Report to BIRS 2006: 06frg310 Statistical Models for the Study of Science Teacher OTL in Canada

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Overview According to the my previous work, a conceptual model was brought to the participants of 06frg310 (see Figure 1). Due to the fact that this conceptual model was largely derived for an international comparative study of mathematics teacher preparation programs, Drs. Ruth Childs (a psychometrician from University of Toronto), David Fry (a physicist from University of Calgary), Julie Luft (a biological science education & secondary science educator from Arizona State University), and Jesus Vazquez-Abad (a physics education & secondary science educator from Université de Montréal) contributed their own subject specialties in transforming the conceptual model into a data collection and analysis model (see Figure 2). A graduate student, Mr. Tony Pascuzzo, from the Faculty of Education, University of Calgary was also present. During the week, most of our time was spent devising the model then took pieces of the model out for focus discussions during the week. This report briefly describes what has been accomplished and what our next steps will be.

0.1 Transformation of the STSO Conceptual Framework

Basing on the STSO [1] conceptual framework, all participants agreed with Dr. Child on the idea of constructing a flow-chart to describe the developmental stages of a teacher and putting this development in the contexts of Professional, Institutional, and National variables (see Figure 2). The figure represents those who choose to become teachers, and what variables influence such a decision. For example, in a given institution of teacher education, what opportunities are provided that shape that individual. If the individual continues to teach, what professional and national contexts is the individual facing? Taking this flowchart of becoming a science teacher in Canadian secondary schools, we then focused much on understanding the academic background of the applicants (Transcript Study), and what can be done to assess the impact each institution has on training people to teach (Pedagogical Content Knowledge in Science). We also devoted our discussions to instrument design.

0.2 STSO Transcript Study Design

The participants suggested that if possible, we should try to compare the transcripts result of Faculty of Education students' courses to the requirement of the students who want to apply to the Faculty of Science graduate school requirement so we have one extreme to compare students teachers' background to.

More discussions were devoted to defining the quality of candidates' background:

1. What kind of courses do they take?

2. What kind of grades do they get?

[1] STSO stands for Survey of Teacher's Sciences Opportunity

3. Are there visible patterns in course-taking in the admitted applicants versus the inadmissible ones?

The participants also suggested that we should obtain the course syllabi from the Faculty of Science at the University of Calgary to study the nature of courses; approaches to study are similar to those that:

- has been done in Bulgaria P-TEDS [2] meeting on constructing an ideal science curriculum that contains content topics as well as pedagogical topics for science teachers,
- with the ideal curriculum, we will then compare students' transcript data against the ideal curriculum to see if the admitted population who graduated from the science faculty of the University of Calgary have received an adequate preparation in sciences that are helpful to teach secondary sciences.
- with the ideal curriculum, we can also code the syllabi from all the courses in teacher education program to understand if students' experiences in the teacher education programs are adequate in preparing them to address both pedagogical knowledge and pedagogical content knowledge in sciences.

Lastly on the transcript discussion, a suggestion came from a distant collaborator, Dr. Richard Houang from Michigan State University, when meeting in Bulgaria regarding P-TEDS, was that to understand the quality of the courses, we may need to:

- Check with the U.S. National Center of Educational Statistics (NCES) list of science course title catalogues for high school courses to see if it is possible to generate an equivalent list of university science courses
- Check with each professional organization (National Science Teacher Association or Association of Teacher Educators of Science, etc.) to see if they have a list of required courses for students in each discipline at the university level; similar lists may be obtained from the Association of Physics Teachers, Association of Biology Teachers, or Association of Chemistry Teachers.
- Check the mathematics requirement in each of the sciences for it may be interesting for future policy recommendations on entry requirement of future science teachers

[2] P-TEDS is the pilot study of TEDS. The Teacher Education and Development Study in Mathematics (TEDS-M) is a collaborative effort of worldwide institutions and experts in mathematics, mathematics education, teacher education and comparative research design. The project is sponsored by IEA and receives partial funding from the National Science Foundation. TEDS-M relies on rigorous methodologies, the use of national representative samples, and large-scale surveys of teacher education institutions, teacher education faculty, and future teachers to study the policy, organization, outcomes, and costs of preparing future mathematics teachers at the primary and lower secondary levels across more than 20 countries.

- Determine how to divide courses into lower division (foundational courses) and upper division (advanced courses); then check with each university if the division is appropriate (e.g. 100 and 200 level as lower; 300, 400, 500 as upper).
- Divide the courses into subject specific and general education experiences
- Look for relationships of the following variables:
  - Lower division (GPA)
  - Upper division (GPA)
  - General education experiences (GPA)
  - Subject specific (GPA)
  - Subject specific (number of courses)

0.3 Measuring STSO Attained Curriculum: Studying the Pedagogical Content Knowledge in Sciences

To construct a multiple regression model, we need to have an independent variable. The variable I am interested in measuring is pedagogical content knowledge (PCK) of science teachers. Both Dr. Luft and Dr. Vazquez-Abad presented their past research studies individually and the group came to the conclusion that there are still a lot of arguments on how difficult or improbable it is to measure PCK. An example item was proposed to the BIRS participants. The problem of this item, as pointed out by the BIRS participants is that we will have no idea about the classroom context. The item is decontextualized and teaching is a very contextualized profession. To understand a teacher's knowledge, maybe a follow-up interview can provide some insights into the student teacher response on the item. An interesting interview question is: why they chose one of the items.

Furthermore, several suggestions derived from the meeting were:

- Give this item to student teachers to find out how the student teachers will respond.
- Use contemporary literature such as the new book in 2006 written by Loughran et al. [3] to find a protocol of what PCK means to STSO research team then revise the item. However it was cautioned that the authors argued that PCK can not be categorized nor measured in a quantitative manner.
- Use the protocol derived to code the audio data collected by Dr. Julie Luft at Arizona State University to test the validity of the PCK protocol.

[3] Loughran, J.J., Berry, A., & Mulhall, P. (2006). Understanding and Developing Science Teachers Pedagogical Content Knowledge. Rotterdam: Sense Publishers.

Some possible questions that can be asked to probe someone's PCK in sciences are:

1. What do you think makes an effective lesson in science?
2. What resources are helpful in preparing for the lesson?
3. What is the 'minimal level' of teacher content knowledge for a beginning science teacher to teach this topic?

0.4 STSO Instrument Analysis and Design

Much of our time was also spent on revising the instruments gathered from P-TEDS:

(i) Future Teacher Survey:

- Pre Program & at the end of the program survey

(ii) School-based faculty Survey (Partner Teachers and Field Faculty)

(iii) Sciences Faculty Survey

(iv) Sciences Pedagogy Faculty Survey

(v) General Pedagogy Faculty Survey

(vi) Institution Survey

Future Directions The participants have contributed greatly to the design of the methodology. We anticipate to continue receiving support from BIRS in the next two summers (2007 & 2008) so that the model developed from this summer can be tested using the data collected in the next two years.

Appendix: Figures

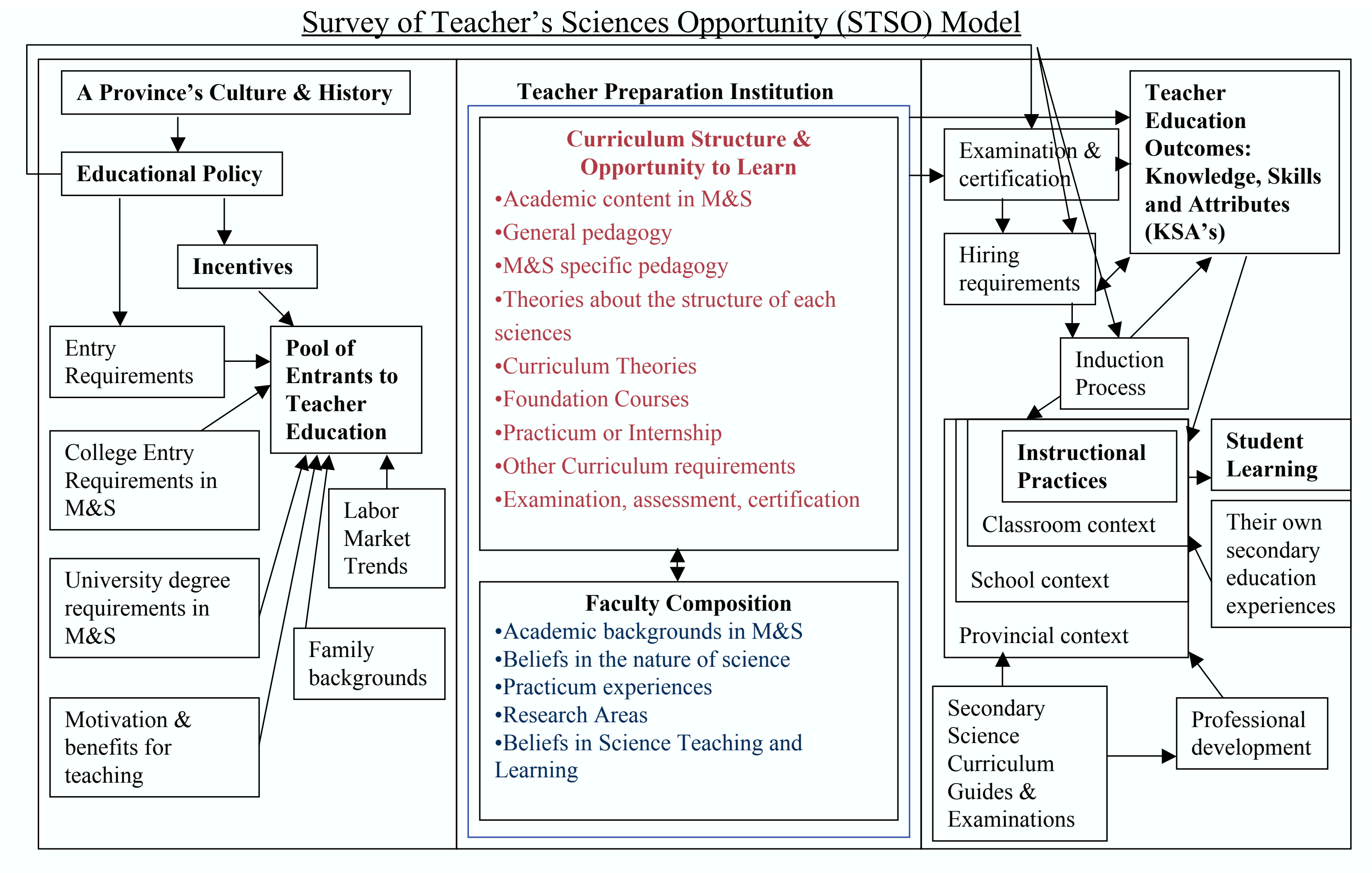

Figure 1: STSO Conceptual Framework Model: Variables Involved in Preparing to Teach Sciences

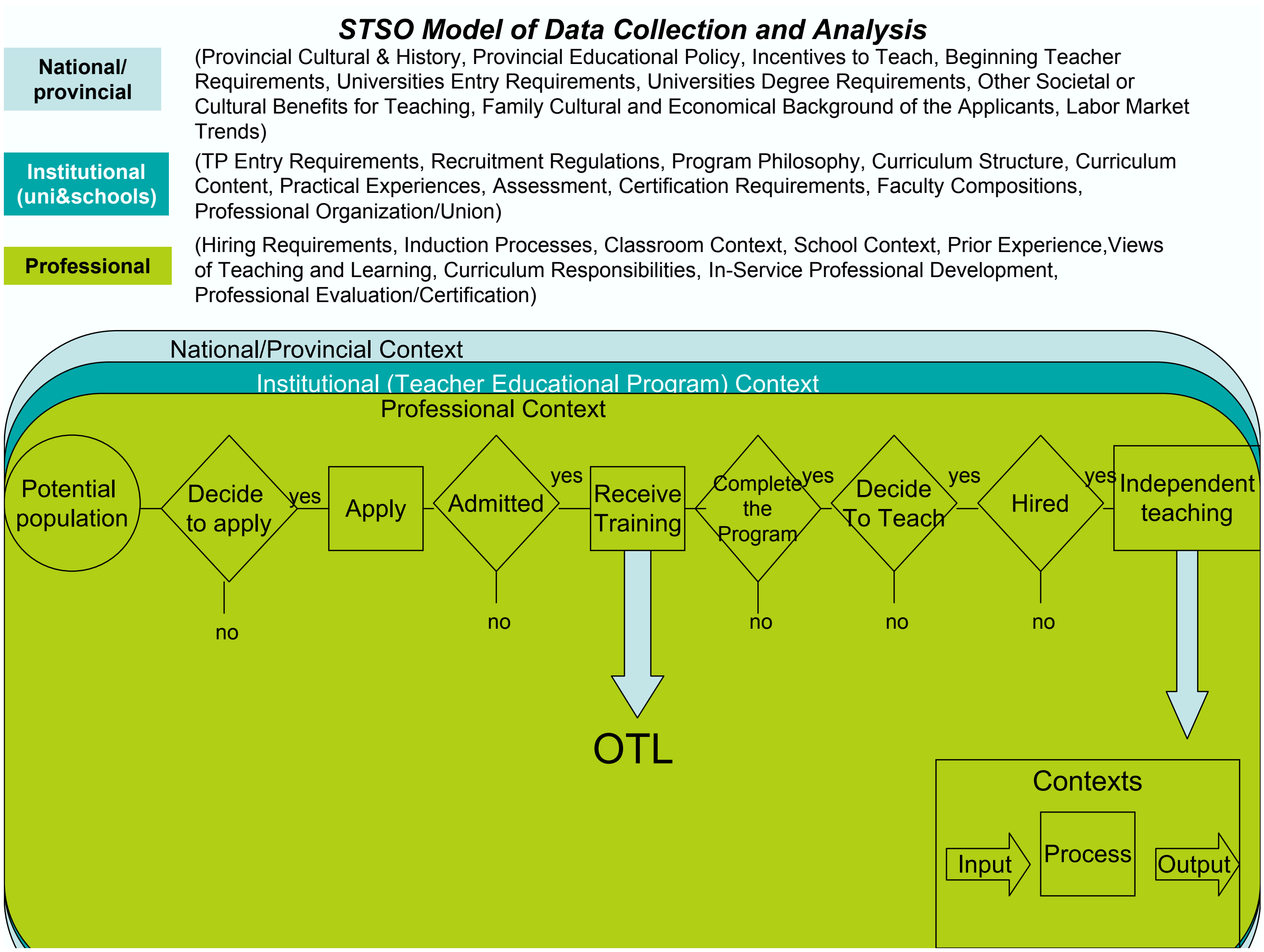

Figure 2: STSO Data Collection and Analysis Model: Contextual Factors Involved in Becoming a Secondary Science Teacher