Integrating Theory and Practice in Primary Science Teacher Education

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Background

Authors have realized through their years of teaching and research experience in teacher education, by working in different capacities in many institutions and by involving in developing various teacher education innovations and implementing both practical and theoretical components of the teacher education programme that there exits a definite gap between theory and practice in Teacher Education. The proposed study intends to investigate ways to integrate theory and practice into the Primary Science instructional programme in teacher education. In this paper authors have presented the conceptual framework of the proposed research.

In a previous research, enhancing the teaching practicum component of the Post Graduate Diploma in Education Course in Sri Lanka, researcher developed and implemented a professional development model aimed at improving teaching practices. In this model, five senior tutors and ten student teachers including myself implemented a peer-coaching procedure similar to Fantuzzo’s (1989) reciprocal peer tutoring (RPT) strategy where student teachers are paired in a reciprocal tutor/tutee relationship. According to Watson and Kilcher (1990) peer coaching is another method for improving teaching effectiveness. In the strategy of peer coaching, teachers work in collaboration with one or more colleagues to achieve specific instructional goals through a process of regular observation and feedback. Similar to descriptions by Kilcher & Watson (1990) I have myself experienced peer coaching as a powerful tool in improving teacher effectiveness. (Wijayawardana, 2000). The senior tutors act as mentors responsible for working with their particular pair of students. At the beginning of this work, the peer pairs observe each other’s lessons with their tutor present. Next, they follow a reciprocal peer tutoring procedure guided by their tutor. Each student also maintains a reflective journal for the entire period of the research study and participates in discussions aimed at improving their teaching skills through reflection on their teaching practicum.

In this professional development model, peer coaching and self-evaluation are two techniques, which provide possible ways to improve and enhance the student teachers’ performance in practicum. These techniques as well as reflection work effectively in enabling and supporting the transition from the traditional practices (Wijayawardana, 2000). Through reflective practice teachers are able to rethink the methods and practices they use in their teaching. Self-evaluation encourages the student teachers to not only reflect on their teaching but also to begin to develop their own teaching “style” and to begin to address their teaching reflectively as professionals.
Figure 1: Model for Professional Development: Integrating Theory and Practice into Primary Science Teacher Education

Primary Curriculum
- Primary Science Curriculum/
  Environmental Related Activities

Improving Primary Sc. Instruction

Integrating Theory & Practice

Professional Development Model
- Student Teacher
- Lecturer
- Myself

Providing Learning Opportunities
- Improvisation of materials
- War effected areas
- Lack Of Resources
- Different environment
- Diversity of Students

Practical Component

Theoretical Component

Subject Studies
- Fair Tests
- Equipment
- Projects
- Display
- Subject Studies
- Professional Studies
- General Studies
The researcher has implemented the model as described above for professional development in the teacher training programme. Prof. Dennis Sumara from York University, Canada visited to Sri Lanka and evaluated the programme. It is this model that we now wish to develop further to link theory and practice in teacher education curriculum with special attention to Primary Science through Environment related activities curriculum in Sri Lanka. The future research structure is visualised in the following diagram (Figure 1).

**Description of the conceptual framework**

**Primary Education in Sri Lanka**

Primary education has been given a special emphasis in the National Education Reforms in Sri Lanaka. The new primary curriculum is based on an integrated approach with emphasis on an Environment-related Activities curriculum.

<table>
<thead>
<tr>
<th>Key Stage 1</th>
<th>Key Stage 2</th>
<th>Key Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Grade 3</td>
<td>Grade 5</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Grade 4</td>
<td></td>
</tr>
<tr>
<td>First language</td>
<td>First Language</td>
<td>First Language</td>
</tr>
<tr>
<td>(5 hours)</td>
<td>(5 hours)</td>
<td>(5 hours)</td>
</tr>
<tr>
<td>Mathematics</td>
<td>English</td>
<td>English</td>
</tr>
<tr>
<td>(3.30 hours)</td>
<td>(3 hours)</td>
<td>(3.30 hours)</td>
</tr>
<tr>
<td>Religion</td>
<td>Second National Language</td>
<td>Second National Language</td>
</tr>
<tr>
<td>(1.15 hours)</td>
<td>(1 hour)</td>
<td>(1 hour)</td>
</tr>
<tr>
<td>Environmental Related Activities</td>
<td>Mathematics</td>
<td>Mathematics</td>
</tr>
<tr>
<td>(6 hours)</td>
<td>(5 hours)</td>
<td>(5 hours)</td>
</tr>
<tr>
<td>Environmental Related Activities</td>
<td>Religion</td>
<td>Religion</td>
</tr>
<tr>
<td>(6 hours)</td>
<td>(2 hours)</td>
<td>(2 hours)</td>
</tr>
<tr>
<td>Environmental Related Activities</td>
<td></td>
<td>Environmental Related Activities</td>
</tr>
<tr>
<td>(7.30 hours)</td>
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<td>(7.30 hours)</td>
</tr>
</tbody>
</table>

**Figure 2: Time allocation for primary grades**

**Environmental-Related Activities Curriculum (ERA) in Sri Lanka**

Environmental-related activities (ERA) is a major subject in the Primary Curriculum. The subject, Environment Related Activities takes up almost one-third of the instructional time in the school day and is taught for more hours than either first language or mathematics teaching.

ERA curriculum consists of major themes and all learning activities are mainly focused on “learning through the environment”. Themes are related to the everyday life of children. The philosophy that underpins this approach is that children learn more effectively when new ideas
are introduced in their natural settings and surroundings. Then children construct new knowledge and develop new skills on the foundations of their past experiences and in the real life context.

The ERA curriculum consists of fourteen themes, for example Our School, How Information is Received and Transportation. I will describe how ERA as a subject has a broad scope and fits into a number of subject disciplines through an elaboration of the Transportation theme. Within this theme a series of activities for children include gathering information about how their family members travel to work, to the market, to festivals and so on, collecting information about local roads and collecting information from their grandparents to find out about the history of transportation. These concepts are related to the subject areas of History and Geography. Children also draw different kind of vehicles, sing and do dramas about riding on different kind of vehicles. These activities fit into Aesthetics.

Science comes into the theme of Transportation when children consider forces like pushes and pulls that make vehicles move. Also there are activities related to the ill effects on the environment caused by vehicles. Here children are dealing with environmental science as vehicle exhaust, air pollution and sound pollution. Children also learn about natural resources such as petrochemicals.

As demonstrated, ERA is an integrated subject of Science, Aesthetics, Physical Education, Geography and History. It provides opportunities for children to develop their knowledge, skills and attitudes through processes such as observation, data gathering, recording and interpreting.

Primary Science Teacher Education with particular reference to Sri Lanka

As mentioned earlier ERA is a subject integrated into History, Geography, Science, Physical Education, and Aesthetics. As a delimitation of the research, the researcher will focus on teacher education in Science from the perspective of the ERA curriculum.

In Sri Lanka, Primary teachers are also class teachers so they are required to teach all the subjects. All primary teachers therefore have to be competent in teaching Science-based units within the ERA Curriculum. As Primary teachers have majored in Primary Education and not specifically in Science Education, providing a broad vision of scientific inquiry is one of the challenges for teachers when providing learning opportunities for the pupils.

From the theoretical component of teacher education courses, primary student teachers can acquire generic methods and pedagogical Science knowledge and understanding. However, the actual teaching settings, which prospective teachers will experience, differ from the learning environment in the teacher education courses, and teachers are left to devise their own strategies according to the available facilities of their school. Similarly, resources, facilities and even students differ from place to place and school to school. In the Sri Lankan school system, for example, according to the available facilities there are four types of schools as 1AB, 1C, 2 and 3. In addition, the natural environment of the school surrounding also differs from place to place throughout the country. As a person who helps pupils explain phenomena in terms of
accepted scientific ideas, a teacher has to be flexible enough to adapt according to the new practical settings.

Furthermore, to prepare, improvise equipments, and use low-cost and reusable materials for Science activities is another challenge for the teachers. Through the theoretical component of their courses, in the teacher education programme and prior education and experience, they are unable to get sufficient experience in how to develop such materials. Teachers need various learning opportunities to be able to help pupils recognise the features of living things, materials and events in the natural and man made world including looking at similarities, differences, patterns and changes according to the different surroundings.

Furthermore, twenty years of war has collapsed the whole education system in the North and East area of the country. Physical distraction of schools has made it impossible for education to continue as normal. Most of the schools in these areas have been damaged or destroyed by bombing. Tens of thousands of families have been displaced as a result of war. The situation is now changing through a peace process and a Catch-Up Education (CUE) programme is being implemented throughout the North and East region. A report released by UNICEF in November 2003 revealed that most of the pupils in CUE classes are low achievers. Kamala Pieris (2003), a consultant author of the report, emphasized that the entire education system should pay attention to the education of these children who are affected by the conflict. However implementing appropriate activities for North-East Region is beyond the scope of this research.

Learning opportunities for developing Primary Science

The philosophy that underpins my proposed professional development model is based on the notion that Primary children make their own observation of phenomena around them. They think about why things happen and how things work the way they do. Teachers should therefore start teaching Science based on the ideas children hold at present. In the proposed professional development model, the researcher will introduce various learning activities that help pupils to recognise the features of living things, materials and events in the natural and man made world including looking at similarities, differences, patterns and changes. Through the development of a network among the group of teachers, who participate in this research, they can communicate about their experiences and share ideas with each other at different practical settings.

Development Process

As mentioned earlier the researchers will introduce various learning activities for primary school children under the topics shown in Table 1. Selected student teachers from each College of Education will implement these activities in their practising schools with the help of lecturers. The student teachers and lecturers who participate in this research will communicate with each other and make a network and develop a professional development model through the entire period of research.
Figure 3: Development Process of the research

Table 1: Learning Activities

<table>
<thead>
<tr>
<th>Discovering children’s concepts</th>
<th>Experiencing variety and similarities in living organisms</th>
<th>Planning and doing Science investigations</th>
<th>Preparing low-cost equipment for science experiments</th>
<th>Designing and implementing small projects</th>
<th>Displaying pupils work in science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal human anatomy</td>
<td>Understanding how plants and animals can be identified and classified Carrying out detailed observation of</td>
<td>Main characteristics of fair test investigations</td>
<td>Improvise equipments</td>
<td>Different projects for different settings:</td>
<td>• Drawings</td>
</tr>
<tr>
<td>Plant growth</td>
<td></td>
<td></td>
<td></td>
<td>• Diversity of students</td>
<td>• Concept cartoons</td>
</tr>
<tr>
<td>Light and shadows</td>
<td></td>
<td></td>
<td></td>
<td>• Different environment</td>
<td>• Concept maps</td>
</tr>
<tr>
<td>Sound and hearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Reports</td>
</tr>
<tr>
<td>Floating and sinking</td>
<td></td>
<td></td>
<td></td>
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<td>• Exhibitions</td>
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</tbody>
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A Typical Example of an activity - Discovering Children’s concepts

How Light Helps us see things

Student teachers should know that they have to start their teaching Science and ERA with ideas children hold at present. Thus teachers need to ask children what they think.

Task one
Children are asked to draw arrows on a picture to explain how they see a book.

(This task is related to key stage 2 of primary curriculum)

Task two
Ask student teachers to analyse the children’s responses on how light help see things

Assign them to do how they can approach little children to show it practically. Let them to draw diagrams. Make a discussion about the science concepts behind. (Light from a source is reflected by the object and reflected light enters the eyes. The light stimulates and nerves transmit the stimulation to the brain.)
Task three

Let the student teachers to do further investigations using this task with different levels of schools and different grades. Encourage student teachers to analyse their findings.

Our aim is to introduce several learning activities to the National colleges of education, Sri Lanka as above and make student teachers to implement these activities in schools and do further investigations on their experiences as a collaborative effort. Then student teachers are challenged to think about the appropriate teaching strategies and think more critically about their role as teachers who engage in teaching Primary Science through ERA.

Furthermore, we will introduce several teaching techniques using a combination of models proposed by Osborne & Witrock (1985) and Osborne & Biddulph (1984).

These models have following key features.

- Encourage students to make their ideas explicit
- Provide learning opportunities
- Opportunities for alternative views
- Transform scientific ideas to different situations.

Further we will focus on the teacher’s role described in the interactive Teaching Approach model (Osborne & Biddulph, 1984) as a stimulator of curiosity, challenger of ideas, resource person and senior co-investigator.

Hong-Kwen Boo (2001) described the challenges of teaching science to teach in a way that enables pupils to learn science concepts while acquiring process skills and positive scientific attitudes. In his study he explained how teachers should provide hands-on action in the context of cooperative learning to enable science concepts to develop.

As the preliminary work of the research the researcher wishes to discuss with the teacher educators in Sri Lanka and identify an appropriate way of implementing the professional development model according to the existing situation. Then the researcher will work out the plan to implement the activities with the help of teacher educators in Colleges of Sri Lanka. According to the visualised diagram (figure 1) we wish to improve primary science instruction through integrating theory and practice as a two way process. Though diagram shows a lot of interrelated aspects, my research is mainly focused on the areas, which are shown in grey.

**Goals and Objectives of Teacher Education**

The main purpose of Teacher Education is that of preparing effective teachers. Therefore, teachers must be able to apply the theoretical knowledge they gain through the theory component of their course into the practical situations they face as beginning teachers. However, as mentioned earlier, a gap exists between theory and practice in Sri Lankan
teacher education. Traditionally within teacher education, theory and practice have been regarded as separate entities. A new trend has appeared in most countries aimed at finding ways to redefine teacher education.

Bridges (1999) suggests that teacher education should be focused on professional behaviour including subject matter knowledge, pedagogical knowledge, and understanding of the broader social and cultural context, communication skills and team working skills. However, integration of all these aspects into a teacher education program is very difficult to implement in prevailing situations. Darling-Hammond (1999) points out that many teachers do not feel that their teacher education programmes adequately prepares them for certain teaching tasks. She argues that practice is important to improvement in the quality of teacher education and that it is necessary to redefine teacher education programmes according to the changing role of the teacher.

Thiessen (2000) describes three phase pedagogical framework as essential for teacher education:

- Studying about skills,
- Observing and trying out skills under simulated and actual classroom conditions,
- Comparing and elaborating skills in classrooms.

Thiessen (2000) argues for the necessity of connecting all three aspects in order to prepare effective teachers. He emphasizes that the third phase should be focused on encouraging self-evaluation, transforming new knowledge into the natural environment, providing varied practice inducing reflection and providing full support for use of the skills in natural settings. As teacher educators we agree with the idea of connection of three-phase pedagogical framework because it is an essential need to develop theory practice links to reach the goals of teacher education. Normally student teachers gain general pedagogical knowledge, subject specific knowledge, subject matter knowledge from their teacher education courses. Though these theories are embedded in the course it is successful only when it is implemented in actual practice. Georg Lind (2001) described the role of practice in teacher education and explained practice as “Actual” knowledge. Further he emphasizes the necessity of links between theory and practice of teacher education.

The main purpose of the Pre-Service Primary Teacher Education programme provided by the National Colleges of Education in Sri Lanka is to prepare primary teachers for teaching the Primary curriculum. The programme consists of both theoretical and practical components. From the theoretical component of subject studies student teachers gain subject specific knowledge and pedagogical knowledge related to the subject matter. Even though innovations have been introduced under the New Education Reforms, it has not, so far, fully embraced the changing role of the teacher. There is an urgent need to ensure that teachers have adequate opportunity to practice the theories and skills learnt within the teacher education programme in ways that will prepare them better for their future work as effective primary teachers.
Professional Development of Science Teachers and Theory–Practice links

Providing content knowledge in Science is a key focus in Science teacher professional development, especially for primary school teachers who teach outside their area of expertise. Montgomery (1998, 2002) examined how in-service training with systematic assignments in classrooms settings serve to link theory and practice and can result in development and change in teacher thinking and practices. Briscoe and Wells (2001) in their action research work point out that classroom practice can best be changed by teachers who engage in their own research. This study revealed that how pedagogical inquiry helps young children’s development of understanding of the processes in Science. In a similar study, Emily and Roberts (2001) describe how teachers analysed their own journals for common themes in order to develop personal frameworks for Science teaching.

Duquette (1993) argues for the need for more demonstrable links between theory and practice. The past decade has witnessed a rapidly developing interest in self-study of teacher education practices. Many teacher Education researchers have constructed a rich theoretical and empirical base, highlighting the power of self-study as a reform tool. Hamilton (1998), for example, describe how teachers learn to teach by using self-study techniques while Olsen (1995) recount her experience of using narrative inquiry to investigate ways in which her work as a teacher educator supports pre-service teachers. Hamilton (1995) reviewed salient reading about action research and argued the merits of self-reflective inquiry based study of practice for school and University based teachers.

Allen and Casbergus (1995) described reflective teaching as a paramount vehicle for enhancing the development of effective teachers. They argue that systematic reflection allows the teacher to be self-directed and it facilitates the growth from novice to expert. Furthermore, it enables teachers to view teaching from a more interpretative and critical perspective.

Fueyo and Hassler (1998) describe teacher research as a catalyst for change in professional development. They examined teaching, research, and professionalism as a basis for learning to teach, while Lierberman (1995) characterises effective professional development as that which includes inquiry, reflection, participant driven experimentation and the naming the role of teacher researcher. According to Darling Hamund and McLaughlin (1995) professional development today should provide occasions for teachers to reflect critically on their practice and to construct new knowledge about content and pedagogy.

Kettle and Sellars (1996) also analysed the reflective writings of a group of student teachers and found that the use of peer reflective groups encouraged student teachers to face challenges and to work in collaboration. The researcher implement a professional development model that consists of peer reflective groups with reciprocal tutor-tutee approach. Therefore my quest would be to implement the professional development model in order to build up theory practice links and forming a strong network of communities and developing mutual growth as professionals.
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Research questions

The research questions will therefore mainly be focused on identifying the gap between theory and practice in Primary Science teacher education in Sri Lanka, and on implementing a professional development model that links theory and practice in this area of Primary teacher education.

The objectives of the Proposed Study

- Identify the gap between theory and practice of teacher education with special attention to primary Science Teacher education
- Discovering Children’s concepts and ideas in Science and identify the appropriate ways to respond them
- Identify the appropriate ways of enabling children to do observations, gathering information and recording.
- Identify the teaching and learning objectives of the existing Primary Curriculum with special attention to Environment Related Activities Syllabus.
- Prepare appropriate learning activities for different practical settings
- Make effective links between actual teaching settings and pedagogy they have gained through the theoretical component of the Teacher Education Course.
- Facilitate pupils to plan, carry out and evaluate Scientific investigations, particularly how to construct a ‘Fair Test.’
- Discuss and share each other’s experiences to improve their professional development.
- Construct new knowledge about content and pedagogy.

The participating student teachers will be able to:

- Develop questions based on their own curiosity about their pupils’ learning
- Investigate the questions with their pupils systematically and documenting what happens during the process of inquiry
- Collect and Analyse data from their classrooms, including their own observations and reflections
- Examine the pupils’ assumptions and belief
- Articulate pupils’ theories
- Discuss their research findings with other colleagues
- Present findings to others
- Write about their research

The participating lecturers will be able to:

- Identify the strengths and weaknesses of the process
- Review learning outcomes
- Building effective links between research team
Facilitate student–teachers by observing teaching-learning process
Make discussions with student teachers to moderate the activities according to the practical settings

Through this professional development programme student teachers will be able to:

- Identify the teaching and learning objectives of given themes of ERA curriculum
- Facilitate pupils to recognise the features of living things, materials and events in the natural and made world, including looking at similarities, differences, patterns and changes
- Encourage pupils consider environmental issues
- Facilitate pupils progress from explaining phenomena in terms of their own ideas to explaining phenomena in terms of accepted scientific ideas or models
- Facilitate pupils plan, carry out and evaluate scientific investigations, particularly how to construct a ‘fair test’
- Support pupils in the use of low-cost and reusable materials in Science Activities
- Encourage pupils to discuss their observations, questions, predictions, explanations to justify a conclusion

This professional development model has the potential to help teachers reflect critically on their practice and to construct new knowledge about content and pedagogy in Primary Science through Environment Related Activities Curriculum.

References:


Syllabi for Primary pre-service teacher education course-Ministry of Education Colombo: Sri Lanka


