

Year Three Impact Study of the Geneticist-Educator Network of Alliance Project

An External Evaluation Report

Submitted by:

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September 2009

The Study Group Inc. (TSG) prepared this report as part of its contract with the American Society of Human Genetics (ASHG) to serve as the external evaluator for the Geneticist-Educator Network of Alliance (GENA) Project sponsored by the National Science Foundation (NSF). Any opinions, findings, conclusions, or recommendations expressed in this document are those of the TSG evaluation team and do not necessarily reflect the views of the project, ASHG, or NSF.

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Chapter I. Overview

The Geneticist-Educator Network of Alliance (GENA) Project is operated by the American Society of Human Genetics (ASHG) through a grant from the National Science Foundation (NSF). The National Science Resource Center (NSRC) is a partner in the project. ASHG established the GENA Project to further NSF's Mathematics and Science Partnership (MSP) Program goal of strengthening the capacity of university faculty to participate in K-12 education in three ways. These include:

1. Helping geneticists and high school science teachers form mutually beneficial partnerships around the development of inquiry-based educational materials that address standards and misconceptions in genetics.
2. Providing an infrastructure that supports geneticists' engagement in meaningful educational outreach in their schools and communities as a worthwhile professional activity.
3. Harnessing the resources of ASHG – as a professional society – to promote the value of K-12 educational outreach in colleges and universities.

The GENA Project calls for the establishment of a network of geneticist-teacher partnerships that work together developing learning plans for high school students focused on one or more misconceptions in genetics reflected in their respective state science standards. GENA convened three cohorts of geneticist-teacher partnerships between July 2007 and 2009. Cohorts I, II, and III consisted of 13, 37, and 20 partnerships respectively. The GENA experience is a one-year commitment beginning in the summer with participation in the GENA Workshop. Partners collaborate throughout the following school year developing and implementing the partnership's learning plan.

The Year Three GENA Impact Study

The Study Group Inc. (TSG) has served as the external evaluator for GENA since the project began in 2006. TSG's role in GENA is to provide an external and independent assessment of the quality and impact of the project's activities on three groups: GENA teachers, geneticists, and ASHG and other scientific societies.

In 2007 and 2008, TSG's work focused on providing formative evaluation information to the GENA staff about the quality of the GENA workshops and support activities. Late in 2008, TSG shifted its focus to summative evaluation and began to investigate the impact of the GENA experience on its Cohort I geneticists and teachers.¹ This study examined

¹ The results of these external evaluation activities are documented in four Evaluation Memoranda that TSG submitted to GENA in July 2007, March 2008, September 2008, and January 2009.

the cumulative impact of the GENA Project during a three-year period from late 2006 through the summer of 2009.

The purpose of TSG's year three study was to document and assess the impact of the GENA experience on the geneticists and teachers who have completed their GENA work (i.e., Cohorts I and II) and on ASHG and other scientific societies. The project's intended impacts on geneticists include their understanding of inquiry-based instruction and misconceptions in teaching genetics; their confidence in communicating genetics to high school students; their use of inquiry-based instruction in their own teaching; the nature and intensity of their engagement in educational outreach; and the value they place on educational outreach as a measure of career performance.

The project's intended impacts on participating high school teachers include their understanding of genetics, particularly misconceptions; their use of GENA lessons and materials; and their commitment to continued professional development and interacting with scientists and research institutions. Finally, the intended impacts on ASHG itself include enhancements to the society's policies, programs, and activities that promote the value of K-12 outreach in colleges and universities and strengthen the capacity of faculty to participate.

Evaluation Questions

The year three impact study addressed five questions contained in TSG's three year external evaluation plan. The questions were:

1. How successful were the GENA geneticist-teacher partnerships?
2. What was the project's impact on teachers at the end of their GENA experience?
3. What was the project's impact on geneticists at the end of their GENA experience?
4. What was the long-term impact of GENA participation on geneticists?
5. What was GENA's impact on ASHG and other scientific societies?

Study Protocol

The TSG evaluation team carried out the year three impact study between April 2008 and September 2009 using a mixed methods convergent design. The TSG team collected evaluation data from GENA staff, Cohorts I and II teachers and geneticists, and ASHG executives using documentary, survey, and interview data collection techniques.

TSG distributed an electronic survey to all Cohorts I and II geneticists and teachers near the end of the GENA experience (see Exhibit A below). Survey data collection occurred in April and May 2008 for Cohort I and in April and May 2009 for Cohort II. Survey items varied somewhat from Cohort I to Cohort II, although both surveys asked

participants about the effectiveness of their partnerships; changes in their knowledge and understanding of genetics, confidence and skills in teaching genetics, inquiry-based instruction, and/or educational outreach; their intentions to turn their immediate learning into long-term outcomes for teaching, scientist-teacher partnerships, career and professional development, and/or educational outreach as appropriate.

The surveys included both closed and open-ended items. Response rates varied from 85% for Cohort I teachers to 100% for Cohort I geneticists.

Exhibit A. Number of GENA Geneticists and Teachers Participating in Evaluation Data Collection

GENA Evaluation Data Collection	Cohort I		Cohort II	
	Geneticists	Teachers	Geneticists	Teachers
Number in cohort	13	13	37	38
Number (%) reached with the survey	13 (100%)	13 (100%)	34 (92%)	38 (100%)
Number (%) responding to the survey	13 (100%)	11 (85%)	33 (89%)	33 (87%)
Number (%) participating in interviews	13 (100%)	0	10 (27%)	0

TSG interviewed a random sample of ten Cohort II geneticists in June 2009 to explore the cohort's responses to the electronic survey. Interview protocols were adapted to the individual geneticist's responses on the survey and included accounts of their partnerships, participation in future outreach activities, interest in writing an article about their GENA experiences, interest in more professional development in teaching genetics, addressing student misconceptions, benefits of participation in GENA, documenting the GENA experience for use in tenure or promotion, and their institution's position on educational outreach.

The TSG team also interviewed each Cohort I geneticist (N=13) between May and July 2009 to follow up on intentions expressed by the cohort in the 2008 survey and to identify longer-term results of the project for these participants. This was one year after the Cohort I geneticists had officially finished their GENA experience. The interview protocol solicited geneticists' views on actual changes in their own teaching, participation in professional development on the teaching of genetics, participation in subsequent education outreach activities, writing and presentation activities, experience with tenure and promotion evaluations, and changes in their department's views of education outreach.

Finally, the TSG team reviewed ASHG policy and program documents and interviewed the ASHG Executive Director in September 2009.

The TSG team analyzed its survey and interview data using valid and generally accepted data analysis procedures. Survey data were analyzed using various measures of central tendency (i.e., descriptive statistics). Content analysis and descriptive analysis using pre-established indicators and criteria were employed to examine qualitative data from

interviews and documents. Findings from the survey and interview activities were then integrated and sorted by evaluation question.

Because TSG was looking at GENA as a *project*, conclusions about its impact on ASHG and its participants reported here are based on the responses of the majority of Cohorts I and II geneticists and teachers. In the few instances where contrasting views are presented to illustrate a difference in viewpoint or assessment impact, they are so noted.

Limitations

TSG believes that the findings presented in this report are a valid presentation of GENA's impact on its participants and its sponsoring organization, ASHG. However, the evaluation questions are descriptive and interpretive. The findings are limited to logical and reasonable associations between participants' GENA experiences and influence on their knowledge, understanding, commitments, and practice. Much of the evidence is self-reported viewpoints of project participants. TSG collected comparable data from more than one source using more than one method to strengthen the validity of the findings and to control for respondent bias when relying on self-report procedures. Finally, the findings are not generalizable to other ASHG or NSF projects, although there may be lessons learned or insights that merit consideration when commissioning similar projects in the future.

Audience for the Year Three GENA Impact Study

TSG carried out this evaluation as part of its contractual agreement with ASHG in the role of external evaluator. ASHG is the audience for this report. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the TSG evaluation team and do not necessarily reflect the views of ASHG or NSF.

Organization of the Report

The report consists of seven chapters. This chapter provides an overview of the evaluation. Chapters II through VI present the TSG team's findings regarding each evaluation question. Chapter VII presents the team's overall conclusions.

Chapter II. The Success of the GENA Partnerships

The first evaluation question was “How successful were the GENA geneticist-teacher partnerships?” We responded to this question based on reports from GENA’s Cohorts I and II as these geneticists and teachers had finished their yearlong GENA experience at the time of the impact study. We defined a successful partnership as one where:

- The members rated the partnership as highly or moderately effective.
- The partnership completed its assignment to develop, implement, and evaluate a learning plan.
- The geneticist received GENA Certification.

We concluded that the GENA Project’s geneticist-teacher partnerships were very successful. All 13 Cohort I geneticists received GENA Certification by the end of their experience. Twenty-eight of the 37 Cohort II geneticists (76%) had received certification by the end of this past school year.

More than three-fourths of both Cohort I and II participants described their partnerships to the TSG evaluation team as highly or moderately effective. Only seven of the 46 geneticists (15%) and two of the 44 teachers (5%) who responded to the surveys rated their partnerships as ineffective.

Six of the 13 Cohort I geneticists (46%) maintained contact with their partner teacher after their yearlong GENA experience. Four continued to implement their learning plan this past school year. Twenty-seven Cohort II geneticists (87%) told us that they planned to continue their relationship with their partner teacher this fall.

Positive Partnership Components

We provided Cohort II participants with a list of seven components of partnership that we drew from research on effective partnerships and best practice and asked them to identify those that they believed were positive factors in their own GENA partnerships. Exhibit B below displays their selections.

Exhibit B. Positive Components of the Cohort II GENA Partnerships

Partnership Component	Number (%) of Cohort II Geneticists Viewing Component as Positive	Number (%) of Cohort II Teachers Viewing Component as Positive
Your knowledge and level of skills	29 (88%)	30 (91%)
Your partner's knowledge and level of skills	29 (88%)	32 (97%)
Attitude and commitment	26 (79%)	29 (88%)
Subjective factors such as personality, work style, or interests	24 (73%)	32 (97%)
Communication channels and abilities	20 (61%)	28 (85%)
Working together from a distance	13 (39%)	14 (42%)
The effect of unforeseen events (e.g., change in work assignments, illness, family responsibilities)	5 (15%)	7 (21%)

The majority of geneticists and teachers agreed on the following five components: their known knowledge and skills; the partner's knowledge and skills; attitude and commitment; communication channels and abilities; and subjective factors such as personality, work style, or interests. More teachers saw communication channels and abilities and subjective factors making positive contributions to their partnerships than did geneticists. Both also agreed on what was much less positive: working together from a distance and the effect of unforeseen events.

Factors Affecting the GENA Partnerships

There were many comments from participants about why their partnership was effective. Facilitative factors focused largely on the interaction of the teacher and geneticist, the success of the lesson plan implementation, or both. Here are some examples:

- Working with the geneticist, I was able to build a unit that captured students' interest in the topic and provided relevant, real-world applications for the information being taught. The students had a unique opportunity to meet someone who, in the words of one of my students, "uses genetics everyday instead of just once on a test." Not only that, but college students assisted us during this lesson, providing a role model for the students, many of whom had not considered college as an option. (Cohort II teacher)
- My students and I have learned much from my geneticist. He has brought an expertise...that is not normally found in a high school classroom. It is also an advantage to develop and implement lessons with a partner. (Cohort I teacher)

- Great collaboration between the high school teacher and myself. We are very different in terms of our thought process and approaches so we are constantly challenging each other. (Cohort II geneticist)
- Working with...was terrific. She is energetic and creative. We enjoyed brainstorming to put together a human gene linkage project that students at the 10th grade level could enjoy. (Cohort I geneticist)

In contrast, reasons why individual partnerships were not effective involved external factors that hindered the partnership from developing and/or relationships that just didn't work. Here are samples:

- I believe we could have collaborated better at the beginning of the school year had it not been for a major hurricane affecting our area and schools. (Cohort II participant)
- My partnership did not fruit the way I had hoped; and due to seriously busy schedules, was easy to blow off. (Cohort I participant)
- There has been very poor communication between the teacher and me. I have initiated communication several times, but we were unable to meet. Although the teacher was interested in the ideas I was bringing to the table, he did not seem to be really interested in building the lesson plan and implementing it. It was very hard for me as the outside member...to bring the plan to fruition. (Cohort II geneticist)

Cohorts I and II participants reported that when there was a problem in developing and implementing the partnership's lesson plan, the problems tended to lie with the teacher rather than the geneticist. Scheduling problems, having to implement the lesson plan at a particular point in the curriculum, and short laboratory time were mentioned as contributing factors. Although teachers' lack of interest and motivation were sometimes cited, it is impossible to know whether low commitment was a result of personal factors or institutional ones that made participation difficult. ASHG had matched geneticists and teachers solely on the basis of geographic location; there was no attempt to match on the basis of personality, interests, length of teaching, or other factors.

Chapter III. Impact on Teachers at the End of Their GENA Experience

The second evaluation question was “What was the project’s impact on teachers at the end of their GENA experience?” We investigated two types of impact. The first type was real and immediate. We defined this type of impact as changes in teachers’ knowledge and understanding, confidence, recognition, and instructional skills that had emerged by the end of participants’ yearlong GENA experience. The second type was the potential longer-term impact promised by teachers’ intentions to apply their learning after their direct involvement with the program ended. This potential impact included intentions to change instructional practice as well as to continue participation in education outreach and professional development.

Immediate Impact on Teachers

We asked teachers of both cohorts to provide a self-assessment of how their participation in GENA affected their content and pedagogical knowledge about genetics, particularly Patterns of Inheritance (PoI), and their confidence in teaching PoI. We also asked if they had become more skillful in identifying and providing appropriate instruction to counter students’ misconceptions. In addition, we inquired as to any recognition they had received from their peers or supervisors regarding their GENA participation.

We concluded that the GENA Project had an immediate impact on the teachers who participated. The impact manifested itself in three ways. First, more than three-fourths of teachers in both cohorts (see Exhibit C below) indicated that they became more skillful in identifying and providing appropriate instruction to counter students’ misconceptions. For example, two Cohort II teachers commented specifically on this item:

- ...this project really made me refocus on anticipating where kids would go wrong, as opposed to simply stressing the “right” answers.
- ...I am more aware of the common misconceptions that kids have in relation to genetic concepts, and I try to be cognizant of those things as I listen to the kids and develop my lesson plans.

Second, teachers indicated that they broadened their repertoire of pedagogical approaches. Third, teachers reported strengthening their level of confidence in teaching PoI. These impacts were more prevalent in Cohort I than in Cohort II. A likely fourth immediate impact was teachers’ deepening their content understanding of PoI as about half of the teachers in both cohorts indicated this result for themselves.

Exhibit C. GENA's Immediate Impact on Teachers

Type of Impact	Number (%) of Cohort I Teachers Who Applied the Impact to Themselves	Number (%) of Cohort II Teachers Who Applied the Impact to Themselves
Became more skillful in identifying and providing appropriate instruction to counter students' misconceptions	9 (82%)	26 (77%)
Broadened repertoire of pedagogical approaches	9 (82%)	18 (53%)
Strengthened level of confidence in teaching PoI	8 (73%)	18 (53%)
Checked out GenEdNet.org	8 (73%)	N/A ²
Checked out other genetics web sites for resources and information	8 (73%)	N/A ²
Deepened content understanding of PoI	6 (55%)	16 (47%)
Looked at the curriculum materials and resources provided by GENA	4 (36%)	N/A ²
Recognized by supervisor for participation in GENA	4 (36%)	17 (50%)
Recognized by peers for participation in GENA	1 (9%)	10 (29%)

The increase in the percentages of Cohort II teachers who were recognized for their participation was noteworthy. This increase might be attributed to 13 of these teachers requesting ASHG to send letters describing their participation in GENA to their supervisors. Thus, their supervisors had a stimulus for acknowledging the teacher's involvement. Recognition from peers also raised substantially, a fact that might be closely related to recognition from supervisors, especially if the recognition was public.

Potential Longer-term Impact on Teachers

GENA's strongest potential long-term impact on teachers was strengthening their intention to target student misconceptions more explicitly when developing lesson plans (see Exhibit D below). Three-fourths of the Cohort II teachers and all of those from Cohort I reported that they had or intended to target student misconceptions. Focusing on

² This type of impact was not included on the Cohort II survey so no judgments can be made about its relevance for Cohort II teachers.

misconceptions in some manner was the immediate and long-term impact teachers identified most frequently for themselves.

A second potential long-term impact involved teachers' use of inquiry-based instruction. A substantial majority of Cohort I teachers and about half of Cohort II said that they had or intended to use inquiry-based instruction more effectively. Almost two-thirds of Cohort II teachers indicated that they would use inquiry-based instruction more often.

Exhibit D. GENA's Potential Longer-term Impact on Teachers

Type of Impact	Number (%) of Cohort I Teachers Who Applied the Impact to Themselves	Number (%) of Cohort II Teachers Who Applied the Impact to Themselves
Use GENA learning plans when teaching genetics	11 (100%)	N/A ³
Continue your relationship with your partner scientist	N/A ³	27 (77%)
Target student misconceptions more explicitly when developing lesson plans	11 (100%)	26 (74%)
Use inquiry-based instruction more effectively	9 (82%)	18 (51%)
Use scientists and their expertise more frequently	7 (64%)	17 (49%)
Develop more effective assessments	7 (64%)	18 (51%)
Develop lesson plans around a learning cycle more frequently	5 (46%)	N/A ³
Seek out more professional development in teaching science effectively	5 (46%)	14 (40%)
Use inquiry-based instruction more often	4 (36%)	22 (63%)
Check more frequently that subject matter content aligns with state or national standards	3 (27%)	15 (43%)

A third potential long-term impact was continued relationships between teachers and geneticists. More than three-fourths of Cohort II teachers planned to continue their relationship with their partner geneticist. (This question was not asked of Cohort I although we know that six Cohort I teachers did continue to work with their geneticist partner after their GENA experience.) Almost two-thirds and about half of the Cohort I and II teachers, respectively, said they had or intended to use geneticists and their expertise more frequently. Comments from Cohort I teachers confirmed this finding:

³ Either the Cohort I or Cohort II survey did not include this item so judgments about trends in responses across cohorts cannot be made.

- I have become better at asking researchers at [university] for help.
- ...too often we're guilty of assuming that professors and geneticists are too important and/or busy to be bothered with what we're doing "down here" at the high school level.
- [I] established ties to the university.

In contrast, fewer GENA teachers reported seeking out more professional development in teaching science or checking more frequently that subject matter content aligns with state or national standards. However, the latter showed a significant increase for Cohort II.

Chapter IV. Impact on Geneticists at the End of Their GENA Experience

TSG's inquiry into the impact of GENA on its participating geneticists paralleled our inquiry with the teachers. The third evaluation question was "What was the project's impact on geneticists at the end of their GENA experience?" As with teachers, we defined two types of impact. Immediate impact included geneticists' understanding of teaching genetics at the high school level, pedagogical approaches to teaching genetics, and confidence in participating in education outreach. Potential longer-term impact included geneticists' continued commitment to education outreach, the role of outreach in tenure and promotion, involvement in the activities of ASHG or another professional society, and changes in their own teaching.

Immediate Impact on Geneticists

We concluded that the GENA Project had an immediate impact on the geneticists who participated in Cohorts I and II. We found four encouraging ways in which the project affected geneticists' understanding of and skills in teaching high school genetics as well as their commitment to education outreach (see Exhibit E below).

Geneticists broadened their understanding of the rewards and challenges of teaching genetics at the high school level, expanded their repertoire of pedagogical approaches, became more skillful in identifying and providing appropriate instruction to counter students' misconceptions, and strengthened their confidence in participating in education outreach. This last impact is especially encouraging since GENA was the first education outreach program in which the majority of genetics had participated.

In particular, Cohort II geneticists we interviewed confirmed the value of their learning how to identify and address misconceptions. Here are some sample comments:

- Previously I did not explore misconceptions with either my clients or students. I assumed that they either didn't know or knew correctly.
- I learned to pay more attention to misconceptions. High school students are not as conscious of what they know and don't know.
- The [GENA] workshop was eye opening. I had never thought about misconceptions. I had thought that if you tell them they will learn.

These same geneticists told us that they had already adapted their own instruction to address students' misconceptions. Their solutions ranged from soliciting information from students to find out what they know and do not know to giving students scenarios and having them apply their misconceptions to see how well they work or reteaching once misconceptions are encountered.

Exhibit E. GENA's Immediate Impact on Geneticists

Type of Impact	Number (%) of Cohort I Geneticists Who Applied the Impact to Themselves	Number (%) of Cohort II Geneticists Who Applied the Impact to Themselves ⁴
Broadened understanding of the rewards and challenges of teaching genetics at the high school level	11 (85%)	28 (93%)
Gained a sense of accomplishment and satisfaction in having contributed to the GENA project	N/A ⁵	24 (80%)
Became more skillful in identifying and providing appropriate instruction to counter students' misconceptions	10 (77%)	24 (92%)
Broadened repertoire of pedagogical approaches	10 (77%)	19 (73%)
Acquired an outreach experience to incorporate into your tenure folder	N/A ⁵	19 (79%)
Strengthened level of confidence in participating in education outreach	10 (77%)	17 (57%)
Recognized by peers for involvement in education outreach	4 (31%)	14 (58%)
Increased your department's level of interest in education outreach	N/A ⁵	7 (29%)
Deepened content understanding of PoI	3 (23%)	4 (15%)

More than three-fourths of the Cohort II geneticists reported gaining a sense of accomplishment and satisfaction in having contributed to the GENA project and having acquired an outreach experience to incorporate into their tenure folder, response items not included on the Cohort I survey.

The significant increase from Cohort I to Cohort II in the percentage of genetics who reported recognition by peers for their GENA participation was encouraging. This increase might be tied to the 20 geneticists who had requested letters from ASHG.

Potential Longer-term Impact on Geneticists

We posed numerous potential long-term outcomes to the geneticists including their commitment to educational outreach, the role of this outreach in tenure and promotion,

⁴ The numbers of Cohort II geneticists who responded to these items on the year-end survey ranged from 24 to 30. The percentages in Exhibit E are calculated based on the number of geneticists who responded to that specific item.

⁵ This type of impact was not included on the Cohort I survey so no judgments can be made about its relevance for Cohort I geneticists.

involvement in the activities of a professional society, and influences on their own teaching style.

GENA's strongest potential long-term impact on geneticists was increasing their commitment to their meaningful participation in education outreach (see Exhibit F below). All of Cohort I geneticists and nearly all of Cohort II said they would definitely or probably participate in another education outreach program in the near future. About two-thirds of Cohort I and nearly all of Cohort II intended to encourage colleagues to participate in education outreach.

We asked ten Cohort II geneticists "How do you encourage your colleagues to participate in outreach?" The most frequent response was "talk it up." Eight out of the nine Cohort II geneticists we interviewed cited some form of letting others know about their outreach experiences. Sharing these experiences, discussing the benefits of outreach, and providing information on additional opportunities are all very important in influencing others, interviewees said.

In particular, about half of Cohort I and more than three-fourths of Cohort II indicated that they would volunteer for an educational activity with another public or private school science teacher. More than three-quarters of the Cohort II geneticists said they would continue their relationship with their GENA teacher.

A second potential long-term impact appeared to be geneticists' plans to change their own teaching. About half of the geneticists in each cohort said that they would change their teaching style to be more inquiry-based, and more than half of the Cohort II geneticists said they would use the curriculum materials featured in the Genetics Education and Outreach Toolkit as well as genetics websites. Nearly half said they would also seek out more professional development related to teaching genetics, a much higher percentage than Cohort I.

The third potential long-term impact on geneticists related to their use of the GENA experience when applying for tenure (or promotion). Around three-quarters of each cohort reported plans to use GENA participation when documenting their performance. (This percentage represents almost all of the geneticists who occupied tenure-track positions.) Two-thirds of Cohort I and about half of Cohort II geneticists intended to promote the use of education outreach as a qualification for tenure to their institutions. We learned from the 10 Cohort II geneticists we interviewed that three had already included information on their GENA experience in their portfolios, although they were not confident that it would help them in securing tenure or promotion. The letter from ASHG was all that the geneticists needed for documentation.

Exhibit F. GENA's Potential Longer-term Impact on Geneticists

Type of Impact	Number (%) of Cohort I Geneticists Who Applied the Impact to Themselves	Number (%) of Cohort II Geneticists Who Applied the Impact to Themselves ⁶
Will definitely (or probably) participate in another education outreach program in the near future	13 (100%)	30 (91%)
Continue your relationship with your partner teacher	N/A ⁷	27 (87%)
Use genetics websites for resources and information	N/A ⁷	20 (65%)
Use GENA participation when documenting performance for tenure	9 (69%)	24 (77%)
Encourage colleagues to participate in education outreach	9 (69%)	29 (94%)
Promote the use of education outreach as a qualification for granting tenure	8 (62%)	15 (48%)
Change teaching style to be more inquiry-based	6 (46%)	14 (58%)
Volunteer for an educational activity with another public or private school science teacher	6 (46%)	26 (84%)
Join (or increase participation in) ASHG's Genetics Education and Outreach Network (Mentor Network)	6 (46%)	13 (42%)
Use the curriculum materials featured in the Genetics Education and Outreach Toolkit	4 (31%)	14 (58%)
Write and/or publish an article on GENA activities in a newspaper, peer-reviewed journal, or other publication	4 (31%)	9 (29%)
Present a seminar or other briefing to colleagues on experiences in GENA	4 (31%)	6 (19%)
Join (or increase participation in) ASHG's Genetics Education Curriculum Committee	3 (23%)	N/A ⁷
Seek out more professional development related to teaching genetics	2 (15%)	11 (46%)
Increase involvement in FASEB-sponsored training and listserv activities	1 (8%)	7 (23%)

The GENA experience did not increase geneticists' plans to participate in the activities of ASHG or another professional society. Neither did it influence the likelihood that geneticists would publish an article about their GENA work. The Cohort II geneticists with whom we spoke explained that the articles they write for publication require data. The GENA experience does not give them appropriate data for publication. Some geneticists believed that it was more appropriate for the teacher to write the article even though publishing is usually not an expectation for teachers. There were certainly

⁶ The numbers of Cohort II geneticists who responded to these items on the year end survey ranged from 24 to 31. The percentages in Exhibit E are calculated based on the number of geneticists who responded to that specific item.

⁷ Either the Cohort I or Cohort II survey did not include this item so judgments about trends in responses across cohorts cannot be made.

exceptions: one geneticist indicated that he enjoys writing and intended to write an article that would benefit not only himself but also his partner teacher. However, it is unlikely that a significant number of geneticists will choose this avenue.

Chapter V. GENA's Long-term Impact on Geneticists

The fourth evaluation question addressed the sustainability of geneticists' insights, skills and commitments. It asked "What was the long-term impact of GENA participation on geneticists?" We investigated this question by interviewing the 13 Cohort I geneticists one year after they completed their GENA experience. None of the geneticists had had any formal relationship with the project during this time. The interview protocol reflected the range of intentions that geneticists expressed at the end of their GENA work: targeting student misconceptions, changing their own teaching style, engagement in education outreach, and the value of outreach as a measure of career performance.

We found that the GENA Project had a long-term impact on geneticists that manifested itself in several forms. These included:

- Attending to and addressing misconceptions in genetics.
- Changes to their own teaching practice.
- Continued participation in and promotion of the value of education outreach.
- Ongoing contact with their GENA teacher.

The Cohort I geneticists also confirmed that their participation in the project helped influence their departments' views toward the value of education outreach. One-third of the geneticists had participated in an ASHG activity or that of another professional society. However, geneticists had not written about their GENA experience or made a significant number of presentations either to their departmental faculty or to external audiences. Finally, GENA's impact on geneticists' tenure and promotion efforts was unclear.

Addressing Misconceptions in Genetics

Every Cohort I geneticist reported ways in which he/she was making an effort to address clients' and students' misconceptions in genetics. Most efforts entailed reorganizing instruction to surface potential misconceptions and address them directly. Many dealt with more sophisticated questioning techniques with clients and students. A few geneticists reported using short assessment activities (e.g., quizzes) to elicit misconceptions. One geneticist commented that "I now realize how I can inadvertently spread misconceptions if I'm not careful."

Changes in Teaching Practice

Seventy percent of the geneticists indicated that they had changed one or more aspects of their own teaching because of their participation in GENA. One-third had sought out additional professional development opportunities related to the teaching of genetics, which they attributed to the value of their GENA participation.

Besides attending to possible misconceptions, the change most frequently mentioned was adapting instruction to communicate with wider audiences. Geneticists were able to apply what they learned during GENA about communicating genetics to high school students to their own teaching situations (e.g., “I am now willing to teach undergraduates. Before I would only teach graduate students” and “I can teach students who do not have much of a background in genetics”). Not surprisingly, geneticists also reported more confidence in making presentations to non-scientific audiences.

One year after their direct involvement in GENA, geneticists were working hard to incorporate elements of inquiry-based instruction into their teaching practice (although some were not quite sure how to define “inquiry”). For the most part, geneticists were investigating alternatives to a straight lecture approach by introducing group work sessions, projects, and more class discussions. About half of the geneticists reported also experimenting with designing instruction around a learning cycle or with different types of assessment activities.

Commitment to Education Outreach

GENA was the first education outreach experience for 10 of the 13 (77%) Cohort I geneticists. At the end of their GENA experience, all of the geneticists registered their intent to participate in another education outreach program in the near future. A year later, two-thirds of them had participated in at least one new program.

The nature of geneticists’ outreach experiences varied from one-day events (e.g., DNA Day on April 24th, classroom presentations) to extensive programs leading to significant career shifts. One geneticist was contemplating a move into informal or K-12 education. Another had gotten so involved in a project with a high school teacher that the topic (sickle cell anemia) had become the major focus of his research and extramural funding.

Almost all of the geneticists reported that GENA had increased their interest in or strengthened their attitude toward the value of education outreach. Their comments evidenced a strong belief that scientists have a role and responsibility in improving science education and that their involvement is essential. Here are a few examples of their beliefs:

- It is essential. One issue is evolution. People still do not believe in evolution. The future of medicine depends on this belief. Otherwise, it is hugely driven by misconceptions. Scientists who really understand their work need to interact with the public....

- The value of education outreach is extremely high. As research increases, the gap for what makes one science literate grows. There should be pressure on the scientific community to do outreach....
- Education outreach should be part of an academic portfolio. It should not only be allowed but encouraged.... It should just be the way that business is done in academia.
- Education outreach is an absolute necessity. Genetics is advancing so fast. Students are behind; the general public is behind. Scientists have to be out there.

The geneticists had taken steps to promote the value of education outreach in their own departments. We asked the Cohort I geneticists how their GENA participation might have influenced the views of their own departments regarding the value of education outreach. Exhibit G below summarizes their responses.

Exhibit G. How Geneticists' Participation in GENA Has Helped Influence Their Department's View of Education Outreach

Type of Influence	Number (%) of Geneticists Who Reported This Influence
More public recognition for those participating in education outreach	6 (46%)
More colleagues participating in education outreach	4 (31%)
More mention of education outreach at faculty or staff meetings	4 (31%)
Greater acceptance of education outreach being a valid criterion for tenure or promotion	4 (31%)
Building education outreach into proposals for external funding	4 (31%)

Ongoing Contact with GENA Teachers

Almost half of the Cohort I geneticists had maintained contact with their partner teacher during the year following their project participation. Four had continued to implement their learning plan during the 2008-2009 school year. Geneticists who did not maintain contact told us that their circumstances changed (e.g., new, consuming assignments within their department) or that the lack of a supportive structure and requirements led to the relationship simply fading away.

Tenure and Promotion

As we stated previously, the long-term impact of GENA on geneticists' tenure and promotion efforts remains unclear. Nine Cohort I geneticists were in tenure track positions when they became involved with the GENA Project. Since then, only two have been evaluated for either tenure or promotion. Both incorporated documentation about their GENA experience into their application portfolio. One believed that the information was helpful; the other reported that it had little effect. Overall, the Cohort I geneticists expressed little confidence that their GENA experience would significantly affect their tenure and promotion process (although about one-third of the geneticists had observed greater acceptance of outreach as a tenure qualification – see Exhibit G above).

Chapter VI. GENA's Impact on ASHG and Other Scientific Societies

One of GENA's central issues was how a professional society, working through its membership, can promote the value of K-12 outreach in colleges and universities and thereby support improved science education. The fifth evaluation question reflects this research interest by asking, "What was GENA's impact on ASHG and other scientific societies?"

Our inquiry into GENA's impact on ASHG relied mostly on the documentary evidence we gathered from ASHG staff, its journal, agendas for its Annual Meetings, and websites hosted by ASHG and other scientific societies. We also interviewed the GENA Principal Investigator (PI) and ASHG Executive Director.

We found evidence of GENA's impact on ASHG as a professional society. We confirmed that the project has already shaped ASHG's policies and programs to highlight and argue for the value of scientists' involvement in K-12 education.

Policy Position on the Participation of Scientists in K-12 Education

Earlier this year, the ASHG Board of Directors formally adopted its first policy statement on the importance of participation of scientists in K-12 science education. The statement reads:

The American Society of Human Genetics (ASHG) encourage administrators and leaders in institutions of higher education, including medical schools, to give appropriate credit to faculty who participate in formal outreach activities involving K-12 students and teachers. For example, during the appointment, tenure, and promotion process, participation in sustainable teaching activities and curriculum and materials development should be highly valued. Continued public support for genetics research and informed participation in an increasingly genetics-based healthcare system demand that consumers understand genetics and its importance in health and disease. ASHG will continue to leverage its expertise, in particular its membership, and provide leadership and organizational infrastructure to improve K-12 science education to achieve the goal of an informed public.

ASHG President, Board members, and society executives have referenced this statement when working with Congress, university presidents, and boards of trustees. According to the ASHG Executive Director, "... the statement has legitimized our [ASHG's] broader educational efforts. It is challenging us to make a difference. It is already changing the tenor of many discussions."

Programs of the Society

The status of K-12 science education (particularly in genetics) and the role that scientists should play in improvement has become more visible in ASHG's key initiatives (i.e., the website, *The American Journal of Human Genetics*, the ASHG Annual Meeting, and the Genetics Education Outreach Network [GEON]).

The ASHG Website

Between 2007 and this year, GENA staff and ASHG's information and technology department collaborated to redesign the ASHG website. The purpose of this redesign activity was to make the society's education activities more prominent.

ASHG's Journal

Historically, ASHG's journal has not included articles discussing K-12 education or science education. However, the current GENA PI, who is also the ASHG Director of Education, authored an article published in the most recent issue of *The American Journal of Human Genetics*. The article is entitled "Closing the Gap: Inverting the Genetics Curriculum to Ensure an Informed Public".⁸

ASHG's Annual Meetings

The GENA Project is well represented on the agenda of the society's upcoming Annual Meeting in November. First, the Undergraduate Faculty Education Workshop, an annual event that covers human genetics content and pedagogies for faculty who teach undergraduate biology, will feature a session for the first time on university-high school outreach. Second, one of four invited sessions on education this year is "Addressing the Crisis in High School Genetics Education: Universities Partnering with K-12 Education." Presenters include the GENA PI, the President of ASHG, the Director of the National Institutes of Health (NIH) Office of Science Education, and a Cohort I GENA geneticist. Third, the GENA luncheon, where the Cohorts I-III geneticists attending the meeting get together to discuss their experiences, will continue this year.

The Genetics Education Outreach Network

ASHG is building directly on GENA's central idea of preventing and addressing misconceptions in genetics to revitalize and expand the work of its GEON. Earlier this year, ASHG articulated a set of Core Genetics Concepts drawn from several sources, including the National Science Education Standards, that ASHG believes should form the

⁸ Dougherty, Closing the Gap: Inverting the Genetics Curriculum to Ensure an Informed Public, *The American Journal of Human Genetics* (2009), doi:10.1016/j.ajhg.2009.05.010.

basis of high school curriculum in genetics. The core concepts were reviewed by members of ASHG's Information and Education Committee. Now the society is working with members of its GEON to evaluate the congruence of states' science standards with its core concepts, so that geneticists and ASHG can recommend improvements in the various standards.

GENA's Benefits of Outreach to Higher Education Meeting

Finally, GENA hosted a two-day invitational meeting this past summer involving GENA participants and representatives from four scientific societies, three universities, and members of ASHG's Board of Directors and Information and Education Committee. The desire for the meeting grew out of the challenges GENA found with influencing the value colleges and universities place on faculty engaging in education outreach. The purpose of the meeting was to explore the dynamics of broadening the higher education reward system to include K-12 outreach in the tenure and promotion process. GENA staff are now using the results of the "Benefits of Outreach to Higher Education" meeting to target ASHG's next steps in responding to the challenges of its outreach policy statement. As the ASHG Executive Director told the TSG team, "We knew outreach was important but we did not realize how much effort it would take to promote it well."

Leadership with Other Scientific Societies

ASHG executives have taken advantage of their membership in the Federation of American Societies for Experimental Biology (FASEB) and other groups of scientific societies to promote the importance of scientists participating in K-12 education. Their advocacy has begun to show promise. The American Society of Plant Biologists (ASPB) adopted a policy position based directly on ASHG's statement. The American Physiological Society (APS) (a FASEB member), the Society for Neuroscience (SFN), and the American Society of Microbiologists (ASB) are considering the adoption of a comparable policy statement.

We believe that GENA's impact on ASHG and other scientific societies is only now accumulating as the project finishes its third year. Since GENA has resources to continue another year, the impact of the project on the societies may well continue to build. Plans are underway for the society to capitalize further on its GENA sponsorship.

Chapter VII. Summary

NSF funded GENA in 2006 as a MSP Research, Evaluation and Technical Assistance (MSP-RETA) project. The role of a MSP-RETA is to support the work of the larger MSP projects by developing and disseminating the knowledge base MSPs need to achieve sustained educational reform. In its 2006 program solicitation, NSF wanted to explore how a national professional society could (1) assist STEM faculty and university administrators in preparing to work effectively in K-12 education, and (2) leverage its influence in identifying and promoting the institutional changes in higher education that are critical to sustaining faculty engagement in K-12 STEM education.⁹ NSF funded ASHG (in partnership with the NSRC) to carry out this exploration through GENA.

TSG carried out this year three GENA impact study as a summative evaluation activity in its role as GENA's external evaluator. The purpose of the study was to document and assess the cumulative impact of the GENA Project in three central areas of interest to NSF. These areas were building mutually beneficial partnerships between geneticists who belong to ASHG and high school science teachers, providing an infrastructure that supports geneticists' engagement in education outreach, and harnessing the society's resources to promote the value of education outreach in colleges and universities.

Based on the findings presented in Chapter II-VI, we concluded that the GENA Project made significant strides in each central area of interest. Specifically, GENA helped ASHG successfully demonstrate how a scientific society can:

- Present a convincing rationale for why scientists need to participate in K-12 science education.
- Establish and operate a productive and mutually beneficial partnership-based outreach program for its members.
- Strengthen the commitment of its members to engage in meaningful education outreach.
- Enhance opportunities for its membership to engage in education outreach.
- Address the challenges that exist in gaining professional recognition for education outreach by colleges and universities.

A summary of each of our conclusions follows.

⁹ See *NSF Math and Science Partnership (MSP) Program Solicitation*, NSF 06-539, pages 2-8. Available at www.nsf.gov/pubs/2006/nsf06539/nsf06539.pdf

Rationale for the Participation of Scientists in K-12 Science Education

The project's decision to its work on misconceptions in genetics was a wise one that motivated geneticists, teachers, and ASHG itself. It provided a convincing rationale for why scientists should participate in K-12 science education. We found that the most significant learning for the greatest number of geneticists and teachers was identifying and addressing misconceptions. It was new and very insightful information for the geneticists and teachers. It was the most frequent application by geneticists to their own teaching. Geneticists who worked in clinical settings related to misconceptions as well as those who worked in universities. As the ASHG Executive Director explained, "Our membership understands the importance of having an informed public when dealing with our health and care systems. We want to know how we can make the general public more literate in genetics."

Mutually Beneficial Partnership-based Outreach Program

The GENA partnerships (Cohorts I and II) were very successful. GENA staff used formative evaluation data from their Cohort I experiences to fine tune recruitment, the GENA Workshop, and support activities. The staff followed the components and factors associated with effective partnerships. By Cohort II, GENA was operating as an effective outreach program.

Our evidence of effectiveness was that the GENA experience benefited every teacher and geneticist in some manner. As a group, teachers became more skillful in identifying and addressing students' misconceptions. They broadened their range of pedagogical skills, and they increased their confidence in teaching patterns of inheritance. We found a high likelihood that teachers would either continue their partnership with the geneticist or seek out ways for involving other scientists in their classrooms.

Geneticists certainly learned about teaching genetics at the high school level while also broadening their own pedagogical expertise and abilities to counter students' misconceptions. Many remained in contact with their partner teacher. We were surprised by the number of geneticists who applied their learning about pedagogy and addressing misconceptions to their own teaching. As expected, the majority of geneticists – for whom GENA was a first outreach experience – sought out new outreach activities when their GENA year ended.

Membership Commitment to Participation in Meaningful Education Outreach

We looked at membership commitment to education outreach from three perspectives: GENA's participating geneticists, ASHG as a society, and members' colleges and universities. We confirmed that the GENA experience led to an increased commitment to education outreach by its participating geneticists. This was the strongest long-term impact on Cohort I geneticists. GENA was the first outreach experience for most of these geneticists. At the end of their GENA year, all of them planned to participate in another outreach program. A year later, two-thirds of them had actually followed through on their intentions. (It is too soon to know about the Cohort II geneticists.) Geneticists told us that their GENA experience coalesced their beliefs about the value of scientists participating in K-12 science education. We are certain that the GENA partnerships were an effective mechanism for strengthening geneticists' commitment to education outreach.

Second, we concluded that GENA has had a visible impact on ASHG's commitment to education outreach. Articles and presentations on genetics curriculum, science education and the role of scientists in genetics literacy are emerging in ASHG's journal and annual meeting agenda. These are encouraging signs of the society's long-term commitment. ASHG's Executive Director believes that "...GENA gave us the language to talk about outreach and an infrastructure through which we could view all of our activities." The Board's adoption of a policy statement on the participation of scientists in K-12 education was a significant accomplishment by a membership organization. ASHG has assumed a leadership role regarding the value of outreach with other scientific societies. This effort is only now beginning to have an effect.

Third, GENA has not yet achieved a programmatic impact on higher education commitment to education outreach, although the experiences of some GENA participants are promising. Some geneticists observed that their departments' interest in education outreach had increased; others noted that they and their colleagues received public recognition for their participation in outreach activities. The few GENA scientists who had gone through a tenure and promotion process had mixed opinions on the influence of their GENA experience.

Opportunities for Membership Participation in Education Outreach

Seventy ASHG members have participated in GENA Cohorts I, II and III. The society's education department is now using GENA's work identifying and countering students' misconceptions to revitalize its Geneticist Education Outreach Network. When implemented, this effort has the potential to engage up to 650 ASHG members working to improve state standards in science and the school curriculum in genetics.

Challenges to the Value of Education Outreach by Higher Education

The GENA Project has given ASHG an opportunity to examine in some depth the barriers to making institutional changes in higher education that support sustained faculty engagement in K-12 education. While ASHG has not yet identified solutions, the society has become better acquainted with the challenges and how a scientific society might address them. Its recent “Benefits of Outreach to Higher Education” meeting outlined an approach that ASHG intends to pursue during the fourth year of GENA support.

Next Steps

We anticipate that the impact of the project on ASHG and other scientific societies will continue to build. We also anticipate that ASHG will take further steps to address the barriers to institutional change that affect the participation of faculty in K-12 STEM reform efforts. Since GENA has resources to continue for another year under NSF sponsorship, this is not TSG’s final external evaluation report. We intend to remain involved with the project to assess its future performance.