

Broadening Diversity in the Geosciences Through Teacher–Student Workshops That Emphasize Community-Based Research Projects

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ABSTRACT

The Geosciences Institute for Research and Education at the University of Michigan–Dearborn has been an example of a successful and effective model in increasing the participation of underrepresented groups in the geosciences. The program emphasizes involving middle school and at-risk high school students from the Detroit area public schools, along with their teachers in geoscience research projects, through a series of spring and summer workshops. The workshops introduce students to the geosciences by emphasizing how geology can be used as a tool to solve community-based environmental problems. Students work alongside their teachers and university faculty on projects ranging from an assessment of brownfield sites in southwestern Detroit to the installation of groundwater monitoring wells to the evaluation of how former land use is impacting groundwater and surface water quality. Spring workshops focused on students from three African-centered middle schools in Detroit, while the summer workshops focused more on middle school and high school teacher training, but included a small group of middle school and high school students. Instruments used to evaluate the effectiveness of the workshops included the Science Teaching Efficacy Belief Instrument, the Geoscience Concept Inventory, and survey questions from the Watershed Task. Pre- and postworkshop questionnaires and separate teacher–student focus groups demonstrate that we have not only increased student awareness of the geosciences, but we have also motivated students to pursue career opportunities in science. For example, more than half of the students completing the workshop (boys and girls alike) have expressed a strong interest in pursuing a career in the geosciences. Since its inception in 2005, we have reached over 100 middle and high school students, and 75 teachers. During this same period, the Earth Science major at the University of Michigan–Dearborn has tripled in size, and we have quadrupled the number of minority students taking introductory geology courses. © 2012 National Association of Geoscience Teachers. [DOI: 10.5408/10-215.1]

Key words: geoscience, teacher, students, workshop, institute, community, research, environment, fieldwork

INTRODUCTION

The Joint Society Conference on Increasing Diversity in the Earth and Space Sciences (IDEaSS) was convened in June 2003 to address concerns of declining student enrollment in the geosciences. The conveners, however, also recognized that broadening participation should be a “critical strategy in the battle to strengthen and revitalize the geoscientific workforce.” Today, as science, technology, engineering, and mathematics (STEM) jobs continue to increase, it is becoming more important that we change our strategy on how we recruit and train students for careers in the STEM fields. Nowhere is this more important than in the geosciences, which continues to have the lowest participation rate of underrepresented minorities than all of the other sciences, particularly at the bachelor’s and master’s degree levels (Karsten, 2003; Czujko and Henly, 2003; Huntoon and Lane, 2007; Levine et al., 2007; Riggs and Alexander, 2007; Velasco and deVelasco, 2010). As a result, the United States is losing its ability to prepare for natural geohazards, to assess and manage our natural resources, and to recognize and mitigate environmental issues. Demographic studies

clearly show that to remain a leader in science and technology, the United States will have to rely on a diverse workforce.

Although the IDEaSS conference focused more on the role that scientific societies can play in promoting diversity in the geosciences, there has been considerable dialogue on the role universities play in increasing diversity. The National Science Foundation (NSF) created the Opportunity to Enhance Diversity in the Geosciences Program (OEDG), which provides funding to projects, particularly outreach projects that encourage the recruitment of students from underrepresented groups into the geosciences. However, understanding the factors that limit the success of underrepresented groups is critical to any successful outreach program. Summers and Hrabowski III (2006), for example, cited that without a support system in place, minority students tend to feel academically and culturally isolated, particularly at institutions without predominantly majority populations. Moreover, the transition from grade school and high school into a university is often difficult for many students, particularly for minority students. Therefore, proximity to home and access to family have been cited as crucial to success for many minority students. One way to ease this transition from high school to university is to offer outreach programs during the summer of a student’s junior or senior year in high school that provide a research experience, and mentoring by undergraduate and graduate students. These are the components of the University of Michigan–Dearborn’s (UM–Dearborn) Geoscience Institute

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for Research and Education (GIRE). Funded with two grants from the NSF's OEDG Program, UM–Dearborn's Geoscience Institute offers spring and summer workshops that provide opportunities for both minority teachers and students to become involved in geoscience research.

PROGRAM RATIONALE

The location of UM–Dearborn in the Detroit metropolitan area has been an important factor to the success of our outreach programs. In the summer of 2000, UM–Dearborn entered into an agreement with the Detroit Public School (DPS) to provide a 1-wk workshop for selected earth science teachers—kindergarten through 12th grade (K-12)—to enhance their professional development. The workshop was well attended and highly successful, primarily because of the general lack of geologic knowledge among the DPS teachers. Teachers who attended the initial workshop indicated that additional training or research opportunities would be not only helpful, but would also be integral to their ability to teach about the geosciences and to talk about opportunities in the field of geoscience to their students. Moreover, the teachers indicated that additional time was needed, and that the workshop could be enhanced by actually involving them in actual research projects.

Thus, the initial concept behind the GIRE was to bring together local professional geologists from environmental consulting firms and regulatory agencies, along with university faculty and students to work with in-service teachers and their students. By 2004, the GIRE was formally established at UM–Dearborn, with a 2-y pilot grant from NSF's OEDG Program. Of importance in the creation of the summer workshops were several factors: First, although earth science is now infused throughout the K-12 curriculum in Michigan public schools and is assessed by Michigan's knowledge-based exam in 11th grade (Michigan Educational Assessment Program), fewer than 15% of the DPS teachers who regularly teach these earth science classes have had a college course in geology. Second, underrepresented minorities make up >80% of the population within the City of Detroit, but they include <5% of all science majors at UM–Dearborn and <2% of geoscience majors. Third, the impact on diversity has been further compounded by institutional barriers. In 2006, the Michigan Legislature eliminated earth science as a required subject in high school. This was a landmark decision for geology in the State of Michigan. Not only did it negate the need for teachers to earn an Earth Science credential in college, it further diminished an interest in pursuing the geosciences as a career, as fewer high schools now offer earth science courses. Although earth science will continue to be taught in many high schools as an elective, this decision has further weakened opportunities for underrepresented groups to learn about careers in the geosciences. To complicate matters additionally, recent studies have indicated that the DPS districts rank last in graduations, with only 21.7% finishing high school in 4 y. Perhaps even more disturbing, the National Center of Education Statistics concluded that Michigan graduated only 39% of African-American male students during the 2003 to 2004 school year compared with 78% of white males. Although these data are somewhat dated, they indicate the struggles of the DPS in achieving parity in graduation rates,

and that a change in how we view education in the inner city needs to be implemented.

PROGRAM DESCRIPTION

The original goal of the pilot program was relatively simple. Provide an enjoyable and stimulating 3-wk workshop experience for both teachers and a few of their students. The idea was to immerse the teachers in field activities that demonstrate how the geosciences can be used to solve community-based environmental problems, with a specific focus on hydrology and watersheds. The concept was to reveal the practical value of a career in the geosciences, particularly in addressing current environmental problems in Detroit. If we could convey this idea with enthusiasm and excitement, then we would be successful in recruiting students and perhaps even a few teachers into the geoscience program at UM–Dearborn.

By the end of the pilot program in 2006, however, we realized that the original program goal was an oversimplified approach to a much more complicated problem. DPS was in financial trouble, there were too many schools and too few students, resources were spread thin, and the dropout rate was soaring. Fewer than one in four high school students in Detroit graduated on time in 2006, and the Schott Foundation for Public Education in Ohio highlighted the graduation gap in DPS between white and African American male students. These findings further indicate that university outreach programs with diversity in mind need to be focused on students before they reach high school. Consequently, the GIRE was expanded in 2007, at the request of three middle school principals, to include an 8-wk spring workshop especially for middle school students, to be held on Saturday mornings.

A second award from the NSF's OEDG Program enabled the GIRE to continue for an additional 5 y. Last year (2011) was the fourth year of the second award. It was also decided that the original goals for both the spring and the summer workshops needed to be changed to reflect our understanding of what was truly important. Thus, our original goal was expanded to include (1) empowering students to stay in school and to stimulate student interest in science through hands-on, cooperative, research-oriented activities; (2) improving teachers' knowledge and curiosity of geology, as well as their ability to construct and implement innovative learning and assessment techniques and in their classrooms; (3) expanding community awareness of the unique interaction between geological, historical, political, and cultural factors in local watersheds (i.e., the Rouge River); (4) providing an awareness of opportunities in the geosciences to underrepresented groups, and to encourage talented students to think about the geosciences as a career; and (5) increasing enrollment and retention of underrepresented groups in the geosciences at UM–Dearborn.

The summer workshops continued to emphasize the participation of educators who teach earth science but lack recent or formal education in the earth sciences. Participating teachers were also selected if they were early in their careers and could benefit from the curriculum materials provided during the workshop. Finally, preference was given to pairs or even groups of teachers from the same school (the implication is that it would be easier to make pedagogical changes at a school if more than one teacher was interested

in implementing change). Secondary criteria included a desire to have approximately an equal number of male and female teachers and an equal number of middle school and high school teachers. Teachers and students from the same school were encouraged to attend as a team. The involvement of students alongside the teachers and professional geoscientists served not only to demonstrate the collaborative nature of environmental research, but also helped to improve the relationship and interaction between teacher and student. A secondary, and somewhat unexpected benefit that was observed, was a growing sense of commitment to community that was gradually infused in the students during the 3-wk workshop. By the end of the workshop, the teachers and their students were excited about carrying their experiences, as well as a newfound enthusiasm for science, back to their classroom, where it could be shared with their peers.

The spring workshops were geared primarily toward African-American, middle-school students from three African-centered middle schools in Detroit. Each workshop hosted approximately 25 students, ranging in age from 11 to 13 y. Occasionally, the students' teachers and principals attended and participated in the workshop, and although their participation was encouraged, the workshop was designed for the students. The content and material covered in the spring workshop were an abbreviated version of the summer workshop designed for teachers because of time constraints.

WORKSHOP ACTIVITIES

On the first day of each workshop program, the participants were taken on a tour of the local watershed (i.e., Rouge River). Various workshop leaders (including faculty and guest speakers, for example), local professional geologists, and land use planners, provided commentary on the social, political, cultural, and geological history of the Rouge River watershed in southeast Michigan. In particular, participants are shown how the Detroit River and the Great Lakes were used to bring iron ore from Michigan's Upper Peninsula, limestone from Ohio, and coal from Ohio and Pennsylvania to Detroit for steel making, giving rise to the auto industry, and ship making before the rise of the auto industry. The decline of the auto industry in the 1960s led to an exodus of workers from Detroit, abandonment of factories, and a legacy of former land use activities and environmental problems that continues to plague Detroit today. The participants toured the Ford Rouge Plant, Henry Ford's industrial complex, the Detroit wastewater treatment facility (which remains one of the largest in the world), and a large, multibillion-dollar water improvement project in southeast Michigan designed to collect and treat storm water and sewage captured by the old combined sewer system (sanitary and storm sewer combined into a single drain) during rain events, instead of discharging contaminated water directly into the Rouge River.

In general, the first 2 d of each summer workshop week are devoted to field trips, guest speakers, and in-classroom activities or inquiry-based modules (Fig. 1). The modules were designed to convey the theory behind the research projects that the participants were to be involved with on Wednesday through Friday each week. At the end of the second day, the participants were split into three groups,



FIGURE 1: Teacher–student collaboration on in-class modules serves to demonstrate not only the theory behind the field activities but helps to strengthen the bond between teacher and student.

with each group to work on a specific research project. Teachers and their students were grouped together, and an attempt was made to have an equal mix of genders in each group. The field activities have varied slightly since their inception in 2004. In general, the field work is a reflection of faculty funding from external grants and has included projects as varied as the sampling of soils at brownfield sites in southwestern Detroit (funded by the U.S. Department of Housing and Urban Development) (Fig. 2), to the installation of groundwater monitoring wells along a branch of the Rouge River (NSF) (Fig. 3), to a geomorphic investigation of the Rouge River (Fig. 4).

On Wednesday of each subsequent week, the groups switch research projects, and each group is exposed to a new set of research skills and activities. It is for this reason that the number of participants attending the summer workshop needs to be limited. Ideally, a workshop of 15 participants allows for a group of five teachers and students to work



FIGURE 2: Collecting soil samples in southwestern Detroit.



FIGURE 3: Groundwater-monitoring well sampling by students along the lower branch of the Rouge River in Dearborn, MI.

alongside a faculty member, one or two graduate students, and occasionally a professional geologist. At the conclusion of the 3 wk, each participant has had an opportunity to work on each of the three research projects. The final day of the workshop is then devoted to creating posters by using PowerPoint (Microsoft, Redmond, WA) and Google Earth (Google, Mountain View, CA) to display some aspect of the research that intrigued them the most. The posters are created working in groups of two or three, typically participants from the same school. The teachers are usually eager to display their posters in their classroom and use them to describe their research experiences to their new incoming students as well as colleagues. This display of posters also serves as inspiration for their colleagues and has helped to fuel workshop applications.

PROGRAM EVALUATION

The summer workshops were evaluated annually by three senior faculty members in UM–Dearborn’s School of Education. The evaluation was based on their assessment of how well the workshop had met the program objectives. To assess the impact of the project on the teachers and students, the evaluation team used the objectives discussed above to create constructs that directly relate to the measures. The evaluation of the Institute focused on the same constructs for



FIGURE 4: Stream profiling of the Rouge River in Dearborn, MI.

all 5 yr including students’ and classroom teachers’ geoscience content knowledge, the teachers’ efficacy toward teaching science, and student and teacher knowledge of geoscience-related careers and local environmental issues. In 2010, however, the evaluators focused the measures so that they related more directly to the geoscience content being taught at the Institute. The next section describes our rationale for creating or selecting the measure along with a description of the instrument.

A “Pre-Workshop Student and Teacher Questionnaire” was presented to each workshop participant. The questionnaire asked participants to provide information relating to their educational level, content knowledge and experience, as well as their knowledge of the geosciences in general, local watershed related issues, and attitude toward outdoor activities. These questions were designed to provide a summary of participant experience and attitude toward the sciences and watershed education. The Science Teaching Efficacy Behavior Protocol (STEBI) (Enochs and Riggs, 1989) was used in each of the last 3 y of the workshop. The STEBI includes 25 Likert-scaled statements relating to personal beliefs about teaching science. It contains two subscales, personal science teaching efficacy beliefs, and science teaching outcome expectancy, based on Bandura’s (1977) social cognitive theory, which states that self-efficacy beliefs motivate people toward specific actions and can be used to predict future behavior. The first subscale measures teacher’s

beliefs in their ability to teach science, while the outcome expectancy measures their beliefs that their teaching will make a difference in their students' understanding of science. Enochs and Riggs (1989) have provided a complete description of the reliability and validity measures for STEBI.

The Geoscience Concept Inventory (GCI) is a multiple-choice assessment instrument developed by Libarkin and Anderson (<http://newton.bhsu.edu/eps/gci.html>). In 2010, the evaluators reduced the number of GCI items to three, as these were the only questions that dealt with groundwater or the hydrologic cycle. Data analysis from 2010 revealed that there was not a significant difference in pre- and post-GCI scores, which is not surprising, as the inventory assesses general physical geology concepts, as well as underlying fundamental ideas in physics and chemistry, such as gravity and radioactivity. In 2010, the Institute evaluation had a much more focused goal of emphasizing the geological, historical, physical, political, and cultural importance of watersheds to the community.

A second new assessment was added in 2010 to parallel more closely the Institute's program objectives with the evaluation measures. The Watershed Task (Shepardson et al., 2005), which asks respondents to "Draw what you think a watershed is" and "Explain the drawing in your own words," is an established instrument to determine knowledge of watersheds of students and adults and was completed by teachers and students at the 2010 Institute. Because this measure was only included in the latest year of the project, the results are not included in this discussion.

Teacher and student focus group

Focus group methodology is appropriate in the course of this evaluation because it facilitates the exploration of programmatic issues by creating a collective conversation among participants, and duplicates the methodology of previous years, as it revealed the rich experiences of the participants. Focus groups allow for the exploration of issues including content, program structure, personal meaning, social implications, and recommendations (Kamberelis and Dimitriadis, 2005). As Lincoln and Denzin (2000) discussed, focus groups do not represent a simple "linear" approach or a retelling of events. This builds on the work of Foucault (1984) in suggesting that the focus groups represent a technique allowing researchers to examine the intersection of personal, group, and experiential forces, and the impacts or effects of that impact.

An important element in the focus group as used by social scientists is the attempt to limit the impact of the power dynamic, which is creating a "risk-free" environment that allows a group interview to occur among peers. The researcher or evaluator is essentially recording and prompting conversations between individuals for strategic purposes (Bakhtin, 1986). In evaluation, focus group data does more than simply triangulate themes, but creates a prism-like body of evidence (Kamberelis and Dimitriadis, 2005). This allows evaluators to use focus group data to supplement other methodologies, as well as to target critical aspects of programs such as the programmatic impact on minority or underserved populations. In the case of this evaluation, focus group methodology enabled us to explore the impact of participation on the individual professionally, personally, educationally, as well as the impact on the individual's environmental and community awareness. The primary

questions used in the focus group related to GIRE program goals and were designed to assess how well each program goal was met. Focus group questions for both the teacher and student group revolved around three common themes: the impact of the GIRE on knowledge of and involvement with the local community/environment, identification of the most significant GIRE experiences, and if relationships (between students and teachers) had changed as a result of the GIRE. Teachers were also asked if they would be more likely to pursue personal or professional development activities related to the geosciences, and how they teach their students about the geosciences. Students were asked if their perceptions of the geosciences and geoscientists had changed, would they consider careers in the geosciences, and of their perceptions of the instructional techniques used at the GIRE.

DATA COLLECTION AND ANALYSIS

Survey data were collected the first and the last day of the institute by one of the School of Education faculty members, who acted as external evaluators. Focus groups were conducted the last day of the summer workshop, with teacher and student focus groups conducted separately. Each focus group was led by an external evaluator and was audiotaped, with all participants consent. Both the student and teacher groups lasted approximately 45 min. The spring workshops were evaluated solely by the participating middle school principals and are thus not included herein. Because a different set of constructs and evaluators were used to evaluate the 2-y pilot program, only the results of the first 3 y of the formal GIRE are presented here.

Results of the student and teacher questionnaire

Student demographics and teacher demographics are presented in Tables I and II, respectively. The number of students that participated in the program in the first 2 y was higher ($n = 9$, $n = 10$) than in the third year, while the number of teachers who participated in the summer GRI has remained at capacity, which is at 11 to 13 teachers. Several characteristics of the students have changed over the course of the project; most significantly, the University altered its policy concerning providing college credit to middle school students just prior to the third year's workshop. As a result, middle school teachers, who were intending to bring some of their students that year, were forced to reconsider their offer, and this led to the drop-off in student numbers in year 3. The University's decision led to an increase in our recruitment efforts to high school students in subsequent years. It is also important to note the decrease in the number of students who completed an earth science course before participation in the GRI in the third year. This is undoubtedly because of the changes made in the Michigan high school curriculum, in which earth science is no longer a part of the required science coursework. This decision on behalf of the Michigan legislature continues to have a detrimental effect on the recruitment of geoscience majors, and has forced changes in the way we teach our introductory courses (for example, few students come into the University today considering a career in geology, most likely because of a lack of knowledge of the geosciences). The participating teachers had taught for a range of 3 to 22 y, with an average of 11.5 y, and typically taught multiple sections of science

TABLE I: Student demographics.¹

Year	Students (<i>n</i>)	Gender		Ethnicity			Grade in Fall					Completed Earth Science Course		
		M	F	African American	White	Multiracial	Graduated	12	11	10	9	8	Yes	No
3	4	3	1	1	3	0	2	1	0	1	0	0	2	2
2	10	3	7	3	5	0	0	1	1	0	7	1	9	0
1	9	4	4	4	3	1	0	0	0	3	4	2	7	0

¹Subtotals might not equal total number of students because of missing data.

courses, as demonstrated by the large number of students they had taught science to in the previous year (Table III). It is interesting to note that while the minority status of the student participants averaged 39% (Table II), the teacher minority status was 24% (Table II), although the 73% of the teachers reported that the students they taught were at least 50% minority students.

During the 3-wk summer workshops, teachers gained the most knowledge about brownfield sites (gain = 2.02) and watersheds (gain = 1.40), with an overall general increase in knowledge of environmental problems in Southeastern Michigan a close third (gain = 1.16). The consistency of teacher responses in all 3 y is possibly indicative of the focus of the workshops and the general level of teacher knowledge in these areas as measured by the constructs (Table II).

In year 2, teacher knowledge and beliefs related to science and teaching (Table III) showed a general increase in their knowledge of what geoscientists do (gain = 0.64) and confidence teaching geoscience concepts (gain = 0.37). The increases are similar to those in years 1 and 2, with the exception of the question that asked teachers to indicate whether they felt confident in incorporating geoscience in the classroom. In year 1 and year 3, teachers indicated they felt more confident after the institute in incorporating geoscience in the classroom and reported a lower level of confidence on the preparticipation survey (2.91 and 3.17, respectively). Teachers in year 2 indicated they were less confident after participating in the institute; however, they indicated in the presurvey a much higher level of confidence before they began the program than the teachers in year 1 and 3. The similar results in years 1 and 3 on this measure lend strength to the hypothesis that the teachers in year 2 did not lose confidence so much as began the Institute with a higher level of experience and confidence. Participating teachers in year 2 had a high proportion of master's degrees, and might have simply felt they had the skills necessary to use geoscience concepts in their teaching. This confidence could have been slightly tempered after completing the workshop.

Interestingly, students had very similar pre- and postresponses to the survey questions (Table IV). Like their teachers, the students reported gains in knowledge in all areas, the most change reported in knowledge of watersheds (gain = 2.25). This is the same pattern reported in year 2, which had a larger sample of students. Students were asked to rate their knowledge of scientist's activities and their understanding of science and environmental issues on a scale of 1 (strongly disagree) to 4 (strongly agree). Students in year 3 responded similarly to students in year 1, showing less predictable changes in attitude toward earth science and taking science classes. In contrast, students in year 2 showed measureable increase in the understanding of science and indicated a substantial increase in the interest in earth science. Five survey questions asked students to rate their experience with, and enjoyment of, select outdoor related activities to shed light on any possible relationship between these activities and science affect. Students in year 3 reported a similar level of general enjoyment in being outside compared with students in the first 2 y, and it remained unchanged after participation except for hiking, which increased. It should be noted that the weather during this year's Institute was very hot, so it is surprising that students' attitude toward hiking increased. However, this could be because of the small sample size, as an analysis of the frequencies showed that one student before the Institute responded that they disliked hiking very much and after the Institute no student responded lower than "enjoy" on this item.

Interestingly, the overall STEBI scores and two subscore indicators of efficacy dropped after teachers attended the Institute. This again is similar to the first-year results. In years 1 and 3, teacher responses indicated they felt less able to teach science after participating in the Institute. It is notable that the STEBI scores in year 2 were generally higher, particularly in the area of personal science teaching efficacy beliefs. This indicates that the year-2 teachers entered the Institute with more confidence regarding their ability to teach science. This could be in part a result of the higher educational level of the teachers participating in year 2. However, it is also possible that teacher awareness

TABLE II: Teacher demographics.¹

Year	Teachers (<i>n</i>)	Gender		Ethnicity			Highest Degree Attained		
		M	F	African American	White	Multiracial	Doctoral	Master's	Bachelor's
3	13	6	6	0	12	0	1	9	2
2	13	2	10	4	8	1	0	10	3
1	11	2	9	4	7	0	0	5	6

¹Subtotals might not equal total number of students because of missing data.

TABLE III: Classroom experience.

Year	Level Taught		Students Taught Science in Previous Year (<i>n</i>)			% Minority Students Taught		Frequency of Laboratories in Science Classes		
	5–8 grade (middle school)	9–12 grade (high school)	<30	60–90 ¹	>90	<50%	>50%	Weekly	Monthly	Quarterly
3	6	6	1	1	10	4	8	7	3	2
2	2	10	0	6	4	4	9	6	6	1
1	8	3	3	1	7	1	10	7 ²	4	0

¹None of the teachers reported teaching 30–60 students in the previous year.

²One responded “never.”

regarding their own knowledge will cause a decline in efficacy (Lin and Gorrell, 2001; Romi and Daniel, as cited in Woolfolk Hoy and Burke-Spero, 2005). This could be because of a realization of the difficulties in teaching science. Encouragingly, however, the data from our demographic survey indicate that scores in self-assessment of area knowledge such as knowledge of geoscience increased. For example, in year 3, teachers rated their knowledge of geosciences as 3.0 before participating in the institute, and as 3.8 after participating (Table V). This further demonstrates, as related in literature, that self-efficacy is context dependent (Bandura, 1981), and teacher efficacy beliefs appear to be dependent on the teaching context (Riggs and Enochs, 1990). Institute teachers might feel much more comfortable teaching the geosciences as a result of the 3-wk workshop, but that teaching might have decreased their overall efficacy toward schooling science. How overall efficacy toward teaching science impacts a teacher’s efficacy toward teaching a particular science topic needs to be explored further. This relationship becomes more complicated as content knowledge is increased. Do teachers with increased content knowledge in a specific area (such as watersheds) increase their overall efficacy toward teaching science? No; our results indicate the opposite.

Analysis of the teacher and student responses on three GCI questions that related directly to watersheds showed an increase in knowledge in the pre- and postassessment scores, although the majority of the teachers (53.8%) answered each question correctly at the beginning of the Institute. At the end, nearly 70% of the teachers answered all of the questions correctly, with all of the teachers answering the item “Where can groundwater be found?” correctly. Questions about the hydrologic cycle had the lowest number of correct responses in the pre- and

postassessment (53.8% versus 69.2%), although more teachers did answer this question correctly on the posttest. At least on the post-assessment, the low correct response rate could be explained, since the Institute did not focus on the hydrologic cycle explicitly, and the question probed understanding about the relationship between temperature, altitude, and cloud composition, which is an abstract concept.

Focus groups 2010

Focus group data support several trends that were present in all 3 y. First, teachers and students stated that the field trip component of the institute was invaluable. Other focus group topics included an increased awareness of geoscience as a body of knowledge and as a career choice, and awareness and knowledge of local environmental issues. Teachers and students reported that participating together in the activities and fieldwork changed their perception of each other, and forged new bonds in the teacher–student relationship.

Teachers also spoke of feeling more comfortable and enthusiastic about teaching geoscience-related concepts and how their approach to teaching those ideas would likely change. In addition, all participants reported an increased awareness of the importance of daily environmental decisions in and out of the classroom. Comments included issues such as waste disposal, recycling, and land use issues. There was also focus on communicating this newfound knowledge to others in their schools and communities. Consistently, participants emphasized their intent to become more involved in environmental activities and causes in their community.

During the focus group, teachers were asked about their experiences participating in the Geoscience Institute, their

TABLE IV: Teacher self-assessment of knowledge.

Category	Yr 3 (Mean)		Yr 2 (Mean)		Yr 3 (Mean)	
	Preresponse	Postresponse	Preresponse	Postresponse	Preresponse	Postresponse
Environmental problems in Southeastern Michigan	2.92	4.08	2.69	4.00	2.55	4.00
Watersheds	2.75	4.15	2.54	4.15	2.55	4.09
Brownfield sites	1.67	3.69	2.00	3.77	1.82	4.45
Knowledge of geosciences	3.00	3.77	2.92	3.92	2.91	3.82
Ability to teach geoscience concepts	3.00	3.77	2.77	3.92	2.82	4.00
Ability to use inquiry-based instruction in the classroom	3.58	4.23	3.23	3.62	3.27	3.91

TABLE V: Teacher beliefs relating to science and teaching.

Belief	Yr 3 (Mean)		Yr 2 (Mean)		Yr 3 (Mean)	
	Preresponse	Postresponse	Preresponse	Postresponse	Preresponse	Postresponse
I know what geoscientists do	2.67	3.31	2.62	3.38	2.55	3.55
I know what biologists do	3.33	3.38	3.23	3.54	3.09	3.36
I currently feel confident that I can incorporate geoscience concepts into my classroom	3.17	3.54	3.77	3.62	2.91	3.73
It is important for students to study geosciences in school	3.58	3.62	3.62	3.69	3.73	3.64
It is important for students to have fieldwork experience	3.75	3.62	3.69	3.77	3.73	3.73
Using hands-on science modules is the best way for students to learn science	3.50	3.46	2.62	3.54	3.82	3.82

perceptions of the impact of participation on students, and any impact the Institute might have had on their perceptions and understandings of geoscience. Teachers were also asked to comment on how their knowledge of local environmental issues had changed, or how they anticipated that their level of involvement in their community and/or environmental issues would change in the future. Analysis of these prompts resulted in five primary themes being identified: (1) understanding of the geosciences and its relation to other disciplines, (2) the fieldwork experiences, (3) awareness of local environmental issues and commitment to action, (4) relationship with students, and (5) impact of the Institute on teaching.

Typically, teacher participants felt that they had inadequate knowledge of the geosciences prior to the workshop. Even when teachers had science endorsements and had been teaching science in the classroom, they felt a lack of preparation for covering geoscience. One teacher expressed the fact that she had only general science instruction during her undergrad education and felt she did not understand geoscience enough to teach it. Teachers often commented on how the Institute experience will be carried directly back to the classroom. They received several real-world examples to present to their students, and they noted that it would be much easier to help the students relate to the issues because they can go outside and directly see the impact on their everyday world.

Because many of the participants were general science teachers, they now felt reasonably comfortable taking additional science credits to complete their continuing education requirements. Many felt that the workshops offered a direct connection to all of the sciences and learning about geosciences will add to their “toolbox” of science skills (Table V).

Like past participants, the 2010 teachers commented on the significance of the fieldwork component of the program for both themselves and their students. Several participants commented that prior to the workshop they had no idea how much information could be found in their backyards or schoolyards or by the creek that runs behind their school. Although the teachers agreed that the fieldtrips were very important and useful, many have noted over the years that the ability to take their students on fieldtrips has been severely curtailed or eliminated from the school curriculum. Several teachers have indicated that it is difficult to get their students out of another teacher’s class because there is so much information that must be covered in each class to meet the testing requirements; so there is competition for the students’ time. Yet, many teachers plan on doing the fieldwork independently of the students and taking the materials necessary to perform tests back into the classroom and present the experience as a lab. Some noted that they could even do fieldtrips on the school property, and one

TABLE VI: Student beliefs relating to science.

Belief	Yr 3 (Mean)		Yr 2 (Mean)		Yr 3 (Mean)	
	Preresponse	Postresponse	Preresponse	Postresponse	Preresponse	Postresponse
I know what geoscientists do	2.92	4.08	2.69	4.00	2.55	4.00
I know what biologists do	2.75	4.15	2.54	4.15	2.55	4.09
I currently feel confident that I can incorporate geoscience concepts into my classroom	1.67	3.69	2.00	3.77	1.82	4.45
It is important for students to study geosciences in school	3.00	3.77	2.92	3.92	2.91	3.82
It is important for students to have fieldwork experience	3.00	3.77	2.77	3.92	2.82	4.00
Using hands-on science modules is the best way for students to learn science	3.58	4.23	3.23	3.62	3.27	3.91

teacher has even attempted to install groundwater-monitoring wells on his school's property.

Another important aspect of the workshops was that participation had a substantial impact on their awareness of environmental issues and desire to make environmentally responsible decisions personally and professionally. Throughout the focus group discussion, the teachers mentioned their increased awareness of and interest in community and environmental issues. Many participants indicated that the Institute had significantly altered their view of their community and environment.

Student participants indicated that increased levels of knowledge and awareness after the Institute had motivated them to take a more active part in their community and environmental issues. Changes in participant involvement in community and environmental activities fell into two categories, changes in consumer behavior and increased emphasis in their teaching on cultivating future positive environmental decisions in students. Many teachers indicated that participation in the Institute had altered their personal and consumer behaviors in such areas as recycling, lawn services, and water usage.

After participating in the Institute, teachers and students alike felt compelled to participate in their community regarding environmental issues. Several participants named specific activities in which they intended to participate in the future. Teachers indicated that one benefit of participation was that the program allowed them to spend time with students in a different environment and to work with students as a part of a team, and that not only did the teacher have the opportunity to get to know the student better, but the student also got to know the teacher better. One teacher noted that since the students and teachers were working along side one another on the research projects, "It probably opened his eyes to how difficult it is to be a teacher and come up with things like this."

Seventy-five percent ($n = 23$: 11 male, 12 female) of the students over the past 3 yr have indicated that after participating in the summer workshop they would be interested in a career in the geosciences. Of the remaining students, several have indicated that they will not pursue a career in the geosciences, but plan to take courses in the geosciences in college to have it as additional knowledge. "I wanted to do something with the geosciences, to be aware of it, it is something good I could put on my resume, I would even consider it as a minor in college because ultimately I want to do something in business, maybe I can take what I learn in the geosciences and put it into a business aspect, maybe I could help other businesses become more environmentally sustainable, build a better environment." Another student noted, "I have not considered getting a job in the geosciences, but I have considered getting a degree in the geosciences so that I can help out my own town, make some changes so that the living standards are better. My town, it's a small rural town and is a stop for people going to the sand dunes but a lot of people use ground water there so testing the water to make sure it is not contaminated and checking the lakes because there is a lot of runoff from many farmers [is important]." Several teachers have commented that technology has provided an opportunity for students to go on "virtual" fieldtrips. They have suggested that they could have their students go to various places near their

homes, take pictures, and then talk about what they saw. Posting the pictures on Google Earth was also suggested.

The experience with the modules also was mentioned as being important as it gave the teachers practice experiencing the activities before they would teach them to students and would be able to use the modules in their own classroom.

Students have universally indicated that coming into the Institute, they had very little knowledge of what the geosciences entailed and what geoscientists did; for them the workshop has filled many of these gaps in their knowledge (Table VI). There were no differences in responses to these questions based upon the gender of the student.

CONCLUSION

As a result of both the teacher and student focus group discussions, and pre- and postworkshop questionnaires, it is clear that institute has exposed both the teachers and their students to a greater understanding of geology and particularly how the geosciences can be used as a tool to solve community-based environmental problems. Both teacher and student alike have affirmed that participation in the Institute has encouraged them to be more environmentally responsible. One student noted, "It was just a good experience. I learned a lot about it [geology] and I learned a lot about earth's features." Another student stated, "I think it is really interesting, with so many different aspects to consider. If you are in one part of the geosciences, like the soil, it can be repetitive, but there are other aspects to it, too; it is interconnected so I can study the soils and connect it to other aspects of the environment."

The workshops enhanced the students' intellectual skills, as it related to application and synthesis. Virtually all of the students attending the summer workshops have made tangible connections between the materials they encountered in their regular classrooms, the lectures they were exposed to in the Geoscience Institute, the activities they participated in during the plethora of field trips facilitated by this institute, and their home and community lives. For example, one student stated, "I did not know much about it, I came wanting to learn and I have. My perception has changed because I thought that the geosciences were just about physical features, and I have learned about all the other branches of the geosciences." All of the participants have agreed that their perceptions of the geosciences have changed positively. Many of the participants noted that the GIRE has allowed them to become more aware of their immediate environment to which they feel more connected; for example, one student noted, "My knowledge of the community and the environment changed a lot. I did not know what groundwater was, I did not know what a brownfield was, I knew nothing and now I know a lot more. I did not even know how contaminated water could really be. My knowledge changed a lot. It was a good experience." Another student added, "It opened my eyes as to what goes on in the water and how it gets contaminated, and it changed my opinion on some of the projects that people are trying to do in my community, what are the things that can go wrong and how contaminated it could be, and how will this affect me and my family."

It is apparent that the Institute effectively introduced students to not only the information geoscientist work with

daily, but also to the various career paths related to the geosciences.

Both teachers and students agreed: People need to become more aware of what is going on [in their communities] because to prevent [environmental problems] cost less than cleaning up problems after they occur. The participants all said that they felt more aware of their local and community environment. This increased awareness has two major effects. The first was the concern they now felt for the environment, and the second was the sense of responsibility this knowledge and concern had fostered.

During the spring and summer workshops, students were introduced to several critical concepts and issues using a variety of pedagogy, the dominant ones being field trips, field work, and in-class activities. The students reported that they learned more because of these methods. The students also noted that participating in the GIRE allowed them to work with their teachers on a more individualized level as they were learning together. All the students remarked that this allowed them to view their teachers as more “human.” Students in general indicated that they now see their teachers as partners in learning. For the first time, they realized that their teachers had a lot to offer and they all indicated that they would be more interested in hearing what their teachers had to say. The students also saw their teachers as models of how to learn. Interestingly, this has been a common statement made by students each year that the workshop has been offered. The students also indicated that the Institute would help them understand future science classes, and it has encouraged them to take more earth science courses in the future. One student noted, “I am going to college and intend to introduce this knowledge to my teachers and friends.” Another stated, “I want to go out there and do some of the soil testing [in] my specific land. I want to work with my teacher in my school to see if we can incorporate some of what I have learned into my science class. This was an amazing experience.” All of the students seemed enthused about their future in the geosciences and learning more about it as well as passing on this knowledge to others. In fact, approximately 75% of all of the students taking the summer workshop indicated a desire to pursue a career in the geosciences in order to help their communities.

Since the program began as a pilot program in 2005, approximately 100 middle school and high school students, and more than 75 middle school and high school teachers have attended our spring and summer workshops. Through this experience, students interact with and are mentored by geoscience majors and graduate students at UM–Dearborn, who not only lead field activities, but also provide students with advice about college life, expectations, and opportunities. UM–Dearborn faculties have developed relationships with the students, their parents, and their teachers, forming collaborative partnerships to encourage education. The GIRE has also provided opportunities for undergraduate and graduate students at UM–Dearborn to work with not only the teachers and students on the community-based project, but has also provided them with an opportunity to serve as teachers and mentors themselves. These activities served as a secondary means of recruiting students into the geosciences major. In the 3 yr that the formal GIRE program has been running at UM–Dearborn, we have also tripled the enrollment in the geoscience and have quadrupled the

number of minority students now taking introductory geoscience courses. As a result, we feel that the GIRE has not only met, but also exceeded the original goals of the workshop: to empower students to stay in school and to stimulate their interest in science; to improve teacher knowledge and curiosity of geology; to increase their ability to construct and implement innovative learning and assessment techniques and in their classrooms; to expand an awareness of the interactions between geological, historical, political and cultural factors in local watersheds, providing an awareness of opportunities in the geosciences to underrepresented groups, and to encourage students to think about the geosciences as a career, of course thereby increasing the enrollment and retention of these students. For these reasons, we believe the GIRE has been, and will continue to be, a successful and effective model in increasing the participation of underrepresented groups in the geosciences.

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