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Using an Innovative Model of Professional Development in Primary Science to Develop Small Irish Rural Schools as Professional Learning Communities

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Abstract

This paper attempts to track and appraise the progress 15 small rural primary schools and their participant teachers made over the two years of a professional development programme in primary science education in the West of Ireland. It focuses specifically on two main areas: (1) breaking down the insulation and isolation that many teachers experience in their day-to-day professional lives and (2) developing "learning communities" between the participating teachers. It also provides a commentary on the issues arising.

Keywords: Meaningful collaboration, Reflective practice, Teacher networks, Professional learning community

1. Introduction

The work shown here describes a professional development programme in primary science for teachers from small rural schools in the West of Ireland. The programme had five main aims: enhancing teachers science content knowledge and pedagogical knowledge; teachers developing positive attitudes towards teaching science; pupils developing positive attitudes towards learning science; breaking-down the insulation and isolation that teachers experience in their day-to-day professional lives; and developing 'learning communities' between the participating teachers.

The current article is concerned with the fourth and fifth aims above and focuses specifically on three key developments of the programme: meaningful collaboration, cultivating reflective practice and promoting teacher networks. According to the Organisation of Economic Co-operation and Development (2003) teacher isolation has been one of the more stable factors in Irish schools, this is particularly the case for those teaching in small schools in rural areas. Rural isolation restricts opportunities for professional contacts with colleagues and can result in limited participation in professional development programmes (Baker & Ambrose, 1985). The programme designed for this study was specifically developed to address this challenge.

However, in regard to the first three stated aims of the programme; it is important to state, further research within the present study (Smith, 2013, 2015) demonstrated that participation in the professional development programme had a positive impact on: participants' confidence in teaching science and their knowledge of science; teachers' classroom practice; pupils' attitudes to learning science.

In Ireland a revised Primary Science Curriculum (PSC) was introduced in 1999, however, it was not formally implemented until 2003 (Department of Education and Science [DES] 1999). The revised PSC, like curricula in many other Western countries places a strong emphasis on enquiry-based methods embedded in a constructivist epistemology (Smith, 2015). Prior to the roll out of the PSC in 2003, all primary teachers participated in nationally organised professional development. This consisted of two curriculum days (in-service) specifically for science and one additional day given over to school planning.

Workshops in an identical format were delivered to all schools. The sessions focussed on providing an overview of the PSC with opportunities for teachers to engage in limited exemplar 'hands-on' activities (Varley et al. 2008). Since the initial two days in-service prior to implementation in 2003, no additional national curriculum days (in-service) have been offered to support primary teachers in teaching science.

Since the roll out of the PSC in 2003 a number of research studies have voiced concerns regarding the teaching and learning of primary science in Ireland. These include: lack of hands-on investigative and inquiry-based approaches; poor teacher confidence in teaching science; poor scientific content and pedagogical knowledge; insufficient provision of continuous professional development for teachers (Department of Education and Skills, 2012; Varley et al., 2008). One of the key aspects for improving the teaching of primary science that

has repeatedly been identified in international research is the need for effective continuing professional development (CPD) for primary teachers (Murphy et al., 2005).

2. Professional Development

A review of the international literature on enhancing the teaching and learning of science at primary level concentrates specifically the role teacher professional development plays in, improving science content knowledge, pedagogical content knowledge and instructional practice (Darling-Hammond et al., 2009; Desimone, 2009). Research (e.g., Desimone, 2009; Guskey, 2002; Hoban, 2002) criticises 'traditional' methods of professional development such as, "one-off" workshops as being unsuccessful at introducing significant or enduring change in classroom practice. There is an increased recognition that for professional development programmes to be effective they should address particular needs and fit into the context in which they will be implemented, as such, they may look very different from place to place. Research studies (Darling-Hammond et al., 2009; Desimone, 2009) have shown that certain key characteristics are necessary to enhance the value of professional development. Desimone (2009) recognizes five main characteristics: focus on content, coherence, duration, active learning and collective participation.

These characteristics are very significant to the present study since they encompass the personal, social and professional development of teachers. They also imply that professional development is more than a series of "one off" workshops; rather, it is a process of placing knowledge into practice within a community of actively engaged practitioners (Smith, 2013).

According to Malone and Smith (2010) traditional teacher professional development courses, as experienced in the Irish context, are inclined to be provider-driven "one-off" courses, or short modular courses. A report authorized by the Teaching Council of Ireland (2009) found that professional development provision is generally short-term, once off and not as related to teachers' day-to-day professional practice as it should be. O Sullivan et al. (2011) claim that such programmes have the transmission of knowledge as their main objective and have the least capacity to support professional autonomy or create teacher change (Kennedy 2005). There is no distinction made between large and small schools and single-grade and multi-grade classes.

The model developed for the present study is very different to the 'traditional' form usually encountered by teachers in the Irish context. It emanates from a different theoretical origin and with a more distinctive practical focus. The model can be seen as 'transformative' i.e. it has the capacity to support considerable professional autonomy and bring about teacher change and development. (Kennedy 2005).

Many of the primary schools in Ireland are small multi-grade and scattered across rural areas. According to Mulryan-Kyne (2005) more than 42% of primary school teachers in Ireland work in small schools and 49% of primary school pupils are taught in these schools. This compounds the problem of delivering professional development. Historically, small rural schools are underserved on account of their isolation from other teachers - the size of the school may mean that there are only one or two professional colleagues to formally and

informally discuss ideas and exchange resources. Such schools are also isolated from research and development institutions, such as third-level colleges and the regional Education Centres. This can result in them being out of touch with optimal teaching strategies (Rossi & Sirna, 2008). Sigworth and Solstad (2001) argue that this isolating factor can only be overcome, "if the providers are able to take account of the circumstances of their small remote schools when planning appropriate forms of in-service education, including networking arrangements" (p. 6).

2.1 Professional Learning Communities

A key objective of the present study is to support small rural schools in becoming professional, independent learning communities through professional development. Research by Jarzabkowski (2003) reveals that teachers in rural schools greatly value the social and emotional aspects of teacher collegiality. The literature provides several definitions of professional learning communities. However, the definition of a professional learning community most relevant to the present study is that of Stoll et al. (2006):

> Inclusive group of people motivated by a shared learning vision, who support and work with each other...and together learn new and better approaches that will enhance all pupil learning (p. 222).

The last two decades has seen a growing appreciation of the need for teachers in small rural schools to collaborate with teachers in similar schools, in order to exchange material, recognize general concerns and work together to develop solutions to them (Giordano 2008). According to MacNeil, (2004) conventional forms of in-service professional development are not sustainable and seldom change into instructional improvements. He argues that cluster-based programmes provide an alternative, effective and cost-effective means of providing professional development that will reach all teachers, especially those in rural areas. Studies by Hogan et al. (2007), and Vescio, Ross and Adams (2006) have shown that working collectively in a community of contemporaries can encourage teachers to reflect on their teaching practice and learn from each other. This type of collaboration is rarely fulfilled in more traditional types of professional development. Bolam et al. (2005) highlight a number of core features that all effective professional learning communities share in common, they include: reflective professional enquiry, mutual trust, respect and support and collaboration focused on learning and openness.

3. The Professional Development Programme

Called the Western Seaboard Science Project (WSSP) this study was carried out in 15 small rural mixed primary schools in the West of Ireland. All of the participating teachers taught in multi-grade classes. To help create professional learning communities the schools were grouped by the author into three clusters of five schools (by geographic location). Significant characteristics of the programme (Hogan et al., 2007, p. 100) included an emphasis on:

- *Active participation* – WSSP workshops were of an interactive nature. They were designed and convened by the author, in on-going consultation with the teachers. As trust grew among the participants, they themselves took an active role and responsible part in

design of the workshops.

- *Meaningful Collaboration* – *M*alone and Smith (2010) argue that professional development that encourages a culture of *meaningful* collaboration (one which enables teachers to discuss issues that affect their day to day classroom practice, as well as sharing resources and ideas) can be very successful in changing teacher classroom practice. An important feature of the WSSP was to build up trust between the teachers as a group, and the author. This was supported and make possible by means of a range of approaches such as sharing resources and ideas and discussing pedagogic practice.

- *Continuity* – On-going and sustained professional development for teachers when they return to school can provide them with time and support to reflect and develop clear connections between the ideas presented and their classroom experiences, contributing to real change and continuous improvement (Jeanpierre, Oberhauser & Freeman, 2005). The programme was planned as organised events within a progressive sequence (over 2 years) unlike short courses or "once-off" occurrences conducted at irregular time intervals. Each workshop had specific inputs to make to the continual development of particular capacities on the part of the participants.

- *Feedback* – the programme included: (a) feedback from the participants to the author at the end of each workshop (b) feedback by participants to colleagues during the workshop and between workshops, regarding teaching initiatives conducted by them in their own schools, and (c) feedback (evaluation) to the author mid-way through the programme and at the end of programme.

The WSSP consisted of twelve three-hour workshops held over a two-year period. The workshops were planned and arranged by the author, in on-going discussion with the participants. Prior to the commencement of the programme the author met with all participants in their schools. This gave the participants an input into the programme design e.g. involvement in picking science content that was relevant to their day-to-day classroom needs.

The author provided on-going support for teachers in between workshops in the form of a virtual learning environment (Moodle), e-mails, telephone conversations and visits to individual teachers in their schools. The main purpose of the school visits was to support the participants in implementing in their classrooms new innovative teaching methodologies explored at the workshops.

Science areas chosen for workshops were those identified by the teachers as causing them particular problems in their classroom. Workshop content included the following elements:

- Participant engagement in a number of hands-on science activities;
- Participants critically reflecting on their own science knowledge;
- Introduction of innovative teaching methodologies;
- Participant feedback to author and other participants on science activities conducted in

their classrooms in between workshops;

- Participant dialogues linked to their experience of teaching science;
- Use of ICT in the classroom and introduction to Virtual Learning Environments–Moodle.

In between workshops participants were encouraged to: critically reflect on new knowledge and skills they acquired at workshops; carry out action research in their classroom on the impact of these on their classroom practice; document their findings for discussion with colleagues at the next workshop.

4. Methodology

A mixed methods design (Johnson & Onwuegbuzie, 2004) was employed in this research as the author drew from a combination of qualitative and quantitative strategies and methods. Multiple data sources (questionnaires, interviews and reflective journals) were used, providing for triangulation of the data and increasing the validity and credibility of the research (Denscombe, 2007).

4.1 Participants

The sample population consisted of 24 practicing teachers and about 281 pupils. Even though the number of teachers participating in the study was limited to 24, it was possible to select teachers with a range of experience and of both genders. Seven male and seventeen female teachers took part in the study. The teaching experience of the teachers varied from less than 5 years to 20 years and over. These 24 teachers represented a range of backgrounds in terms of: years of experience in teaching; prior science qualifications; and previous attendance at science education-related professional development courses (Table 1).

Table 1. Personal characteristics of participating teachers (n = 24)

	Frequency	Percentage
Gender		
Male	07	29
Female	17	71
Teaching Experience		
0 – 5 years	03	12
6 – 10 years	05	21
11 – 15 years	02	08
16 – 20 years	01	04
Over 20 years	13	55

Highest Qualification in Science		
Junior/Inter Certificate	04	21
Leaving Certificate	17	67
Degree	01	04
None	02	08
Science Subjects studied at second level (age 16-18yrs)		
Physics	02	08
Chemistry	04	16
Biology	16	67
Physics / Chemistry	01	04
Science Professional Development Courses attended		
Diploma	01	04
Curriculum implementation in-service days	18	75
Discover Science	02	08
Summer Course in Teaching College	03	12
Other	03	12
None	04	16

4.2 Questionnaire (Pre/Post Intervention)

The format for the questionnaire used in this study was adapted from Pell and Jarvis (2003). The questionnaire was separated into two sections. The first section was concerned with information that could have an impact on teachers' attitudes to teaching science, including, gender, teaching experience and qualification in science. The second section of the questionnaire gathered data concerning teacher confidence: in teaching science; in teaching different aspects of the primary science curriculum; in their own science teaching skills and using inquiry-based teaching methodologies in science lessons. Piloting of the questionnaire was carried out with four non-participating, qualified teachers to ensure acceptable content validity. Participants were asked to complete the questionnaire at the beginning of the first CPD workshop of the programme, and at the end of the last CPD session. It is important to note that for the purpose of this paper only the data gathered from the teachers' responses to questions in the first section are reported.

4.3 Interviews

After piloting with two non-participating teachers, three separate semi-structured group interviews (one for each cluster) took place at the end of the final workshop. The interview schedule was designed and aimed at probing teachers' perceptions of the intervention programme and its influence on their learning, teaching beliefs and teaching practice. Each

interview lasted between 30 and 40 minutes. Interviews were audiotaped and then transcribed verbatim.

4.4 Monitoring Project Development

All teachers in the 15 schools were asked to complete reflection templates at the end of every workshop and an open-ended reflection template at the end of Year One. Part of the reflective template sought to gain information about the participants' views of the impact of WSSP on their classroom practice and pupils learning.

4.5 Reflective Journals

At the start of the WSSP the participants were asked to keep a reflective journal. They were encouraged to write into the journal after each workshop and after teaching the various activities (from workshops) back in their classrooms. A general list of questions was collected and settled on by the author and participants. These were only to be used as a guideline; participants did not have to stick to them when writing reflections. The main aim of using the reflective journals was to gain some insights into participants' ideas and experiences of learning at the workshops and implementing the new methodologies in their classrooms.

4.6 Data Analysis

Qualitative data collected from the interviews, reflective journals and reflection templates were analysed and coded into thematic categories. This involved the author and colleague reading the data several times, recognizing concepts set within the data, establishing distinct concepts into categories and connecting them to general themes. The data was coded separately to provide inter-rater reliability.

5. Key Developments

This article attempts to track and appraise the progress, which, the fifteen rural primary schools made over the two years of the project. It focuses specifically on three key developments: meaningful collaboration, cultivating reflective practice, and promoting teacher networks.

5.1 Meaningful Collaboration

The insulation and isolation of teachers from their professional colleagues has been one of the more enduring factors in Irish schools (Hogan et al., 2005). Before implementing the programme the author met all the participants and other teachers in the participating schools. This gave him the chance to listen to the concerns and needs of the participants. It was clear from these meetings that there was little or no formal dialogue with colleagues within their own schools on matters concerned with teaching and learning. This was understandable, for the majority of the teachers sitting around a table discussing their classroom practice with others was something that many of them did not experience since their initial teacher training days. Breaking this down and building up a professional learning community posed a key challenge during the first year of the programme.

Building up trust over time was the key to developing a culture of meaningful collaboration.

This involved the author: working closely with the participants; looking at areas relevant to the day-to-day reality of the participants' classrooms; including participating in decision-making processes; engaging them in critical reflection.

Findings from interviews, reflective journals and templates show all teachers stressed that a particularly positive aspect of the WSSP was the strong emphasis placed on collaboration.

> This science project [WSSP] has taught me that it is important to collaborate with others…especially for us working in small schools…good to meet like-minded teachers…this project [WSSP] is concerned with science, we could do the same kind of professional development in other subjects with same colleagues…we learn so much from each other (reflective journal).

> There are many good things about this programme. By far the greatest benefit for me has been the opportunity to exchange ideas and resources and engage in discussion with colleagues from other schools. This leaves me with a renewed enthusiasm for my day-to-day experience in the classroom (interview).

There was widespread agreement among the participants that unlike other professional development programmes they experienced, the WSSP offered frequent opportunities for them to collaborate with each other:

> This approach [WSSP] unlike other workshops I have attended [other CPD] offers help…rapport and it emphasises how to teach science as well as what to teach…you learn a lot here [workshops] that you can use in your classroom (interview).

> It is great to talk to other teachers about what works for them in their classrooms and the problems they face…we learn a lot from each other…about science and teaching and learning. These workshops help me to feel less isolated (interview).

A major benefit of meaningful collaboration is that it enables participants themselves to see insulation and isolation as a restricting feature of their professional lives. This is perfectly captured by a participant with 35 years teaching in rural schools speaking about the value of participating in professional development programmes in the breakdown of teacher isolation. In relation to previous professional development courses he attended, he stated, "you just received information from the course facilitator and you then went back to the privacy and isolation of your own classroom". He stressed, "what was good about this course [WSSP workshops] was we were encouraged to get to know other teachers as well as receiving information and resources. This is very important for teachers teaching in small rural schools…it helps to overcome isolation…I have learned so much from talking to other teachers."

In addressing the core issue of teacher isolation and professional insulation, evidence suggests that many teachers developed a level of trust, and began to develop 'critical friendships' (Costa & Kallick, 1993) around the teaching and learning of science, with their fellow participants. In between workshops the teachers communicated with each other on an

informal basis. They sought explanations of ideas and activities that may have been demonstrated or addressed at a previous workshop.

> I have learned so much from conversations with her [fellow participant] regarding the ways that she implements the activities [from workshops] with her pupils who are of a similar age group to mine. This encouraged me to go back my school and try some of those ideas (Interview).

5.2 Cultivating Reflective Practice

In general, the main aim of most conventional professional development programmes in an Irish context seems to be the improving of teachers' content knowledge and skills (Malone & Smith, 2010). Teachers are not encouraged to critically reflect on the new knowledge and skills they have learned or their effect on classroom practice. Pritchard and McDiarmid (2005) stress that, in teacher education, reflective practice is one of the core components required for effective teaching and professional development.

From the outset, a key feature of the WSSP was to provide the participants with the opportunities to develop their capacities to critically reflect on their roles as teachers and learners, with a view to bringing about change in their classroom practice. Reflective practice concentrated on key issues regarding the teachers' experiences of teaching science. It included discussions about: the research-based methods modelled in the workshops; teachers' experiences as pupils in the workshops; successes and challenges of using activities back in the classroom. Participants were encouraged to, question the quality and nature of the learning that takes place in their classroom.

Evidence of the advancement of self-reflection and group reflection is evident from the following comments, which were made by teachers during interviews and written reflections.

> Sharing your own ideas and bringing back other people's ideas to school is very important.
>
> It was great to talk and listen to other people regarding science teaching; you learn so much.
>
> It is very important to talk to other teachers who are teaching the same age group of children as yourself; you can share ideas and resources.
>
> Sharing and helping each other, others have the same problems, having open discussions at workshops is very important.
>
> I try out new ideas I picked up at the workshops with my class, think about the best way to teach it. I will ask for help if I need it.
>
> Great to try out what we learned in a workshop with our pupils and then discuss how it went with the other teachers at the next workshop.

The reflective journal data also revealed that all the teachers became more conscience of their own classroom practice and of how their pupils learn.

> The activities we do in the workshops [WSSP] help me to imagine how my children learn science…gives me a better understanding of the questions they ask and the frustrations they face when carrying out activities (reflective journal).
>
> At the workshops [WSSP] we were put in role of the pupil…we worked in groups, were asked for our ideas on various concepts and encouraged to test our ideas. This has given me a better understanding of how my pupils feel in same situation and how they learn science (reflective journal).

These findings show that the teachers fruitfully developed their capacity for self-reflection and group reflection. They also show that for many of the participants teaching practice became the centrepiece of the professional development. However, it is important to note that it was not until the later part of the project (start of Year Two). Time was required to build up trust. The on-going nature of the WSSP gave the participants time to reflect on their teaching and instigate changes in their classroom practice.

5.3 Promoting Teacher Networks

The WSSP model promoted and supported the foundation of two types of teacher networks, one formal and one informal. The formal network developed during the workshop time. The informal network, on the other hand happened outside the programmes regularly arranged activities and was created by a significant number of the participants.

5.3.1 Formal Networks

During the workshops, networking with colleagues offered the participants different learning experiences that they could not obtain from expert-led activities. As well as swapping materials and exchanging ideas teachers worked, talked and shared their expertise on issues of teaching and learning, with their fellow teachers.

The following two interview excerpts show the type of networking described by teachers that occurred during the scheduled timeframe of the WSSP.

> During the workshops as well as the facilitator providing us with information, other teachers would bring up new ideas and concepts and discuss how they would carry out science activities with their pupils. This has enabled me to learn a lot more than if the facilitator alone dictated the direction of the workshop content (interview).
>
> I have really learned a lot about science at the workshops, especially working with other teachers who would be very open about successes and challenges of teaching activities [picked up at workshops] back in their classrooms. It is nice to have the resource of other teachers to talk to (interview).

Between workshops a significant number of group members would implement aspects of the methodologies with their pupils. On numerous occasions they would also contact other group members to give and receive advice on their experience. At the next workshop they would give feedback to their colleagues and the author. The participants shared their *true* science

lesson experiences with colleagues, difficulties as well as successes. Collaboration and collegiality along these lines becomes part of one's professional identity and therefore works to generate more valuable adjustments in teacher's practice (Malone & Smith, 2010).

> The first 20 minutes of each workshop was key for me…. Sharing with others the problems and challenges we all faced in our classroom when it came to the teaching of science. This really helped by teaching and confidence (interview).
>
> Some days I really got frustrated teaching science…I tried to implement some of the activities I picked up at the workshops with my class however they did not work…I would contact one of my colleagues [participant] and share my frustrations and seek advice (reflective journal).

5.3.2 Informal Networks

As well as the formal networks that arose during the workshops, the participants established their own informal networks within and between the three clusters of schools. Informal networking mainly involved teachers sharing resources and teaching ideas. As mentioned previously it occurred through face-to-face contact, telephone calls, e-mail and virtual learning environments. Teachers regarded these networks as a major benefit of the project.

> This [WSSP] has been a good experience for me and teachers from other schools. It is important to know what my peers from the same district are doing in their schools. We can learn so much from each other and because we all teach locally we can be a good resource to each other (interview).
>
> With other PD courses I have attended you are given information, you don't really get to know other teachers. This [WSSP] is great because it is carried out locally and over a long period, you get to know the other teachers and build up a good productive relationship with them… sharing ideas and work over a long period of time (interview).

Various technology-related parts, such as, web-based virtual learning environments (VLE), online and electronic conferencing features can help overcome location and time constraints. At the outset of the programme, the participating teachers were set up on their own virtual learning environment (Moodle) and trained to use it. Moodle allowed teachers in the project to contact each other through a university-based secure web network, enabling them to actively upload and download digital resources, share information and, most importantly, engage in sophisticated conversations around their pedagogical practices.

The following reflective journal excerpt describes the importance of a VLE to effective networking of teachers in the different geographic locations.

> Moodle [VLE] is brilliant, it allows me to contact teachers in other counties [teachers from 3 counties involved in WSSP] and find out what they are doing in their classrooms, share resources, ask for advice and collaborate on projects. (reflective journal).

6. Discussion

The isolation of teachers from their professional colleagues has been one of the more lasting features for teachers in small rural schools (Sigworth & Solstad, 2001). The key developments discussed above are especially important for those teachers teaching primary science in small schools in rural locations. These encouraging developments demonstrate the changes in professional thinking and action that the WSSP encouraged among the participants. The WSSP made significant inroads in overcoming professional isolation and supported the development of a learning community i.e. the convergence of teachers in a group to identify and develop shared purposes to improve pupil learning (Hord, 2009). Key to this was the targeted and contextualised design of the programme to meet the specific needs of teachers in small rural schools. The WSSP drew together the core characteristics recognized as essential for effective professional development and adapted them to the needs of teachers in small rural schools (Desimone, 2009). The clustering of schools provided teachers with opportunities to: use group processes such as group reflection, collaboration and professional dialogue, thus, overcoming some of the challenges of working in isolated areas. The workshops were designed to provide participants with frequent follow-up and feedback. The long duration (2 years) of the programme gave the participants the chance to develop their pedagogical and content knowledge, and the opportunities to test activities acquired at the workshops, back in their classroom.

This approach to professional development proved effective in bringing about a change of classroom practice for the majority of the teachers. As the participants experienced the in-depth open pedagogical discussions they realised how isolated they were professionally in their own schools. As one teacher explained "Most importantly for me this [WSSP] has helped me to get to know new colleagues who teach in the same area [district] as me…teaching in small rural schools increases your isolation…interacting with other teachers at these workshops [WSSP] has helped me to share and develop good ideas regarding the teaching of science…I can use these with my pupils when I go back to my own school".

The selection of participants for the WSSP from a limited geographical location could be seen as a possible limitation of the study. However, examination of the participants (table 1) demonstrates that they by and large reflect the general teacher population in terms of qualifications, gender and teaching experience. A second limitation of this study is that it is only concerned with the affective domain of pupil participants, and not with their cognitive domain. Pre-intervention and post-intervention achievement tests in science for the pupils would have enhanced the findings of the study as to whether the programme had had an effect on pupil learning outcomes.

According to Guskey (2002) changing teachers' classroom practice is difficult and 'traditional' forms of professional development (generally experienced by Irish teachers) are fruitless at effecting change in practice. In the Irish context, teacher professional development programmes mainly serve the requirements of the system (Malone & Smith, 2010). This has led to insufficient value being placed on teachers' requirements, resulting in a reduction of their sense of ownership. There is a need for a more balanced approach involving

professional development that endorses the requirements of the system and that of the individual teacher. The key developments of this research imply that the model of professional development used in this study, can lay the groundwork for 'successful' alternative models of professional development.

While the study was carried out on a small scale in an Irish rural setting, the author considers that the key developments have important implications for the professional development of primary teachers in rural primary science in Ireland and internationally. Firstly they show that an effective professional development programme as well as enhancing teachers content knowledge and confidence teaching science can counteract the geographical isolation of rural teachers and establish networks for on-going collaboration and support (Sandholtz & Ringstaff 2011). Secondly, they demonstrate that a professional development programme targeted to the specific needs of the participants is effective at bringing about a change in classroom practice (Desimone 2009). The core features of the WSSP are general enough to be modified universally to the specific local needs of teachers and school community environments, especially for teachers in rural areas.

Shifting a culture in professional development and developing a professional learning community takes vision, dedication and an investment in resources. A key challenge for the future is the development of a system of professional development that will support and encourage individual schools and teachers to carryout school-based, collaborative, relevant, on-going and sustained professional development activities. However, the present economic crisis in Ireland has resulted in the limitation of government supported professional development opportunities for teachers in areas other than literacy and numeracy. If the WSSP approach is to effect more than the 15 schools in the programme and become part of the national picture, it must have the opportunity of reaching most schools in a sustainable way. To this end, the author, in collaboration with the Irish American Partnership and key national education agencies are presently transferring the programme from a research and development pilot stage, to a mainstream stage (WSSP Transfer Initiative) using the features that proved so productive during the present study.

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