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The Development of Exemplary Science Teacher Education Programs over 50 Years

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Abstract

This article focuses on the development of exemplary science teacher education programs. References are given to the changes that took place to the Iowa Science Teacher Education Program at the University of Iowa. The transformation that occurred because of the Stalish Research project and Investigating the Meaningfulness of Pre-service Programs Across the Continuum of Teaching (IMPPACT) are highlighted. Specific results of IMPPACT for improving science teacher education as well as the semester hours of credit for the courses needed and developed to provide an outline for reform efforts are provided.

The Iowa Science Teacher Education Program at the University of Iowa in 1960 was like most. It consisted of one three semester hour methods course which was required for licensure. It was also the course required for a person minoring in -- Home Economics and Physical Education programs (for both male and female students). The General Science major in Liberal Arts was also recommended as the undergraduate program for pre-medicine, dentistry, and other health fields. The "methods" course frequently enrolled nearly 200 students each semester. It was the only course needed for teaching licensure other than 45 semester hours of science and several general Liberal Arts courses. Specifically the General Science major included the 3 s.h. methods course, 30 s.h. in one science and 15 s.h. in a second science area. It seemed silly to think that teacher preparation program course could be completed with a single course taught as a lecture in a large auditorium. This situation did not change all at once!

The research regarding new teacher preparation across the U.S. was summarized by Newton and Watson and reported as a most interesting and needed study of teacher education which was completed in1968. The closing statement indicates where we were as the Seventies arrived.

> A few of the most obvious trends in science education today can be highlighted rather simply. First, the diversity of programs in science education is very great. Whether one

> talks about methods courses, practice teaching arrangements, course requirements, or almost any other aspects of teacher preparation programs; there are examples of almost every conceivable pattern to be found somewhere in the nation. Second, the lack of basic, objective evidence on the effectiveness of teacher education is striking. The courses and programs described are almost entirely acts of faith with little or no feedback or follow-up information to support the practices that institutions follow. In view of some of the student comments reported in the study, the demand for a further investigation of the effectiveness of these programs seems to be a critical priority. Finally, the isolation of science educators from their colleagues at other institutions seems to have some serious implications for programs for the preparation of new science teachers. The chaos in the profession is probably one consequence of the inability of science educators to confer about and agree upon the goals and structure of the teacher preparation program in the sciences. The times call for a strong professional organization to assume a leadership role in the focusing of energy and efforts in science education.

The first change in the Iowa program was the creation of a single methods course enrolling only teaching majors – and a second one for future elementary teachers. The elementary ones often consisted of four sections to accommodate the large number of elementary education majors. The secondary science courses were understood to deal precisely with science teachers preparing for licensure. The courses were taught in the University of Iowa Laboratory School where all classes consisted of 30 students in each of grades K-6 and the doubling of that number for 7-12 grade students. All the teachers in the regular lab school were outstanding teachers who were working on PhDs in science education (outside of the College of Education!). The PhD students (often more than 10) were the teachers in the lab school and so the number changed completely over the period of five years. All were involved with numerous Action Research projects individually and collaboratively. Two new methods courses for secondary science teachers were developed in science (7-9 and 10-12). The number of science students in science classes in the secondary school was limited to 20 taught for one class period – the K-6 number of students remained at 30. Since science was the only course with 20 students in grades 7-12 – science was taught at the same time period by the teachers in separate lab rooms.

The first additional course to be added to the teacher education program was developed and taught as an elective (later required by all) in 1959. It was constructed to match the Worldview Domain defined as views of the meaning of science. It considered the history of science as well as the theory and philosophy of science. The two methods courses were followed with one course for biology and one for physical science majors (both teachers and students) for several years. Later the Methods Courses were increased to three each involving work in regular classrooms and schools along with teachers interested in continuing their own education and the nature of current reform efforts.

The 70s brought several opportunities to work with federal funding for high ability students (and often teachers interested in the reform of their science programs). Most financial support (from NSF) for separate teacher groups was conducted for one or two months during the summer sessions – each followed by two short courses during the following academic year. Often there were up to five such separate sessions offered across the whole state of Iowa each year. The greatest changes occurred in 1990s when the U.S. Department of Education funded the Salish Research project. The leaders in the department in Washington, DC helped choose the

universities and programs to assure that all types of science teaching preparation would be involved in a verity of colleges. The ten universities selected shared the research results arising from their teacher education programs. This was a change from the original use of involving only students enrolled in major research universities. All programs were planned to also improve teaching and teacher actions designed to assist student use of their study efforts in their personal lives.

As the reform efforts were underway, it was interesting, to note that four of the ten Salish school settings had two types of licensure – one totally on campus and one that was offered in schools where they assumed part-time teaching rolls. These programs used outlines to meet those offered on campus. These teachers and students were assigned to teach while working to complete licensure courses. A newly funded program (1996-99) noting difference in the route for licensure was funded with a separate grant from the MacArthur Foundation and termed Salish II. It was a program that prepared teachers for incomplete licensure – during the first few years before being fully licensed. Two programs developed as teacher interns were not used for Salish I offering -- but with classes funded separately over three years with instruction on campus involving fully University staff. The Salish II efforts also involved school administrators, and some of the varying faculty with credentials for at least three or four years of experience. The major finding from the MacArthur effort revealed that more teachers were needed to plan and develop exemplary science programs. Exemplary science teaching cannot be only methods courses with focus on methodology and involving science teachers with selected classes of students – often enrolling the 30 students. Many of the eight courses required on campus were considered as valuable requirements for others to use. Certainly the focus was on research, specific school projects, and varied opportunities to work as co-collaborators with one another.

As student research continued with reports of science education research, there was great interest in trying some of the examples and new ideas. Initial results were reported to other researchers and used for exchange at professional organization programs. These other major researchers were invited to try at least two of the reform ideas from the Iowa program. Their research was defined as Salish III and involved 15 new universities. It was used to gain more information regarding use of the original changes in programs in the ten Salish I universities. The results illustrated the power of collaboration and its effect on teacher learning. Science teacher reform was professed as being a science itself. This means it starts with questions, attempts to answer, and collecting evidence to support it. Too many still seem to miss the point, and the meaning, of making sense about where all are actually “doing” science.

Major Salish findings were:

1. Students were much more likely to believe they could express their opinions about classroom instruction than to believe they could actually play a role in the decision making about that instruction.
2. Science students understood better the nature of science.
3. Student classes were seen by science students as more relevant to their daily lives.
4. Students were able to apply science concepts and process skills in new situations.

One of the original researchers with Salish I was selected to head a new program at Syracuse University – using ideas from the Salish I, II, and III. That was John Tillotson who proposed a project to extend Salish into another major research effort. This new research effort was titled:

Investigating the Meaningfulness of Pre-service Programs Across the Continuum of Teaching (IMPPACT) with major funding from NSF. It was offered as an attempt to define specific research efforts and to respond to the 1968 findings reported earlier by Newton & Watson.

The IMPPACT (2004-2012) continues with new and enlarged research efforts. The IMPPACT project has existed over a decade and has resulted in more evidence of what is needed for an exceptional program, especially from the Iowa and Syracuse programs. North Carolina State was selected as one of the original Salish projects but as one to provide comparisons like the typical one year methods program that was required for "the" major course offering. There was very little effects of science teaching in the schools beyond a single course required of students prior to their student teaching. This "least changed" program involved with IMPPACT consisted of only one methods course, only developed for undergraduate students, and involved virtually no students being required to teach via specific projects. There was little or no student experience with collaborative teaching and learning. The one unique difference was the focus and ties to research for science educational technology. Again this was direction translating from teacher to student.

The two fundings for Salish and IMPPACT consist of eight course ingredients for licensure and general physiology. Figure 1 indicates the semester hours of credit for the courses needed and developed to provide an outline for reform efforts. A basic feature of the reforms started with separate classes consisting of eight semesters of program credits and descriptions reporting on evidence of success for the enlarged teacher education program per se.

The specific results of IMPPACT for improving science teacher education are:

1. Stressing the nature of science and how it affects daily living, problem resolutions, and continuing active involvement.
2. Stressing the meaning of STEM education efforts – beyond the individual four science disciplines.
3. Stressing that science teachers must learn to practice science and use it as a basis for teaching, i.e., start with student questions, their proposed answers, ways of collecting evidence to support ideas, and sharing the results of the whole process with others.
4. Preparing exemplary science teaching to be a collaborative enterprise which continues throughout a lifetime.

A. Courses for Credit

1. A Major in one science area (i.e., biology, chemistry, physics, earth science)	30 s.h.
2. An additional science minor	12 s.h.
3. Three methods courses over three semesters (focusing on elementary, middle, and high school)	9 s.h.
4. A field experience in a school coordinated with each methods course	9 s.h.
5. A science research experience dealing with STEM for a semester (lasting a full year or two)	9 s.h.
6. Four applications of science courses (one for each major science discipline)	12 s.h.
7. Three courses in the "Social Sciences of Science" (philosophy, history, sociology)	9 s.h.
8. Research projects for publications, thesis, vita preparation	3 s.h.
Total	93 s.h.

B. Teacher Education Licensure Efforts Aside from "Courses"

1. A continued use of Teacher Leaders like those in the Iowa Chautauqua Program.
2. Communication with university instructors for at least three years after licensure.
3. Experiences with "Doing" real science in courses or as separate projects (not Textbook or Lab Manuals!).
4. Consider wider definitions and uses of "Science in Society" that focus on current, local, and personal issues.
5. Planning collaborative projects with practicing teachers designed to deal with real problems (instead of using only what is in textbooks and/or lab manuals – or even National Standards!).
6. Collaboration regarding M.S. research -- often with Teacher Leaders who meet the graduate requirements.
7. Coordinate program with National Standards regarding teaching and student assessment of learning.
8. Practice with organizing and evaluating reform efforts.

Figure 1. Features of most "successful" science teacher education programs.