

## **Cross-level Peer Tutoring of Primary Teachers in Science**

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### **Abstract**

*This research involved the design and implementation of a cross-level peer tutoring programme for primary level teachers focusing on the teaching of science. Undergraduate pre-service science teachers in their fourth year of study acted as tutors to primary school teachers with varying levels of teaching experience. The aims of the research were to investigate if mentoring and coaching of primary teachers by undergraduate science education students can help in the development of their pedagogical knowledge and subject matter knowledge and in turn the teaching of science in primary schools.*

*This involved the collection of both quantitative and qualitative data, by the distribution of questionnaires and carrying out interviews both with pre-service primary and science teachers, and in-service primary school teachers.*

*The main findings of this report were as follows: 1). Many primary teachers currently teaching the primary science curriculum, lack confidence in their levels of subject matter knowledge and pedagogical content knowledge 2). In-service and pre-service primary and second level teachers are unaware and uninformed of the pedagogy and content of science curricula at second and primary level respectively 3). Feedback from the case study teachers and tutors indicated that the cross level peer tutoring programme was very successful in developing primary teacher's pedagogical knowledge and knowledge in key scientific concepts and 4). The collegial peer tutoring programme was successful as a strong trusting relationship was developed between the tutor and tutee, where regular feedback and follow-up support was provided, placing an emphasis on reflection, joint problem solving, and sharing of expertise and experiences.*

*This research has provided a deeper insight into the needs and supports required by teachers in primary science. This research highlighted that there is a need to reform the provision of continuous professional development to Irish primary school teachers in science, moving away from one off events to a more collaborative mentoring approach providing support to teachers on an on-going basis.*

### **1. Introduction**

It is a major concern that in many countries primary teachers' lack scientific knowledge and overall expertise in the teaching of science [1,2,3,4]. The OECD (2006) highlighted that most primary teachers come from a non-science teaching background and many have not undergone any specific professional training in science and technology [4]. It has been reported in many countries that the teachers' lack of knowledge, expertise, confidence and training in the teaching of science needs to be addressed [1,2,5].

A teacher's ability to teach is directly linked to their level of knowledge of the topic and that poor science teaching being carried out in schools is due to the teachers' inadequate subject knowledge [6]. This in turn affects the teachers' confidence in their own ability to teach the subject thus affecting the quality of and standards in teaching and learning occurring in primary schools [7]. A low level of knowledge and confidence in the teaching of science has been reported to result in the focusing of process skills in science among teachers, avoiding developing the understanding of key scientific concepts among pupils. A study carried out in Ireland reviewing the implementation of the primary science curriculum raised a number of concerns which included: The lack of and depth associated with pupil-led hands on, open investigation; and helping pupils link their learning in science to the wider world [8]. This may be due to the fact that many teachers currently in Irish schools would have received very little, if any formal training and professional development in science and science education.

This study focuses on developing pedagogical content knowledge and knowledge in scientific concepts among primary science teachers through cross-level peer tutoring by final year undergraduate students studying Bachelor of Science (in Education) and a Principal Investigator

(primary teacher educator in science education). The method of cross-level peer tutoring that was employed in this project involves peer mentoring and coaching i.e. coaching by the peer tutor through practical demonstrations, providing tutees (primary teachers) with; stronger conceptual frameworks for teaching science, teaching strategies and activities appropriate for the teaching of primary science [9,10]. The aims of the research were to investigate if mentoring and coaching of primary teachers by undergraduate science education students can help in the development of their pedagogical knowledge and subject matter knowledge and in turn the teaching of science in Primary schools.

## 2. Continuous Professional Development (CPD)

A report by Murphy *et al.* (2007) found that teachers who had carried out professional development in science were significantly more confident to teach science [3]. It is recommended that the nature of in-service provision for Irish primary science now needs to progress beyond a “show the teachers how to do it” approach to incorporate more opportunities for action and reflection [11]. In this way it is hoped that teachers would gain the confidence to develop their own ideas for teaching and promoting science in schools. Varley *et al.*, (2008) recommended that a comprehensive support for Irish primary teachers needs to be provided in science [8]. Many researchers have recommended in-services in developing teachers’ science process skills. However it is also important that extensive in-service is provided to develop understanding in key scientific concepts among primary school teachers, identifying teachers’ knowledge of key scientific topics, their misunderstandings and working from there [12]. In this project peer tutors worked with teachers to: Identifying areas of need; Providing one on one support to teachers and staff development activities that aimed to help the teachers improve their ability to teach primary science and; Meeting with teachers on a regular basis for collaboration and professional development.

## 3. Methodology

### 3.1 Phase 1: Exploratory Phase

An explanatory sequential mixed methods design was employed in this research where quantitative data was firstly collected and analysed to determine the results and questions that needed further exploration in the second qualitative phase (Cross-level peer tutoring (questionnaires and interviews)).

Phase 1: Questionnaires		
Primary Teachers & Pupils	Pre-service Primary Teachers	Pre-service Science Teachers
<p><u>To investigate:</u></p> <ul style="list-style-type: none"> <li>Teachers background, knowledge &amp; competencies in science,</li> <li>Areas teachers need support with the teaching of science,</li> <li>Teachers’ views cross level peer tutoring,</li> <li>Pupils’ experiences of &amp; attitudes towards science,</li> <li>Pupils’ views on successful teaching methodologies.</li> </ul>	<p><u>To investigate:</u></p> <ul style="list-style-type: none"> <li>Undergraduate B. Ed (in primary education) students’ background in science and science education and,</li> <li>Their views on peer-tutoring and how primary school teachers could be supported in the teaching of science.</li> </ul>	<p><u>To investigate:</u></p> <ul style="list-style-type: none"> <li>Undergraduate BSc. Ed (in Biological Sciences) students’ knowledge and experience of the Primary Science Curriculum and,</li> <li>Their views on peer-tutoring and how primary school teachers could collaborate with post primary science teachers.</li> </ul>
<p>N: 31 Teachers N: 148 Primary Children</p>	<p>N: 24 Final Year Pre-service N: Primary Teachers</p>	<p>N: 40 Pre-service Science Teachers.</p>

Table 1. Description of Phase 1 of the research project.

### 3.2 Phase 2: Peer-Tutoring of Case Study Teachers

1. Training sessions were provided by the principal researcher (Lecturer in Primary Science Education) to the peer tutors.
2. One-on-one meetings were arranged between tutors and case study teacher (tutees) (N=2).

3. The tutees completed a pre-questionnaire and an informal semi-structured interview to identify areas in science where the teacher would like support, how to address these issues and to decide on the format of the Cross-Level Peer Tutoring Programme.
4. From the interviews, the tutees requested assistance in designing and planning lessons in three specific areas which they found difficult (Forces, Sound and Ecology). Modules containing lesson plans were then designed by the tutors and teachers collaboratively. The modules included lessons for pupils from Junior Infants to Sixth class, student worksheets, possible questions and background information on children's ideas and misconceptions in different areas of Forces, Sound and Ecology.
5. The tutors and principal investigator provided workshops in science to all teachers in the case study schools which involved follow up sessions and continuous contact with the case study teachers.

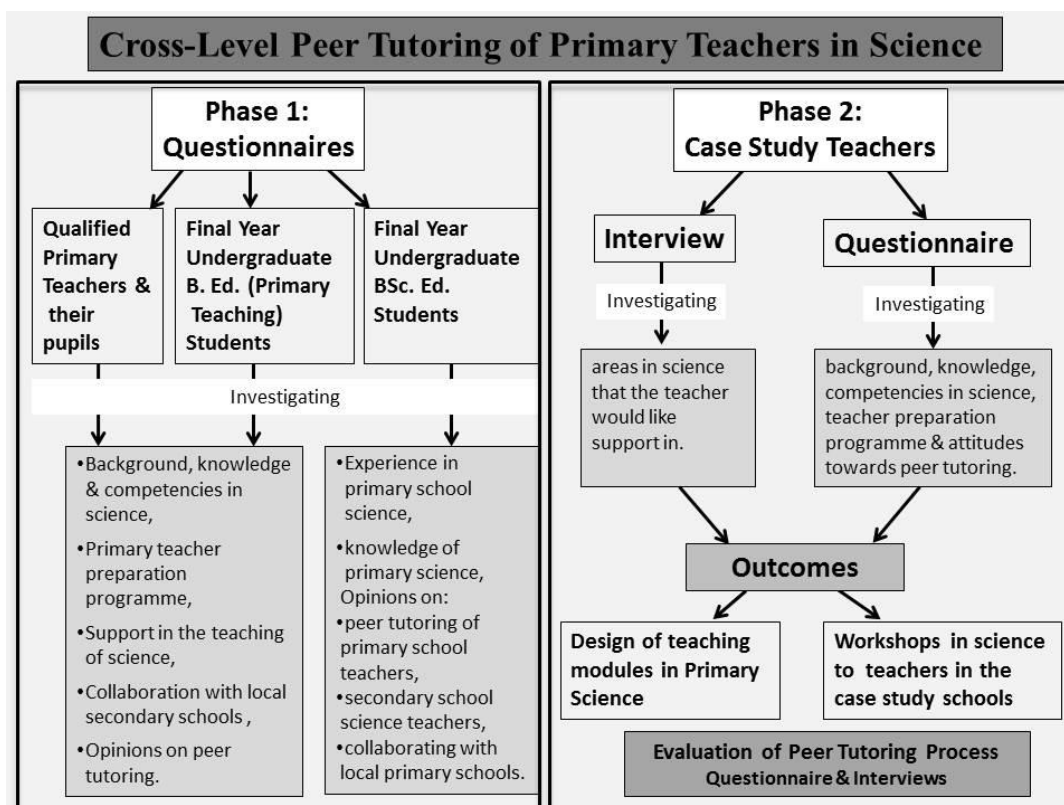


Fig. 1. Summary of the Overall Research Project

#### 4. Results

Results of the Cross-Level Peer Tutoring Phase will be reported in this section.

Both case study teachers had between 5-10 years of teaching experience. Both studied science at junior cycle level in post-primary school (12-15 years old). However only one of the teachers studied Biology at Senior Cycle level prior to entering third level education (16-18 years old). Their ranking in their knowledge of science varied greatly (Table 2 &3).

	V. Good	Good	Average	Poor	V. Poor
Your knowledge of the Primary Science Syllabus	T1		T2		
Your knowledge of the Junior Certificate Syllabus			T1		T2
Your Knowledge of Science in General		T1	T2		

Table 2. Teachers' ranking of their knowledge in science (T 1: Teacher 1 & T2: Teacher 2)

The teachers were asked to rate their level of confidence in different areas of Primary School Science. 1 being least confident and 5 being most confident. Neither of the teachers felt they were very confident in any of the areas listed below:

	1	2	3	4	5
Ability to teach science in primary school		T2		T1	
Ability to plan lessons in science		T2		T1	
Ability to carry out experiments in science		T2		T1	
Knowledge of different teaching methodologies in science		T2		T1	
Ability in organising experimental work		T2		T1	
Ability to organise group work			T2	T1	
Introducing new science theory and concepts			T1 & T2		
Explaining science and scientific principles			T1 & T2		
Managing the science classroom			T2	T1	
Thinking of investigations to carry out with pupils			T2	T1	

Table 3. Teachers' ranking of their level of confidence in the teaching of science (T 1: Teacher 1 & T2: Teacher 2)

Both teachers felt the amount of preparation provided in third level education for the teaching of science in primary school was only **adequate**. One teacher felt that the teacher preparation programme prepared him to be confident in the teaching of science whereas the other teacher felt it did not: *"Not enough time is given to science – especially for those with no/very little previous science experience. It can all be overwhelming when faced with teaching the subject"*.

The areas in which the teachers felt they would like to develop as part of the peer tutoring partnership were:

1. Pedagogy in science:  
*"Ideas for different teaching methodologies in science"* T1
2. Investigation skills:  
*"Investigation (practice of investigation skills)"* T1  
*"Investigation skills can be a problem to get across to pupils when the teacher does not have the skills"* T2
3. Design and development of lesson plans:  
*"Would like help in designing lesson plans"* T1
4. Delivery of a science lesson:  
*"Managing Science investigations"* T1  
*"Delivery of Science lessons"* T2
5. Gain further understanding of any science concepts:  
*"Have a basic background in Science, would prefer to have a stronger background knowledge for example in topics such as force, sound and ecology"* T1  
*"Would like to further develop my knowledge of science in general"* T2

#### 4.1 Evaluation of the Peer Tutoring Process (Questionnaire & Interview)

Both teachers ranked the process as **Very Successful**. They felt that working on the science modules together with the tutor was very beneficial:

*"The curriculum was studied while planning the module"* T1.

*"Covered all of the Living Things, Sound and Forces strand of the curriculum"* T2

They also stated that the most successful aspect of designing the modules and tutoring sessions was the provision of background information as this *"gave the teacher confidence when teaching"* T1.

Both teachers felt their knowledge, confidence and ability to teach science had increased after participating in the peer tutoring process (Table 4).

	Increased	Decreased	Unchanged
Level of knowledge of the topics	T1 & T2		
Ability to teach the topics Ecology, Forces & Sound	T1 & T2		
Confidence to teach the topics Ecology, Forces & Sound	T1 & T2		

Table 4. Teachers' ranking of their level of confidence in the teaching of science (T 1: Teacher 1 & T2: Teacher 2)



The teacher also listed the teaching methodologies they incorporated into lessons as a result of ideas discussed in the peer tutoring sessions and from designing and teaching the modules which included: Inquiry based learning, Hands on activities, Discovery learning, Incorporation of ICT and multimedia resources, Developing the child's scientific skills, Group and Independent work. They commented that they felt more confident in including such teaching methodologies after discussing how to incorporate such activities with their tutor and on post-lesson reflections with the tutor

Both teachers were asked if their teaching of science had changed in any way since participating in the programme, both clearly stated **Yes:**

*"More discovery based learning activities"* T1

*"Allowed for a well structured lesson"* T1

*"Less written activities than I used to, more discussion on their ideas"* T2

*"Discussion between groups on their concepts of a given subject"* T2

## 5. Discussion

The feedback from the case study teacher indicated that the cross level peer tutoring programme was very successful i.e. a successful strategy in developing teacher's pedagogical and content knowledge. In this study the main difficulties facing the case study teachers were the implementation of investigations and the design development and delivery of lessons. This became the main focus of the peer tutoring sessions placing an emphasis on building the teachers' pedagogy and subject matter knowledge. At the end of the peer tutoring programme the teacher noted an increase in their confidence in teaching the topics and also increased their knowledge of Ecology, Forces & Sound. Informal discussions with the teachers allowed time to discuss and find effective solutions and guidance to overcome any difficulties they were having in the teaching of science, in particular the delivery and management of lessons, gathering of resources and development of their own investigation skills.

This research highlights that there is a need to reform the provision of CPD for Irish primary school teachers in science, moving away from one off events to a more collaborative mentoring approach providing support to teachers on an on-going basis. This has been shown to be feasible using pre-service teachers in the role as peer tutors for in-service teachers.

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