Linking teaching and learning: a Masters level programme for primary and secondary classroom teachers

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Abstract

This article describes the development and structure of a Masters programme designed for practising primary and secondary school classroom teachers in the United States. Designed in collaboration between the Wright State University Colleges of Science and Mathematics and Education and Human Services, this hybrid postgraduate programme offers long term professional development in Earth/Space and Environmental science and includes coursework designed to increase their understandings of science content knowledge, inquiry based science teaching, the use of technology in the classroom and content specific pedagogy and assessment strategies. Courses are taught in the field during the summer months and on-line and in traditional classroom settings during the academic year. The Masters of Science in Teaching (Earth Science) programme has attracted a growing number of participants in response to legislation mandating an increased emphasis on Earth/Space/Environmental science and a newly mandated program of state-wide high stakes testing.[1] The Masters of Science in Teaching (Earth Science) programme has positively impacted departmental enrolment figures while the interactions with primary and secondary teachers have brought a renewed sense of the importance of teaching, learning and assessment to the Department of Geological Sciences faculty.

Introduction

Science teaching reform efforts in the United States are cyclical. In 1957 after the launch of Sputnik by the former Soviet Union the American educational establishment responded with efforts to increase the quantity and quality of science courses that American students were taking. The focus of the reform efforts at that time was to produce more scientists. Science education for the student not headed for a science career was given scant attention. The latest round of reform began with the publication of *A Nation at Risk* (AAAS 1983) which suggested that the economic future of America hinged on all students gaining a measure of scientific and technological literacy. In response to this call for the reform and the development of the National Science Education Standards (NRC 1996) many states developed their own science standards that tracked the national science standards in content and suggested pedagogy. Ohio is one such state.

In 1994 the Ohio Department of Education published Science: Ohio's Model Competency-based Program (Ohio Department of Education 1994) and developed a programme of high stakes testing of students in the fourth, sixth, ninth and twelfth grades. Students in these grade levels are approximately nine, eleven, fourteen and seventeen years of age. These proficiency tests were aligned with the content and inquiry based pedagogy suggested in the National Science Education Standards. The results of the state wide tests are used to determine the effectiveness of local education agencies, individual schools and as measures of teacher success in their classrooms. Because the new Ohio science programme was aligned with the National Science Education Standards subjects such as Earth/Space and Environmental science suddenly became mandatory topics for the science curriculum at all twelve grade levels. Recently passed legislation mandates that starting in 2007 all tenth grade students must pass an Ohio Graduation Test in order to receive their diploma of graduation from high school. Passing the science portion of this high-stakes examination is difficult without a good working content knowledge of Earth/Space science, Environmental science and the ability to apply their content understandings in new circumstances.

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This mandate was a serious challenge because many primary and secondary school educators have had little Earth/Space/Environmental (ESE) science in their own academic backgrounds. They find themselves in the position of having to teach topics in the curriculum for which they themselves have had limited academic preparation. Short in-service workshops provide classroom teachers with much needed exposure to content and pedagogical best practices in teaching ESE science, but experience has shown that there are limitations on the amount of material that can be covered in a short workshop.

Post-workshop assessments indicate that although participants report that workshop topics have been folded into their science teaching, they perceive that without repeated, long term exposure to inquiry based science activities, they do not have the means to fundamentally change the way that they teach science. In order to meet the needs of classroom educators for long term professional development, and to reach as many teachers as possible, the Department of Geological Sciences has restructured its Master of Science in Teaching (Earth Science) degree programme. This restructuring has taken the form of the development of several inquiry-based summer field experiences, the development of several asynchronous on-line courses, and the refinement of existing courses to reflect the content and process suggested by the National Science Education Standards.

The Masters of Science in Teaching (Earth Science) programme

The Master of Science in Teaching (Earth Science) degree programme (MST) is a hybrid programme blending ESE science content courses provided by the College of Science and Mathematics and pedagogy courses offered by the College of Education and Human Services. It is housed in the Department of Geological Sciences within the College of Science and

1. High stakes testing: standardized tests that are used to reward or sanction schools for their academic performance in the US.

Mathematics. The program requires participants to complete a total of 45 quarter hours of graduate credit. Under the United States system, course credits are based on the number of classroom contact hours each week. For example, a course carrying three hours of credit would meet for three hours each week during the ten week term. It is expected that three additional hours of work per week will be done outside the classroom by students for each hour of credit a course carries. Participants in the MST program earn up to 12 graduate credits for coursework taken in the College of Education and Human Services, and the remaining 33 quarter hours in the Department of Geological Sciences. As in most graduate programmes in the United States, up to 12 quarter hours of graduate credit may be transferred in upon approval of the participants' graduate committee made up of faculty from both colleges. The Department of Geological Sciences offers the Master of Science in Teaching (Earth Science) degree to applicants possessing a Bachelor of Arts or a Bachelor of Science degree from a recognized institution.

The MST programme is available to teachers of all primary and secondary grade levels. Extensive undergraduate preparation in Earth/Space/Environmental science is not an admission requirement. Because MST classroom teachers enter the degree programme with widely different backgrounds and academic preparation in the sciences, programs of study are tailored to individual needs, and consider prior coursework and career plans and goals. Available courses are aligned with the National Science Teachers Association guidelines for the preparation of classroom teachers, and include courses in Physical and Historical Geology, Natural Resources, Earth Systems, and Oceanography.

Although the MST programme is non-thesis, a capstone independent study project is required. This project is conceived and developed with the support of a faculty advisement committee, and the project usually takes the form of an independent assignment combining Earth and Space science content, pedagogy, and assessment of student learning. Participants are encouraged to take education courses (e.g. in authentic assessment strategies) that support their project. A two quarter hour course taken in the first quarter of the academic year assists programme participants in developing ideas for their projects, and writing project proposals that include a project synopsis, literature search, timeline, and assessment plan. Examples of recent Master of Science in Teaching (Earth Science) projects include the development of a stream monitoring programme for middle school students, assessing the impact of technology on elementary school students' Earth and Space science learning, and a classroom action research project to assess the efficacy of Earth and Space science laboratories in a high school classroom. The goal of the independent capstone projects in all cases is the development of reflective teaching practices by classroom teachers. In addition to a written report, MST programme participants are required to orally present the results of their project to faculty and peers. See Figure 1 for a typical 45 quarter hour programme of study.

Discussion

Courses in the MST programme are designed to meet the content requirements of national and state science educational standards, help teachers to be independent science learners themselves and to build their confidence to teach Earth/Space and Environmental science to their students. Courses fall into three broad categories. Field courses are offered in the summer, while on-line courses and traditional classroom experiences are offered in the academic year. The number of credit hours awarded for field based courses varies from institution to institution in the United States. Wright State University's Department of Geological Sciences policy awards the same number of credits for field courses as it does for lecture courses. Therefore, a course that runs for four days with eight contact hours per day yields 32 contact hours, while the out of class hour requirement is satisfied by pre and post meetings, independent reports and the development of lesson plans built on the field experience. Courses take MST participants to the New Jersey

Figure 1. Typical program of study for a Master of Science in Teaching (Earth Science) programme.

Academic Department granting credit	Course	Number of Credits	Course Delivery Method
Fall Quarter			
Education	MST Project Development	2.0	Face-to-face and Distance learning
Education	Instructional Design & Development	4.0	Face-to-face
Geology	Global Change	4.5	Distance learning
Winter Quarter			
Geology	Plate Tectonics	4.0	Distance learning
Geology	Teaching Earth Science by Inquiry	4.5	Face-to-face
Spring Quarter			
Geology	Geologic Hazards and Environmental Quality	4.0	Face-to-face
Geology	Water and the Environment	4.0	Distance learning
Geology	MST Project	4.0	Independent research project
Summer Quarter			
Geology	Field and Lab Studies of Coastal Processes	4.0	Field-based experience
Geology	Glacial Landforms	3.0	Field-based experience
Geology	Field Trip to Central Appalachian Region	3.0	Field-based experience
Education	Using Instructional Technology	4.0	Face-to-face

Figure 2. Students on the New Jersey coast

coast to study Coastal Processes (Figure 2), to the Appalachian Mountains of West Virginia and Pennsylvania to study stratigraphy and paleontology and to New York State to study glacial landforms first-hand.

Most participants in the Master of Science in Teaching (Earth Science) programme teach full time, so an array of on-line courses and classroom courses are offered each quarter during the academic year to minimize time spent on campus. On-line courses are delivered in Plate Tectonics, Water and the Environment, and Earth Systems science. The course in Earth Systems Science was developed in collaboration with NASA and uses remote sensing images and NASA mission websites to enable classroom educators to build their own content knowledge of Earth systems and to develop Earth Systems Science lessons for their own classrooms (Slattery *et al* 2004).

Evening classes each quarter are provided at convenient times for teachers to come to campus and provide integrated lecture/laboratory settings for the study of such varied subjects as using GIS in the classroom, remote sensing and near Earth astronomy. Taking several different field based courses for each of two summers, with an on-line and one classroom course during each of the three intervening academic year quarters, it is possible to complete the entire program of 45 quarter hours in two summers and an intervening academic year.

The Master of Science in Teaching (Earth Science) programme has proven to be a classic "win-win" situation for the Department of Geological Sciences, for the teachers involved and for their students. There has been a downturn in the number of traditional Master's level geoscience students in recent years. Many geoscience departments in the United States have been downsized, merged with other science departments, or eliminated altogether. In contrast, over the past five years over 150 primary and secondary teachers have graduated with their MST degree from the Department of Geological Sciences. These post-graduate students have positively impacted the enrolment figures of the department. In addition, because of their interactions with the faculty, they have brought a new interest in teaching, learning and assessment to the department as well.

Classroom teachers well prepared in ESE content, pedagogy and technology are able to provide their students with enriching age-appropriate science activities aligned with the science education standards. Indeed, because they have had the experience of attempting to make sense from data they themselves have collected, have used the internet and library resources to research questions they themselves have asked and have built a personal model of what science is and how it works, they are more likely to deliver science learning of that kind to their students.

References

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