



Research Project **PROFESSIONAL DEVELOPMENT APPROACHES FOR REFORM-BASED CURRICULA**

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Project Summary

This randomized field trial is investigating the effectiveness of *Great Exploration in Math and Science* (GEMS) curriculum and professional development in improving teachers' knowledge in enacting reform-minded instruction and elementary students' learning in science. It is being conducted in 120 elementary school classrooms (2,400 students total) over two years in Florida's Seminole County School District. The recently published GEMS space science sequence for grades 3 - 5 will be the treatment condition for this project. All treatment group teachers will participate in professional development that has at its heart the reform-minded instructional approach and the Great Explorations in Math and Science (GEMS) *Space Science Curriculum Sequence*. Other science teachers in a control group (who will also be wait-listed for treatment the following year) will address the same content standards through traditional approaches to instruction (lecture, following by reading from the text). Teacher learning, concepts and affective dimensions (pre, post, delayed post) and student learning, concepts, inquiry skills, and affective dimensions (pre, post, delayed post) will be compared across groups. During Year 2, in addition to providing the same professional development and materials to the wait-listed group, a third group will be added to the research if possible: teachers who teach the GEMS Space Science Curriculum Sequence using the materials provided, but who do NOT receive the professional development or science coach follow up support. Additionally, plans will be made to extend the study longitudinally into the middle grades. The GEMS Space Science Curriculum for grades 6-8 is due for release in April, 2008.

Rationale

Recent studies on learning science emphasize three key areas critical to student success: (1) understanding the discipline's core concepts, theories, and models; (2) understanding, in general, how scientific knowledge is generated, tested, and accepted; and (3) using the first two to extend understanding into new areas. Research findings leading to federally funded curriculum development suggests that in order for students to come to understand scientific concepts, be able to apply the concepts, and understand how science is done, their learning of science should in some ways echo the way science is conducted by scientists (e.g. using a learning cycle instructional tool) (Karplus & Thier, 1967; Bybee, 1997).

National reforms have produced promising, well-designed instructional materials that have undergone years of development, field-testing, and revision (e.g., *Great Explorations in Math and Science*, *Insights and Outcomes*, *Full Option Science Systems*, *Math Connections*, *Connected Mathematics Project*). However, despite the huge effort to precipitate educational change, classroom practices remain unaffected. Because these reforms require fundamental shifts in the way teachers understand both their content and the appropriate ways to teach this content, a central issue is teacher professional development. What kinds of professional development do teachers need? How must they be supported over time in their use of new ideas and curricula to improve student math and science learning? Do the answers differ based on student demographics (e.g., grade level; SES; race or ethnicity) and, if so, how? Thus, a central role for this center is to study, through randomized field



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trials, teacher professional development, teachers' subsequent enactment of reform-based curricula in math and science - across grade levels, geographic regions, and student demographic groups - and the impacts of well-enacted curricula on student learning.

This randomized field trial investigates the effectiveness of *Great Exploration in Math and Science* (GEMS) curriculum and professional development in improving teachers' knowledge in enacting reform-minded instruction and elementary students' learning in science. The new GEMS *Space Science Curriculum Sequence* (Lawrence Hall of Science, 2007) was chosen for this study because it embodies the qualities of the reform-based approach to science teaching as described in the *National Science Education Standards* (NRC, 1996) and *Inquiry and the National Science Education Standards* (NRC, 2000), *Taking Science to School* (Duschl et al., 2007), and *Ready, Set, Science* (NRC, 2008). Additionally, it exemplifies curricula *designed* to best enable teachers to provide reform-minded instruction for their students, including detailed classroom lesson plans complete with exact enactment instructions, detailed content background appropriate for elementary-school teachers' understanding, pedagogical professional development notes for the teacher about the instruction (e.g., learning cycle, leading discussions, nature of science, etc.), timeframes, critical junctures, assessments, etc.

Research Questions

1. Do well-designed reform-based curricula and professional development improve teachers' knowledge in enacting reform-minded instruction in the elementary and middle school classroom?
2. Does the use of well-designed reform-based curricula augmented by teacher professional development improve elementary- and middle -school students' learning in science?

Research Design

This study is a randomized field trial. The treatment group is comprised of teachers who have participated in professional development on the GEMS *Space Science Curriculum Sequence* and who then employ this recently published curriculum. A control group of science teachers (who are wait listed for treatment the following year) address the same space science content standards through traditional approaches to instruction (lecture, followed by reading from the text and activities that are related to the topic but do not extend the depth of the student learning) using the district-adopted traditional text. Teacher learning, concepts, and affective dimensions (pre, post, delayed post) and their students' learning, concepts, inquiry skills, and affective dimensions (pre, post, delayed post) will be compared across groups. During Year 2, in addition to providing the same professional development and materials to the treatment group, a third group will be added to the research: teachers who teach the GEMS *Space Science Curriculum Sequence* using the materials provided, but who do NOT receive the professional development or science coach follow up support. Finally, in years three and four the research plan calls for the extension of the study longitudinally into the middle grades using the GEMS *Space Science Curriculum Sequence* for grades 6-8, due for release in April 2008.

All treatment group teachers will participate in professional development that has at its heart the reform-minded instructional approach and the Great Explorations in Math and Science (GEMS) *Space Science Curriculum Sequence*. This is a new curriculum for teaching space science concepts for grades 3 through 5, built in the GEMS format that has garnered the attention of such groups as the AAAS and the NSF. Through participating in activities, discussions, and reflections centered around the pedagogies that underpin the GEMS *Space Science Curriculum Sequence* teachers will be prepared for teaching using this very "teacher friendly" curriculum. Through professional



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development which practices these pedagogies (e.g., learning cycle approach to science instruction, questioning strategies, evidence circles, assessment strategies, nature of science teaching strategies, etc.) in an explicit/reflective experiential approach, teachers will be supported in other areas of their science instruction as well. The first professional development session encompassed a week in August prior to teachers reporting back to their schools for the new academic year. Accompanying that there was a follow-up half-day prior to the beginning of the teaching of the space science unit in the fall. We anticipate this same schedule to be used in Year 2. Members of the professional development team regularly visited the school district in the fall for classroom observation of treatment and control group teachers and networking/support of treatment group teachers. Furthermore, a science coach, who is a resident of Seminole County, provides regular classroom support for treatment group teachers.

The control group for this study is a matched cohort of teachers who will teach in the traditional manner from the current district text. They will be invited to participate in the same rigorous GEMS training in the summer of 2008, to join the 2008/09 treatment cohort. Year 1 control group teachers participated in a meeting that lasted about 2 hours at least 3 weeks prior to the teaching of the control space science unit to go over their part in the project and to collect the same research data from them that was collected from the treatment group teachers. We anticipate following the same schedule for Year 2.

Through a comparison of teacher pre/post/delayed post data the effects of well-designed, reform-minded curricula and professional development followed by enactment of the curriculum on teachers will be assayed. Through a comparison of pre/post/delayed post data from their students the effects of the same on student learning will be assayed. The large size of the sample will build upon previous research using much smaller research sample sizes and less extensive assessment..

Sample

This randomized field trial is being conducted in Florida's Seminole County School District. It seeks to sample the classrooms of 120 elementary-school teachers (60 treatment group and 60 control group) over the first two years of the study. Each class consists of approximately 18-20 students for a total of approximately 2,400 students (1,200 from treatment group teachers and 1,200 from control group teachers). We anticipate that these numbers will be somewhat smaller depending on the percentage of parents granting permission, student absenteeism on test dates, and other factors that invariably affect the number of participants for whom complete data samples can be collected.

Data collection and analysis

Quantitative data (see section below for description of instruments) will be analyzed using HLM methodology as appropriate. Other statistical analyses will be employed as warranted. In addition, in-depth teacher and student interviews will be conducted to lend further depth of understanding of quantitative results (see qualitative research description below).

Five instruments will be used to assess teacher learning, concepts, and affective dimensions (pre, post, delayed post). These instruments are: a space science content test (Sadler, Coyle, Cook-Smith, & Miller, 2007), the Test of Science Related Attitudes (TOSRA, Fraser, 1978), the Beliefs about Reformed Science Teaching and Learning assessment (BARSTL, Simpson & Benton, 2006), the Teaching Science as Inquiry assessment (TSI, Dira-Smolleck, 2004), and the Views on Science Inquiry assessment (VOSI, Lederman & Lederman, 2005). Year 1, each assessment was administered prior to professional development, within two weeks following completion of teaching the space



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science unit, and will be administered four months following completion of teaching the space science unit. For the control group the initial testing was completed at least 3 weeks prior to teaching of the textbook-based space science unit; post and delayed post testing are accomplished on the same schedule as for the treatment group relative to teaching of the unit. The same schedule will be employed year 2.

To assess fidelity to the assigned curriculum for both experimental and control group teachers, the research team has attempted to observe each of the teachers involved in the study at least two times during the teaching of their assigned curriculum. Teachers will be rated on their adherence to the lesson for that day as structured in either the GEMS guide (treatment group) or the textbook (control group). As well, the Reformed Teacher Observation Protocol (RTOP, 2004, Piburn & Sawada) will be used as an indirect assessment of fidelity during this observation. These observations and RTOP scoring will be done both in person and via videotapes of lesson submitted by the teachers. After completion of the teaching of the entire unit all treatment teachers will be interviewed to assess why they made the teaching decisions that they made and about their beliefs about teaching. These will be phone interviews and we plan to use some or all of the questions from the Teaching Beliefs Inventory (TBI, see Roehrig, Kruse and Kern, 2007) using Luft's coding maps for scoring. At the post-teaching meeting for assessment completion, teachers (control and experimental) also completed a self report survey to assess their feelings about their fidelity to the curriculum that they were teaching. The instrument used for this is the *MSP Teacher Feedback on Science Instructional Materials* assessment (Michael Howard and Associates, 2007). The same protocol will be employed in year 2.

Four instruments will be used to assess treatment and control group student learning, concepts, inquiry skills, and affective dimensions (pre, post, delayed post). These instruments are: a space science content test (Sadler et al., 2007), the Homerton Science Attitudes survey (Warrington, Younger, & Williams, 2000), the Views of Science Inquiry elementary student version (VOSI-E, Lederman & Lederman, 2005), and the Knowledge of Models and Evidence assessment (KME, Granger et. al., constructed and validated for this study). Each assessment was administered prior to space science unit instruction, immediately following completion of teaching the space science unit, and will be administered again four months after completion of teaching the space science unit. Additionally, copies of the pre- and post-section questionnaires embedded within the GEMS curriculum and administered before and after each of its four sections were collected for insight into other quantitative data collected. These questionnaires are constructed to assess common student space-science misconceptions. Finally, the team will attempt to obtain access to student FCAT results of 5th-grade students on appropriate space science questions. The same data collection protocol will be followed in year 2.

The sheer number of students involved in the quasi-random control design of the GEMS curriculum study requires that data collection addressing gains in student content knowledge (both space science content and Nature of Science content) utilize standardized testing protocols. Three of the four tests are multiple choice. This raises the concern that we may not be adequately assessing the question of depth of knowledge differences between the experimental and control groups. To address this concern we plan to implement a qualitative research component to the student learning portion of the study. In keeping with the spirit of the research, the qualitative research will strive to include the greatest number of students whose data we can realistically assess given the personnel constraints of the project. In year one, the qualitative study will interview 36 students within a four week period following their completion of the experimental or control curriculum unit (post-teaching interviews). 18 of these students will be from the experimental group and 18 from the control group. These students will be selected as follows:



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	<u>Experimental Group, High RTOP Teacher</u>	<u>Control Group, Low RTOP Teacher</u>
4 th Grade	3 high performing students 3 ave. performing students 3 low performing students	3 high performing students 3 ave. performing students 3 low performing students
5 th Grade	3 high performing students 3 ave. performing students 3 low performing students	3 high performing students 3 ave. performing students 3 low performing students

The classrooms from which these students will be selected for participation in the qualitative aspect of the project will be those assessed by RTOP as those most faithful to their assigned curriculum. Each interview will be structured to take a maximum of 20 minutes. The interview protocol will ask space science questions adapted from Barnett (2002).

Timing of Reports

We hope to complete statistical analysis of the data from the first year of the project during the summer of 2008 and have a preliminary report of findings from the first year ready by the end of August 2008.

Brief Summary of Findings to Date

Teacher and student pre-tests have been completed and cataloged and are currently being sent to Evaluation Services for machine scoring. Post-tests are in transit from the classrooms as of the writing of this report (1/08). The classroom observations and videotapes using RTOP that have been completed so far surprisingly paint a very interesting picture of teacher enactment of curriculum. The research team will not be surprised if a paper on these observations alone is published which will contribute some new and interesting information to the curriculum enactment literature.

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