one student recorded in her evaluation of coteaching 'teaching alongside my partner teacher was amazing. I could see how she was dealing with each scenario and that when I was doing the talking and the questioning the lesson was just as good. Later when we discussed the lesson she was just like me, analysing incidents and asking what I thought. I really felt we were a team exploring new ways and finding out what was working!'

We have found that coteaching between two student teachers is also very effective in developing the practice of both parties. By planning together they bring together a wider range of ideas and prior experiences which can now be explored further through discussion and possibly trialled and tested. The collaborative and cooperative approach enriches the dialogue and therefore enhances the level of critical analysis. Student-student coteaching has also much to offer the host teacher as the quality of the lessons being observed is usually richer than what might be expected from a student teacher working on their own. The host teacher can now get a real sense of what might be possible within their own classroom and therefore be more inclined to consider how they may incorporate what they have observed into their own teaching. Having a positive experience and sound understanding of coteaching would therefore be most beneficial to a future subject leader.

In the final stage of coteaching we invite both partners to try and continue this approach when they have reverted back to 'solo' practice- a period often referred to as 'the January blues', by one of our project teachers who felt bereft and vulnerable without their student partner. The final 'solo practice' phase of coteaching aims to consolidate and incorporate the new teaching approaches developed during coteaching into the individual practice of each partner. We request that our student teachers include these new approaches during the course of their annual school placement. This task can prove quite challenging as it requires adapting and transferring their practice to suit the requirements and demands of a new classroom setting. In-service teachers are required to choose an approach which they found effective during coteaching and modify it for teaching on their own or with the support of teaching assistants. Often to their surprise, the in-service teachers find going 'solo' to be easier than they had anticipated and the resultant benefit to children's learning rewards and sustains their efforts. Our in-service teachers describe this as the most effective programme of professional development they have ever experienced as it is situated within the context of their classroom and their needs, and the project activity and support from the pre-service students and the project leaders extends over a complete school year. This experience and understanding of coteaching is an ideal preparation for future subject leaders who should act as mentors and critical friends for colleagues throughout their future careers.

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

Coteaching is therefore a powerful method for simultaneously ensuring the provision of high quality ITE for pre-service teachers and effective continuous professional development for in-service teachers as summarised in Figure 4 below.

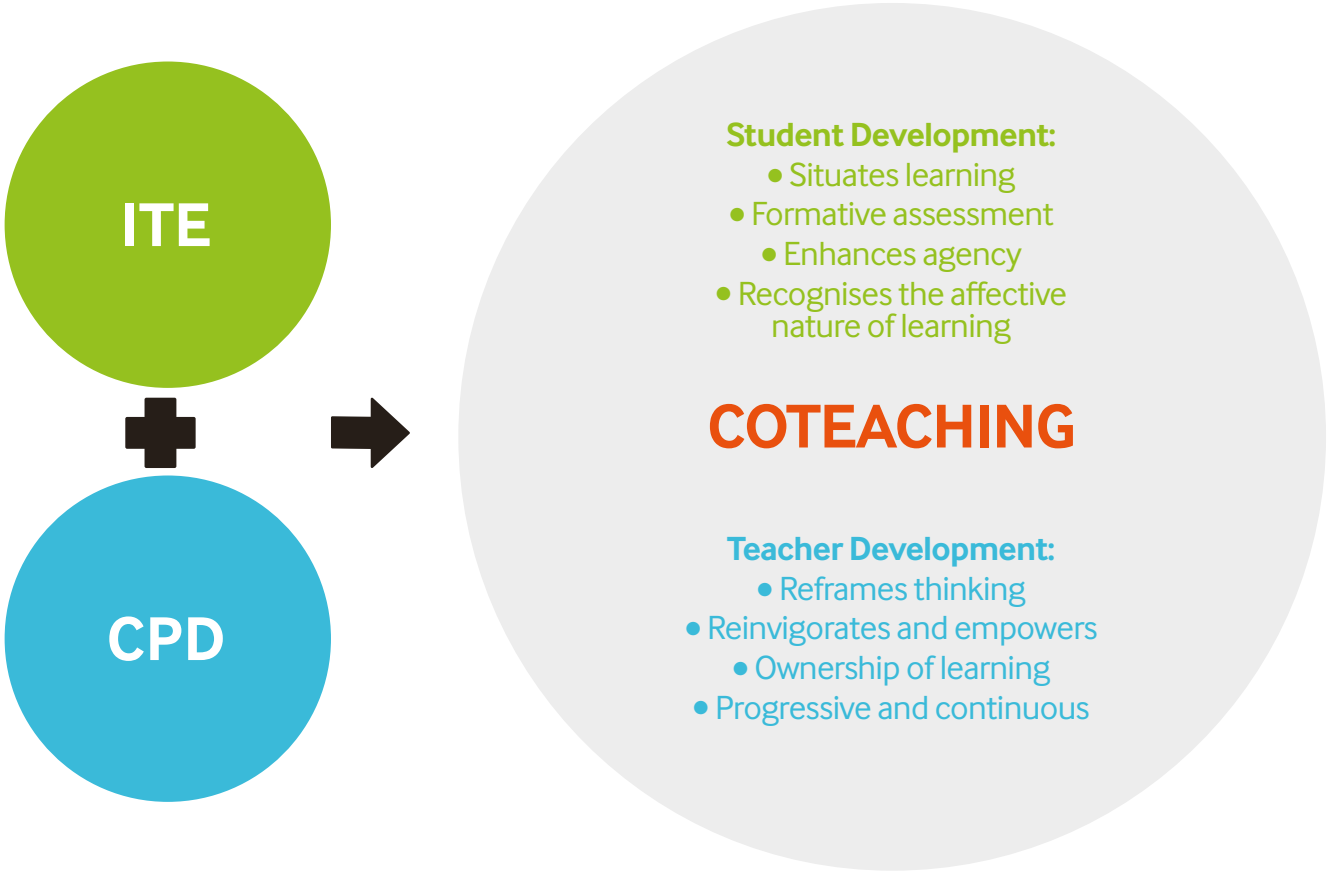

Figure 4. Coteaching as an effective pedagogy across the continuum of teacher education.

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

Microteaching in science education

WHAT IS MICROTEACHING?

Since it was first developed six decades ago, microteaching has been experienced by an entire generation of teachers and continues to be a popular activity within ITE programmes. The activity allows student teachers to make their first attempts at teaching within their ITE setting where tutors, peers and video recordings can provide feedback, guidance and support. Yalmanci & Aydin (2014:7) describe it as a practice-based activity ideal for 'nurturing them (pre-service teachers) as good teachers'. The ITE setting ensures that pupil learning isn't compromised by any poor practice and allows for tutors to be at hand to provide situated instruction and advice. It is therefore an ideal 'starter activity' for pre-service teachers, allowing them to attempt to teach short sections of a science lesson to their peers and providing feedback and encouragement from tutors and fellow learners. It's potential to development practice is not limited to novices and has been used to extend and progress the practice of more competent pre-service teachers and in-service teachers alike. Microteaching has been the subject of numerous studies and reports. The reported benefits include the progression of teaching skills, development of reflective and critical thinking and the enhancement of confidence and self-efficacy beliefs as shown in Table 2.

Reported benefits for pre-service teachers	Reference
Better planning skills	Bell(2007)
Enhanced instructional methods	Roth et al (2006)
Exploration of cause-affect dynamics of their actions	L'anson et al (2003)
Better lesson evaluation skills	Napoles (2008)
Better presentation and communication skills	Benton-Kupper (2001)
Connection of theory to practice	Fernandez & Robinson (2010)
Develop reflective thinking skills	Amobi (2005)
Critical thinking skills	Arsal (2015)
Increased Pedagogical Content Knowledge (PCK)	Bahcivan (2017)
Enhanced self-efficacy beliefs	D'Alessio (2018)
Increased confidence and motivation	Subramanian (2006)
Reduced anxiety	Peker (2009)

Table 2. The reported benefits of microteaching

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

DIGITAL MICROTEACHING

Advancements in video and digital technology enable the process of video recording to be user-friendly and unobtrusive and also allows for interacting with recordings and sharing video-based analysis. Digital microteaching therefore represents an authentic learning activity and provides for productive collaboration. Research reports that microteaching is most effective when it involves interacting with the video (McCullagh et al, 2013) either by editing the videos or adding text at particular times in the video to explain or discuss their practice. The Office 365 Streaming facility can be used to add time markers and text to video. Pre-service teachers can set up the group of peers and the tutor who they want to share their annotated video with. The annotations can identify strengths or areas of development or comment on particular classroom incidents.

An effective way to develop reflective thinking is to require pre-service teachers to explain their actions, assess their effectiveness and suggest modifications for future teaching. This analysis of practice framework is based on Amobi's (2005) work on developing reflective thinking.

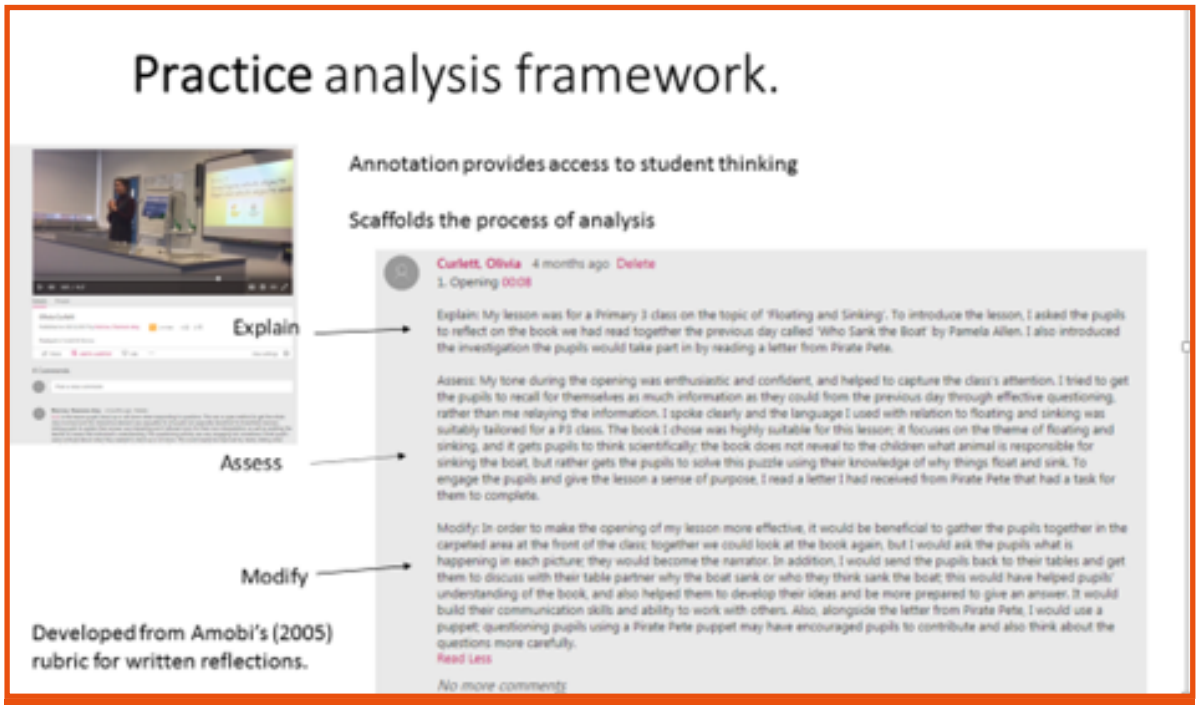

Figure 5. An analysis framework based on microteaching.

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

Pre-service teachers' ability to plan, teach and evaluate their teaching can be greatly enhanced by making the microteaching classroom focussed as shown in Figure 6.

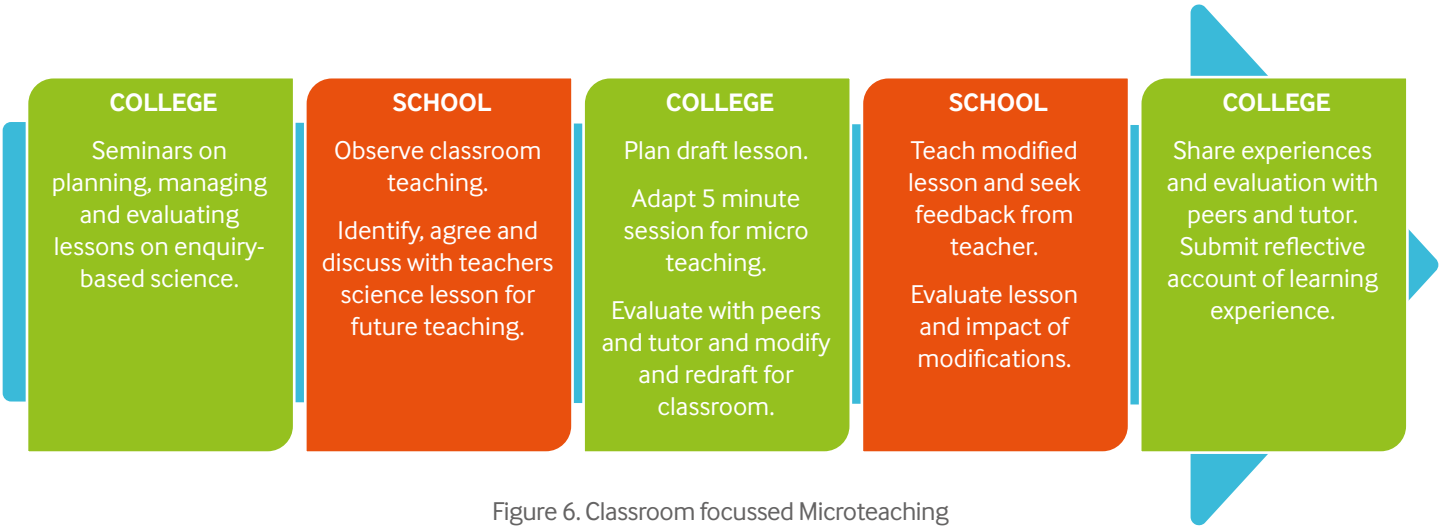

Figure 6. Classroom focussed Microteaching

From its early use as a means to develop novice's specific teaching skills within a small scale teaching setting, microteaching has become used within methods courses to try to connect aspects of theory with classroom practice (Pringle, Dawson & Adams, 2003). The transition from the theory–rich college to practice-focussed school can compromise the consistency of a pre-service teachers' learning experience particularly with respect to guidance and feedback. Based on Pultorak's (1996) work on developmental learning, Zhang and Cheng (2011: 345) devised an approach which eases and nurtures pre-service teachers into the practice of reflecting on their teaching in "a transitional learning situation, beginning in a supportive university learning situation with anticipation of implementation in schools, and then moving onto the actual classroom." Their three-phased model for practicum-based microteaching differs from other forms in that, following a microteaching session in college (phase 1), pre-service teachers go on to teach a modified version of the lesson in an actual classroom (phase 2). The third and final phase is back in college where they prepare written reflections on their overall learning based on their experience and feedback from the previous two settings.

A PEDAGOGY FOR SCIENCE INITIAL TEACHER EDUCATION

The merits of making firm connections between microteaching and school placement are evident in this short extract from a case study of this form of microteaching.

The study involved a cohort of 96 undergraduate pre-service teachers specialising in primary education. Not all pre-service teachers may have the opportunity to teach a science lesson during placement or they may feel less confident in science and therefore be less likely to choose to teach it. The project therefore sought to develop the pre-service teachers' confidence and competence in teaching science and encourage them to teach it during their forthcoming placement. During day visits to their placement schools the pre-service teachers familiarised themselves with the classes' current science scheme of work and identified a science topic for teaching later in the term. Back at college, the pre-service teachers were placed in pairs and tasked with planning a science lesson for teaching during a future day visit to the school. The microteaching task required them to choose a five minute segment of the lesson and adapt it for teaching to peers. The segment could be a part of the lesson which was considered to be potentially challenging (egg. explaining a science concept, using questions to guide pupil thinking) or an aspect of the lesson which they felt would be worth 'seeing' from the pupils' perspective (e.g. a visual demonstration of a science phenomenon or their attempts at simultaneously handling equipment and addressing the class). Following analysis of the video recording and feedback from the tutor, partner and peers, the microteaching lesson plan was redrafted to accommodate modifications and areas for development identified by the microteaching. Following the teaching of the full lesson during the next day-visit to the school, the pre-service teacher received feedback from the host teacher and drafted an evaluation of their teaching for sharing with peers and tutor when back in college.

Data from questionnaires, focus group interviews and their written reflective accounts all indicate that the pre-service teachers found the experience to have developed their skills in planning (84%), teaching (78%) and evaluating (80%) and that as a result they now felt more confident and more inclined to teach science during their placement. The advantages of aligning the microteaching with school placement were reported to be:

- The opportunity to 'rehearse the lesson' in a safe setting.
- Modifying and revising the lesson plan unearthed previously unchallenged assumptions about pupil learning.
- The provision for feedback and guidance from tutor and teacher throughout the planning process.
- Being able to see what needed to be improved and the chance to follow through and re-evaluate changes.
- Working closely with a trusted peer provided moral support, informed planning and added rigour and balance to evaluation.

Focus group interviews with 12 of the pre-service teachers carried out after they had completed their annual block placement in the same school found that the microteaching experience had continued to inform and support their overall practice. All the participants felt better prepared for placement and were much less anxious and apprehensive about teaching. The main theme from the feedback was that the placement-focussed microteaching had helped them appreciate the relatedness of teacher planning and pupil learning and enabled them to deconstruct their practice and to develop evaluation strategies.

REFERENCES

Amobi, F.A. (2005) *Preservice teachers' reflectivity on the sequence and consequences of teaching actions in a microteaching experience*, Teacher Education Quarterly, 32(1):115-130.

Arsal, Z. (2015) *The effects of microteaching on the critical thinking dispositions of pre-service teachers.* Australian Journal of Teacher Education 40(3) :140-153.

Bahçivan, E. (2017) *Implementing Microteaching Lesson Study with a Group of Preservice Science Teachers: An Encouraging Attempt of Action Research.* International Online Journal of Educational Sciences, 9(3): 591-603.

Bell, N. (2007) '*Microteaching: what is going on here?* Linguistics and Education, 18(1):24-40.

Benton-Kupper, J. (2001) *The Microteaching Experience: Student Perspectives. Education*, 121(4): 830-835.

Burn, K. and Mutton, T. (2015) *A review of 'research-informed clinical practice in Initial Teacher Education*, Oxford Review of Education, 41(2):217-233.

Carter, A. (2015) *Carter Review of Initial Teacher Training. London*: Department for Education. Available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/399957/Carter_Review.pdf (Accessed: 18 June 2019).

Confederation of British Industry, (2015) *Tomorrow's World: Inspiring Primary Scientists.* London: CBI

D'Alessio, M.A., 2018. *The Effect of Microteaching on Science Teaching Self-Efficacy Beliefs in Preservice Elementary Teachers.* Journal of Science Teacher Education, 29(6):441-467.

Darling-Hammond, L. (2010) *Teacher Education and the American Future.* Journal of Teacher Education, 61(1-2):35-47.

Department of Education (2015) *Learning Leaders: A Strategy For Teacher Professional Learning.* Bangor: Department of Education.

Education and Training Inspectorate (ETI) (2015) *An Evaluation of the Implementation of the 'World Around Us' in primary schools.* Bangor: Department of Education.

Fernandez, M.L., (2010). *Investigating how and what prospective teachers learn through microteaching lesson study.* Teaching and Teacher Education, 26(2):351-362.

Grossman, P., Compton, C., Igra, D., Ronald, M., Shahan,E., & Williamson,P. (2009) *Teaching Practice: A cross-professional perspective.* Teacher College Record,11(19):2055-2100.

Hagan, M.(2013) '*Developing Teacher competence and Professionalism in Northern Ireland: An analysis of 'Teaching: The Reflective Profession'* (GTCNI, 2007)' TEAN Journal 5 (1) February [Online]. Available at: http://bit.ly/AtMwtr (Accessed 12 June 2019).

Hiebert, J., Morris, A. K., Berk, D. & Jansen, A. (2007) *Preparing Teachers To Learn From Teaching,* Journal of Teacher Education, 58(1):47-61.

Hobson, A. and Malderez, A. (2015) '*Judgementoring and other threats to realizing the potential of school-based mentoring in teacher education*', International Journal of Mentoring and Coaching in Education, 2(2):89-108.

Irish Teaching Council (2011) *Policy on the Continuum of Teacher Education, Maynooth: The Teaching Council.* Available at www.teachingcouncil.ie/en/Publications/Teacher-Education/Policy-on-the-Continuum-of-Teacher-Education.pdf

Irish Teaching Council (2013) *Guidelines on School Placement, Maynooth: The Teaching Council.* Available at www.teachingcouncil.ie/en/Publications/Teacher-Education/Guidelines-for-School-Placement-.pdf

Johnson, A. (2013) *Is Science lost in the 'World Around Us'?*Primary Science, 126:8-10.

Kenny, J. (2010) '*Preparing Pre-Service Primary Teachers to Teach Primary Science: A partnership-based approach'*, International Journal of Science Education, 32(10): 1267-1288.

Korthagen, F. A. J., Kessels, J., Koster, B., Lagerwerf, B. & Wubbels, T. (2001) *Linking practice and theory: the pedagogy of realistic teacher education.* Mahwah, NJ: Lawrence Erlbaum Associates.

REFERENCES

Korthagen, F., Loughran, J., & Russell, T. (2006) *Developing fundamental principles for teacher education programs and practice.* Teaching and Teacher Education, 22: 1020-1041.

L'Anson, J., Rodrigues, S. and Wilson, G. (2003) *'Mirrors, reflections and refractions: the contribution of microteaching to reflective practice',* European Journal of Teacher Education, 26(2):189-199.

Lawrence, L. (2011) The Science Subject Leader (pp. 133-140) in Harlen,W. (Eds) *ASE Guide to Primary Science Education*, New Edition. Hertfordshire: Association for Science Education.

Lortie, D. (1975) *Schoolteacher: A sociological study. Chicago Il.* University of Chicago Press.

Lowry, C. (2017) *An Investigation into the attitudes and confidence levels of prospective teachers in delivering science in the primary classroom.* Undergraduate Dissertation. Belfast: Stranmillis University College.

McCullagh, J.F., Bell, I., Corscadden, F. (2013) '*How does video analysis support student teachers in the very early stages of their initial teacher education?,* TEAN Journal 5(3):38- 51.

McDonald, S. & Rook, M. (2015) '*Digital Video Analysis to Support The Development of Professional Pedagogical Vision'* in Calandra,B. & Rich, P.J (Eds) Digital Video for Teacher Education. New York: Routledge.

Menter, I. (2016) '*What is a teacher in the 21st century and what does a 21st century teacher need to know?'* Acta Didactica Norge, 10(2):11-25.

Murphy,C. (2016) *Coteaching inTeacher Education.* Plymouth: Critical Publishing.

Murray, J., Czerniawski, G. and Barber, P. (2011) *'Teacher Educators' identities and work in England at the beginning of the twenty first century',* Journal of Education for Teaching: International research and pedagogy, 37(3):261-277.

Napoles, J. (2008) *'Relationships among instructor, peer, and self-evaluations of undergraduate music education majors' microteaching experiences',* Journal of Research in Music Education, 56(1) :82-91.

Parry, S., Britten,E., & Allen, M. (2019) *Where has all the science gone?* Primary science, 157:14-16

Peker, M. (2009) *The use of expanded microteaching for reducing pre-service teachers' teaching anxiety about mathematics.* Scientific Research and Essay 4(9):872-880.

Philpott, C. (2014) *'A pedagogy for teacher education in England',* Teacher Education Advancement Network Journal, 6(3) Special Issue 2:4-16.

Pringle, R.M., Dawson, K. and Adams, T. (2003) *Technology, science and preservice teachers: Creating a culture of technology-savvy elementary teachers.* Action in Teacher Education, 24(4):46-52.

Pultorak, E.G.(1996) *Followling the Developmental Process of Reflection in Novice Teachers: Three Years of Investigation.* Journal of Teacher Education, 47(4):283-291.

Roden, J (2003) *Bridging the gap: The role of the science coordinator in improving the induction and professional growth of newly qualified teachers.* Journal of In-Service Education 29.2 (2003): 201-220.

Sahlberg, P., Broadfoot,P., Coolahan,J., Furlong,J. and Kirk,G. (2014)*Aspiring to Excellence:Final Report of the International Review Panel on the Structure of Initial Teacher Education in Northern Ireland.* Belfast: Department for Employment and Learning. Available at https://dera.ioe.ac.uk/20454/1/aspiring-to-excellence-review-panel-final-report.pdf

Schon,D. A., (1983) *The reflective practitioner: How professionals think in action:* New York: Basic Books.

Subramaniam, K. (2006) *Creating a microteaching evaluation form: The needed evaluation criteria.* Education, 126 (4): 666-667

Tatto, M.T. and Furlong, J. (2015) *'Research and teacher education: papers from the BERA-RSA Inquiry',* Oxford Review of Education, 41(2):145-153.

Wellcome Trust (2017) *State of the Nation Report of UK Primary Science Education Leicester:* CFE Research.

Zhang, S. and Cheng, Q., 2011. *Learning to teach through a practicum-based microteaching model.* Action in Teacher Education, 33(4):343-358.

STRANMILLIS UNIVERSITY COLLEGE
A College of Queen's University Belfast

why & how?
PRIMARY SCIENCE TEACHING TRUST

Accreditation of pre-Service teachers' innovative practice in primary science

Guide for initial teacher educators

Dr John McCullagh & Dr Andrea Doherty
Stranmillis University College Belfast

Accreditation of pre-Service teachers' innovative practice in primary science

Guide for initial teacher educators

Stranmillis College in Belfast have developed their Stranmillis Primary Science Accreditation programme to recognise pre-service teachers' innovative practice in primary science. The intention of this guide is to support other initial teacher education providers to develop similar initiatives in their own settings. The guide explains the rationale for the accreditation programme and outlines how to implement it.

Primary science accreditation in initial teacher education

A Primary Science Accreditation programme aims to serve as a 'Community of Practice' for student teachers with respect to primary science and establish mind-sets and dispositions to professional development which will be sustained throughout their professional careers. The programme encourages student teachers to develop their science teaching skills and engage in professional development activity. It enhances their professional profile and future employability.

Nurturing future science leaders

New subject leaders may have had few opportunities during their initial teacher training or early professional career to observe and learn from good practice in primary science teaching and leadership. Being a subject leader requires a positive disposition to change and growth. Initial teacher education should ensure that the future leaders of science education possess the necessary skills and competences to become critical and reflective exchangers of best practice and curriculum innovation. An accreditation scheme should provide opportunities for student teachers to develop an appreciation of the value of collaboration and ensure that they have sufficient confidence and sense of agency to inform their own and others' practice. All subject leaders should possess a deep belief that change is possible and a lived experience of having played an active role in bringing it about.

Stranmillis have also produced a full report about the development of this accreditation programme and the research initiatives that underpin it; this report can be accessed here

The research and development underpinning this work was supported by funding from The Primary Science Teaching Trust.

why & how? PRIMARY SCIENCE TEACHING TRUST

STRANMILLIS UNIVERSITY COLLEGE
A College of Queen's University Belfast

Why have an accreditation programme for pre-service teachers?

Various reports indicate that the profile of science and technology in primary schools has decreased in recent years. As with what is happening in the primary school curriculum, science can seem squeezed within an already crowded initial teacher education programme. Insufficient time and resources for developing pre-service teachers' confidence and competence in teaching primary science may significantly compromise the quality of science provision in our schools. This situation is exacerbated by the fact that often pre-service teachers have limited opportunities to teach, or even observe, science lessons during placement. One way to overcome this is to provide pre-service teachers with the opportunity to teach or support primary science within primary schools in addition to their annual school placement.

At Stranmillis University College (SUC) we have developed the 'Stranmillis Primary Science Accreditation', within the University College's degree enhancement programme. The skills and experiences gained through the course of the accreditation are designed to develop student teachers' sense of efficacy and agency and provide opportunities for them to network with schools in their community. The scheme requires pre-service teachers to teach science in primary schools and to present and share their work with their peers, schools and other educational stakeholders. These presentations take place during seminars and at an annual student-led primary science conference at SUC. As well as going some way to enhancing the current quality of science education, the scheme aims to nurture the potential science leaders of the future.

How does the Stranmillis accreditation programme work?

To achieve accreditation students are required to submit a portfolio of evidence which demonstrates their excellent classroom teaching and their involvement in professional development seminars either in a partner school with in-service teachers, or on the university college campus. The accreditation scheme is offered to all years of the B.Ed primary and post-primary programme and our PGCE course. In order to encourage as many students as possible to participate and to provide progression the accreditation is offered at two levels, Silver and Gold. For accreditation at Silver level a student's portfolio must evidence

- Excellent classroom teaching in teaching primary science
- Engagement in peer dissemination (which may take place within a science module or at a science sharing seminar in the university).

For accreditation at Gold level students must meet the criteria for Silver and in addition provide evidence of

- Contributing to the development of science provision in a school through sharing their work with in-service teachers.
- Engagement with science education theory and policy through written assignments or critical evaluations of practice.

Silver Level

A portfolio containing the evidence of the following:

1. Excellent classroom teaching in primary science throughout the course of a project or school placement (to include lesson plans/ notes, units of work, teaching resources, and examples of pupils' work). Teaching a minimum of five lessons is required.
2. Taking part in a peer dissemination event such as an annual science student conference or a presentation seminar within your university programme.

Gold Level

A portfolio containing evidence of the following:

1. Excellent classroom teaching in primary science throughout the course of a project or school placement (to include lesson plans/ notes, units of work, teaching resources, and examples of pupils' work). Teaching a minimum of five lessons is required.
2. Taking part in a peer dissemination event such as an annual science student conference or a presentation seminar within your university programme.
3. Contributing to the development of primary science outside the university, for example contributed to staff development in a school, an after-school science club or a science education event.
4. Critical engagment with research or policy regarding science education, e.g. essays or reflective accounts of practice.

Nurturing future subject leaders

TEACHING/COTEACHING

Develops high quality classroom practice.

Extends experience from lesson planning to curriculum innovation.

Enhances confidence in subject.

Pedagogical knowledge and agency.

PEER DISSEMINATION

Enhances presentation skills.

Nurtures a collaborative culture.

Increases level of attainment.

GOLD PRIMARY SCIENCE ACCREDITATION

PROFESSIONAL DEVELOPMENT

Introduction to professional practice and discourse.

Presents teacher education as a continuum.

Introduces network of stakeholders.

RESEARCH

Illustrates the relationship between theory and practice.

Promotes research as relevant and valuable for curriculum development.

Suggested activities and how these meet the accreditation criteria.

ACTIVITY	ACCREDITATION CRITERIA
Teaching Science and Technology on placement (Planning, teaching, evaluating).	Excellence in Teaching Engagement with research
Curriculum development projects	Excellence in Teaching Engagement with research Peer Dissemination Professional development
Afterschool Science and STEM clubs	Excellence in Teaching Professional development
Student Conference and Project Dissemination Events	Peer Dissemination Engagement with research
RDS Science Fairs, ASE workshops, PSTT International Conference	Engagement with research Peer Dissemination Professional development

The principal event in the Stranmillis SPSA calendar is the annual conference. Students are invited to submit an abstract outlining a short presentation, a poster or a display of resources. All students, tutors and science education stakeholders and local teachers and science leaders are invited to the event. Students' abstracts, along with the programme, are posted on the College website so that students can use it as evidence of participation in their own CVs.