COMPARATIVE ANALYSIS OF ELEMENTARY SCIENCE TEACHER PREPARATION IN AUSTRALIA, BRAZIL, AND CANADA

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Abstract

The overarching rationale for comparative studies research is to promote local understanding through international analysis and cooperation. In the area of science teacher education, there is only one significant and recent publication (Abell, 2000) that addresses science teacher education from an international perspective. This paper builds upon this seminal work by reporting on a comparative analysis of elementary science teacher preparation programs across three different contexts: Australia, Brazil, and Canada. Specifically, the research provides a qualitative analysis of the similarities and differences of science teacher certification policy and general institutional program requirements for a specific jurisdiction within each nation. Emerging from these analyses is a number of themes, highlighting common structural and functional mechanisms underpinning teacher education preparation. The findings from this study bode well for future comparative studies research of science teacher education.

Key words: Science education, Teacher education, Comparative studies.

1. INTRODUCTION

Acknowledging the unique political, cultural, and historical differences among nations raises questions about the potential benefits of conducting comparative studies in teacher preparation. To address this concern, Phillips (2000) identified a number of reasons for pursuing research of this type based around the possible discovery of alternative models for organizing educational systems; descriptions of consequences from reform interventions tried in other countries, and; opportunities for fostering cooperation and mutual understanding among nations by discussing differences and similarities and the reasons for these variations.

In the area of science teacher education, there is only one significant and recent publication that addresses this critical area from an international perspective: Sandra Abell’s (2000) edited publication, Science Teacher Education: An International Perspective. In the book, various authors examine comparative policy and practice issues in science teacher education, preservice teacher learning across a number of international contexts, and cross-cultural perspectives on science teacher education based around international partnerships. Other notable publications in journals include Cobb (1999) and Lloyd et al. (1998).

This paper builds upon this seminal research through a comparative analysis of elementary science teacher preparation across three different contexts: Australia, Brazil, and Canada. The paper describes the educational contexts of each country to provide an overview of current educational policy and practice. Following this, a synthesis of an elementary science teacher preparation program for a specific jurisdiction (i.e., state/province) within each nation is presented. Finally, a comparative analysis across three science teacher preparation courses is undertaken to identify common themes and disparate concepts.

2. METHODOLOGY

The overarching research question being addressed is: What are the similarities and differences between elementary science teacher preparation courses across specific educational jurisdictions within Australia, Brazil, and Canada? To address this question, national and jurisdictional context information, policy and program data for elementary science teacher certification, along with additional documents (i.e., educational Ministries, handbooks from authorities, university program calendars, course materials on websites and in printed formats) were collected for an educational jurisdiction in each country. Each document was interrogated using content analysis to provide qualitative analysis of the similarities and differences in science teacher preparation programs across the three nations.
data. The first phase of analysis involved open coding by segmenting the data to produce underlying concepts. These concepts were then considered in light of commonalities to form categories using a grounded theory approach (Creswell, 2002). The emerging categories were considered in relation to similarities and differences to produce overarching themes.

3. EDUCATIONAL CONTEXTS

3.1. Australia
The provision of education lies within six states and two territories resulting in eight different educational authorities monitoring curriculum, assessment and educational standards across the country. Governance of this type allows each jurisdiction to meet the needs of students by developing curricula relevant to the specific educational context. This has resulted in eight different curricula operating in Australia for many years. While supported by many educators, it results in a lack of consistency at a national level. To address this issue, moves are underway to implement a National Curriculum although this is causing considerable debate and angst. In the interim, the Federal government has endorsed National Statements of Learning in five disciplines, including science (MCEETYA, 2006). The science statement embraces three broad areas: Science as a Human Endeavour, Science as a Way to Know, and Science as a Body of Knowledge. At present these statements are the only commonalities in curricula across all states and territories in Australia.

3.2. Brazil
In Brazil, the Ministry of Education (Ministério da Educação [MEC]) is the body responsible for organizing and integrating the national education system of education. MEC, through its Secretariats, coordinates the policy guidelines for the organization, evaluation and qualification of teachers for both schooling levels, Basic Education (0-6 year-old; 7-14 year-old; 15-18 years-old) and Higher Education (Universities and Superior Education Institutes). However, the states and municipalities also establish guidelines and instructions for their specific education systems based on MEC policies. In accordance with the last issue of National Law of Guidelines and Foundations for Education, only two institutions are authorized to provide qualifications for teachers to work within the Basic Education level: Universities and Superior Institutes of Education (Brazil, 2005). The qualification of science teachers for the final years of Fundamental Education is governed by the Brazilian National Curricular Guidelines for Preparation of Basic Education Teachers, and also by the Curricular Guidelines for Courses of Biological Sciences. The curricula for teacher education are the responsibility of each educational institution (i.e. universities) and these programs for accreditation of teachers have validity in all national territory.

3.3. Canada
In Canada, there is no Federal department of education and no integrated national system of education (Council of Ministers of Education, 1997). In each jurisdiction Departments or Ministries of education are responsible for the organization, delivery, and assessment of education at the elementary and secondary levels (5-18 year-olds; kindergarten to year 12). The institutions in the postsecondary system (i.e. Universities) have varying degrees of autonomy from direct provincial government control. Like Australia, each province or territory has its own provincial curriculum for science and technology education. In 1997, the Council of Ministers of Education released the Common Framework for Science Learning Outcomes, K-12: Pan Canadian Protocol for Collaboration on School Curriculum. This document, while not having any authority within any educational jurisdiction in Canada, has been adopted to some degree by all provinces and territories (Fazio et al., 2007). Science teacher education in Canada is offered by accredited institutions (i.e. Universities). Each degree-granting post secondary institution must abide by provincial educational legislation in order to be accredited but has control of its own science teacher education curriculum.

4. INTRACOUNTRY SCIENCE TEACHER PROGRAMS

4.1. Australia – New South Wales Case Study
Presently, there are two pathways for entry into an elementary teacher education programme in NSW. The first requires students to complete Year 12, which involves an
external examination. Acceptance into the program (in most instances) requires students to meet a particular Tertiary Entrance Score (TER) that varies from year-to-year. Students enrol in a Bachelor of Education (B.Ed.) program (4 years) that provides knowledge of subject disciplines, pedagogy, and curriculum. The second pathway allows students to complete a three-year Bachelor of Arts/General Studies/Science (or similar undergraduate University degree), followed by a one or two-year education program (i.e., Bachelor of Teaching).

Accreditation of all elementary teacher education courses/programs occurs through the NSW Institute of Teachers. The process requires that Universities address 45 professional teaching standards around seven elements. Students complete their degrees having attained Graduate Teacher status and are able to teach in NSW schools. To meet these standards, elementary teachers are expected to demonstrate knowledge of mathematics, English, human society and the environment, physical education, creative arts, science and technology, and teaching and learning. They must complete a specified number of courses within each subject, with two required for science and technology. Underpinning each science and technology course is constructivism and the importance of building upon the personal experiences and understandings (Driver et al., 1994). While some lectures are included in the courses, most of the teaching is conducted through workshop sessions around particular scientific themes identified in the syllabus. A central focus of the workshops is an inquiry or investigative approach using group work and collaboration. The aims of the workshops are that preservice teachers develop skills around observing, questioning, predicting, testing, collecting, recording and analysing data while developing an understanding of scientific concepts. In this manner students develop subject content knowledge and skills that are linked to a range of pedagogical strategies appropriate to the elementary classroom. In addition to University work, all elementary preservice teachers complete either 110 days in schools for B.Ed. students (i.e., four-year program) or 60 days for Bachelor of General studies/Bachelor of Teaching students. Clearly, this highlights an issue around the inequity of practice teaching experience provided for the two groups of students.

In considering elementary teacher preparation for science and technology in the NSW context, there is much scope for competent teachers to engage their students using problem-solving and investigative processes. However, with the majority of students entering into teacher education programmes lacking confidence in their own background knowledge and teaching experience many are quickly daunted and overwhelmed. Subsequently, the cycle of disengagement with science that is so prevalent in the literature (Goodrum et al., 2001) is reinforced with teachers relying on worksheets and teacher-directed lessons dominating their teaching while students become less and less interested. NSW is currently in the process of developing a new syllabus to address some of these concerns.

4.2. Brazil – São Paulo Case Study

In Brazil, teaching science to students in the final grades of Fundamental Education (i.e., 11-15 years-old) is undertaken in most cases by teachers from a range of academic backgrounds. This is due to the diversity of laws and guidelines supporting different academic trajectories into teaching (Garcia et al., 2006). In addition to this difference, many of the Fundamental Education students experience science with teachers who have not completed formal courses in the discipline (Bizzo, 2005). This has emerged because Brazilian legislation does not stipulate the need for specific education in science for teaching the final grades of Fundamental Education. Without this, most Universities offer courses in other discipline areas thereby impacting the quality of science education in the country. Subsequently, most teachers in Brazil who teach science to students at this level major either in other subjects or Biology. According to Argüelo and Gimenes (1991) and Wortmann (2003) students in these years of schooling need a curriculum based around physics and biological concepts.

To address these issues, four courses focusing around enhancing the qualifications of Fundamental Education teachers are currently being implemented in Brazil. One course in the State of São Paulo (University of São Paulo - East Unit) provides a full major in Nature Science for teachers of Fundamental Education grades. This new course emphasizes the study of nature by integrating Physics, Chemistry and Life, and Earth
Science. This set of integrated knowledge around nature is critical in promoting the relationship between humans and the natural world while helping to produce educated future citizens who are concerned for the Earth and recognize their responsibility around its resources. Aimed at qualifying teachers for the final grades of Fundamental Education, the curriculum takes into consideration not only the science-related specific knowledge but also the pedagogical qualification. In summary, the course is structured into four parallel topics entitled Pedagogical Education, Theoretical and Practical Basis of Education, Teaching Methodology, and Specific Knowledge.

The first year is the Basic Cycle in that it establishes the connection between the new paradigms of science and culture and it provides students with an initiation through an interdisciplinary approach to the comprehensive and critical issues of scientific and social knowledge. Underpinning the general pedagogical project of the program is problem based learning along with an investigative approach. As from the second year, the course develops general and specific pedagogical education around Nature Science (including Physics, Chemistry, Earth Science, Universe and Life, plus required content in Mathematics and Information Science). The structure is intended to overcome the lack of articulation between theory and practice. The program is administered over 4 years and comprises 8 modules (6 months each) with a total of 838 days in total. The courses consist of academic, scientific and cultural activities. As well, there are 100 days of teaching practice in the subject areas.

4.3. **Canada – Ontario Case Study**

All of Ontario’s initial teacher education programs, under the auspices of Universities, are accredited by the Ontario College of Teachers (OCT). The review of teacher education programs includes determination if it reflects current Ontario subject curriculum plus relevant Ontario Ministry of Education legislation and government policy, including the OCT’s *Standards of Practice for the Teaching Profession* and the Ethical Standards for the Teaching Profession (OCT, 2008). Also included is a review of an education programs’ conceptual framework, course content and program format and structure, practicum requirements, resources available to teacher candidates, faculty qualifications, institutional policies, and procedures governing the program. While the standards for accreditation of teacher education programs in Ontario are ample, there are no noteworthy subject-specific criteria (other than curriculum congruence) for accrediting elementary science teacher education programs in Ontario.

In Ontario, there are two common pathways for becoming a certified elementary teacher: (a) one-year baccalaureate or consecutive professional year program; (b) concurrent or integrated four or five year program (Epp & Epp, 2000). At the end of each program, a B.Ed. is granted to the teacher education program. However, with the concurrent pathway, a secondary undergraduate degree may also be granted (e.g. B.A., B.Sc.), as the degrees are typically completed concurrently. The elementary teaching degree granted from these two pathways cover two consecutive divisions: primary/junior (years 1-6; ages 6-11), and junior/intermediate (years 4-10; ages 8-15). In addition, the provincial elementary curriculum in science and technology (Ministry of Education, 2007) is designed only for years 1-8. Therefore, elementary teacher candidates generally do not teach in secondary schools, even though junior/intermediate teachers are certified to do so for grades 9 and 10 only.

Primary/junior teachers are not required to have a teaching specialty (e.g. science) and are considered generalist, capable of teaching all subject areas. Students undertaking a concurrent program, particularly in preparation for teaching, are likely to take a science content course(s) as part of their concurrent education degree, although this is not a requirement. With a consecutive program, no science content courses are required for a B.Ed. degree. In contrast, junior/intermediate teachers are required to have one specialty teachable area (e.g., science, mathematics). These elementary teacher candidates would have an undergraduate degree in science, undertaken prior to applying for a consecutive elementary teacher education program, or completed in concert with a concurrent education program. Admission to an Ontario elementary teacher education program can vary, but students do require a high school diploma. Typically in the Faculty of Education, only one elementary science and technology pedagogy course (i.e. methods courses) is required for an accredited elementary education program. These
courses are intended to support curriculum and instruction of the Ontario Science and Technology curriculum (Ministry of Education, 2007). The courses range from 18-40 contact hours, depending on the institutional emphases and the education program (concurrent versus consecutive). It should be noted that no mandated contact hours are required. The course content can vary considerable from university to university, but generally, the science pedagogy course are seminar based combined with some “laboratory” component. Courses may include some of the following topics: lesson planning and assessment in science; safety and material management; science instructional strategies; information and computer technology; curriculum scope and sequence; integration of curricula; and, dealing with diverse student populations.

Finally, elementary teacher certification requires a minimum of 40 days practicum experience in schools, yet most Ontario universities expect students to complete well above this number of in-school practice teaching days. For primary/junior elementary teachers, no science teaching practicum is required; yet for junior/intermediate teachers who specialize in science, they are required to complete some of their practice requirement teaching science.

5. FINDINGS AND ANALYSIS

5.1 Policy and Practice Themes in Elementary Science Teacher Preparation

The three international case studies presented above highlight a number of similarities in terms of levels of policy development and degrees to which these policies are implemented to provide consistencies (see Table 1). It is interesting to note that while there are various educational authorities within each country with a brief to develop policy, ultimately in most cases it is left to the Universities to develop and implement teacher education programs.

Table 1. International comparisons of teacher education across themes

<table>
<thead>
<tr>
<th>Emergent Themes</th>
<th>Similarities</th>
<th>Differences</th>
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<tbody>
<tr>
<td>Level 1 Policy - National educational authority</td>
<td>Organizations exist in each country providing overarching expectations rather than specifics around teacher education.</td>
<td>Australia is working towards a National Curriculum.</td>
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<tr>
<td>Level 2 Policy - Localized educational jurisdictions</td>
<td>The guidelines and requirements for teacher education in the three jurisdictions is specified including contact hours, curriculum congruence, and practical experience.</td>
<td>In Ontario, course requirements but contact hours are not specified by the Ontario College of Teachers.</td>
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<tr>
<td>Level 3 Policy - Universities develop teacher education programs</td>
<td>Universities in each of the jurisdictions ultimately decide on the structure of the programs, content to be included, and hours provided.</td>
<td>In NSW the recently devised Institute of Teachers ensures that Level 2 Policy becomes consistent across all Universities in NSW.</td>
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<tr>
<td>Flexible entry into program with no science requirement</td>
<td>Requirements into elementary teacher education do not require science at any level in all jurisdictions.</td>
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<tr>
<td>Minimal science background – no science specialization</td>
<td>Students complete set hours in science as with other subjects. May involve lectures/workshops/practical work.</td>
<td>In Ontario, teachers may have a science specialization, but is not a requirement.</td>
</tr>
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<td>Integration of science with pedagogy</td>
<td>In each jurisdiction strong links between pre-service teachers learning science and methods of teaching science.</td>
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6. IMPLICATIONS
Our comparative analysis of elementary science teacher preparation identified many coherent similarities, highlighting the common structural and functional mechanisms that underlie teacher preparation regardless of the nation. This bodes well for future research involving discovery of possible alternatives for organizing elementary science teacher educational systems based on more detailed descriptions of specific university teacher education programs. In turn, it also provides a basis to help foster co-operation and mutual understanding among nations by discussing cultural and political differences and similarities in science teacher education.

7. REFERENCES


