Evaluation of the 2013-14 Discover, Explore, and Enjoy Physics and Engineering (DEEP) Program

Prepared by
Education Research Center
at Texas A&M University

Prepared for
Department of Physics and Astronomy
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TEXAS A&M UNIVERSITY

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Credits

Education Research Center at Texas A&M University

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For additional information about ERC at TAMU research and evaluation, please contact:
Education Research Center
at Texas A&M University
112 Harrington Tower
4232 TAMU
College Station, Texas 77843-4232
erc.cehd.tamu.edu

Contributing Authors

Education Research Center
at Texas A&M University:

Jacqueline R. Stillisano
Kim B. Wright
Hersh C. Waxman

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EXECUTIVE SUMMARY

The Discover, Explore, and Enjoy Physics and Engineering (DEEP) program was established in 2012 as an outreach effort by the Department of Physics and Astronomy at Texas A&M University. Envisioned and implemented by Dr. Tatiana Erukhimova and Dr. Edward Fry, faculty in the Department of Physics and Astronomy, and by Dr. John Junkins and Dr. Kristi Shryock, faculty in the Department of Aerospace Engineering, DEEP was funded by a 3-year, $300,000 Tier I grant provided by Texas A&M University. The program was purposed to enhance undergraduate and graduate students' learning and research experience by incorporating active learning, service learning, and teamwork activities.

The present evaluation examined the impact of the 2013-14 DEEP program, including its effect (a) on undergraduate participants' knowledge of physics and engineering concepts and analytic and hands-on skills in conducting research and (b) on mentors' skills in leading and facilitating research teams. The evaluation was a mixed-methods study that included undergraduate participant post-perceptional surveys, mentor post-perceptual surveys, undergraduate participant interviews, and mentor interviews.

Key Findings

The DEEP 2013-14 program was found to include the following strengths:

- Overall, both undergraduate and graduate participants were enthusiastic about their DEEP experiences, with many reporting that they hoped to participate in subsequent years.
- Undergraduate participants believed their DEEP experiences increased their understanding of physics and engineering concepts, as well as their problem-solving skills.
- Mentors and undergraduate participants reported that mentors provided effective leadership for the project teams, although mentors appeared only moderately confident in their abilities to encourage collaboration among team members.

Key Recommendations

Primary recommendations include the following:

- Investigate additional methods to incentivize undergraduate participants, to increase motivation and follow-through
- Explore ideas to more effectively manage resource allocation for building the demos
- Continue the bi-weekly lunch meetings among DEEP mentors and program staff, (a) adding a training or information component for new mentors and (b) structuring regular opportunities for experienced participants to "mentor the mentors"

In conclusion, the DEEP Program is on target to achieve its overall goal to enhance undergraduate and graduate experiences at Texas A&M University by incorporating active learning, service-oriented learning, and teamwork activities. Moreover, undergraduate participants in particular were enthusiastic about opportunities to share their love of physics through outreach activities, while mentors believed they were able to enhance undergraduate participants' engagement in the academic community.

CHAPTER 1: Introduction

Outreach programs are offered with great success by university physics and science departments in many universities across the country, such as Virginia Tech University, University of Pennsylvania, University of Maryland, Northern Illinois University, and University of Texas at Austin, just to name a few. These outreach efforts vary in their program focus and target population. Purdue University's Department of Physics and Astronomy, for example, offers its Physics Educational Activities, Resources, and Learning Strategies (PEARLS) program to scout groups, nursing homes, schools, etc., as an example of innovative outreach (Conlon, 2004). The University of Colorado–Boulder, on the other hand, offers a 3-hour course that combines physics, education, and community outreach for upper-division undergraduate physics majors with an interest in teaching physics (Finkelstein, 2003).

At Texas A&M University (TAMU), the Department of Physics and Astronomy initiated the Discover, Explore, and Enjoy Physics and Engineering (DEEP) Program in 2012 as part of its outreach efforts. The program is designed to enhance the learning and research experiences of undergraduate and graduate students from the College of Science and the College of Engineering. A key component of the program is students' participation in high-profile outreach activities, including the Texas A&M University annual Physics and Engineering Festival, fall and spring DEEP Showcases, and Physics Shows and demonstrations for K-12 students and teachers from across the state.

The Education Research Center at Texas A&M University (ERC at TAMU) was commissioned by DEEP in February 2014 to conduct an external evaluation of the 2013-14 DEEP program. This report describes the findings from the DEEP evaluation, which addressed research questions related to overall effectiveness of the program and to the following program objectives:

1. Increase undergraduate student participants' knowledge of physics and engineering concepts
2. Positively impact undergraduate student participants' analytic and hands-on skills in conducting research
3. Enhance undergraduate student participants' communication skills
4. Encourage undergraduate student participants' teamwork skills
5. Improve graduate student participants' leadership skills
6. Increase graduate student participants' teambuilding skills

Program History

The Discover, Explore, and Enjoy Physics and Engineering (DEEP) program was established in 2012 as an outreach effort by the Department of Physics and Astronomy at Texas A&M University. Envisioned and implemented by Dr. Tatiana Erukhimova and Dr. Edward Fry, faculty in the Department of Physics and

Astronomy, the DEEP program was funded by a 3-year, $300,000 Tier I grant funded by Texas A&M University. The goal of the program is to enhance undergraduate and graduate students' learning and research experience by incorporating active learning, service learning, and teamwork activities.

The DEEP program was purposed to enhance the learning and research experiences of TAMU undergraduate and graduate students through participation in high-profile outreach activities. Teams of undergraduate students—led by graduate student mentors—collaborate to research, design, and develop science demonstrations (demos). These demos are presented by teams of students and faculty members during the annual Physics Festival, Physics Shows, and other outreach opportunities. Ultimately the demos are used to enhance the undergraduate curriculum at Texas A&M University (Texas A&M University Department of Physics and Astronomy, 2014). DEEP participants who work on the projects for two semesters receive a stipend.

The first DEEP cohort participated in academic year 2012-13. Participants included 45 undergraduate participants and 14 graduate student mentors. The second DEEP cohort participated in academic year 2013-14. Participants included 59 undergraduate participants and 17 graduate student mentors.

Organization of the Report

The primary purpose of this report is to address the evaluation questions related to the Discover, Explore, and Enjoy Physics and Engineering (DEEP) 2013-14 Program. The report is organized into five chapters. Chapter 1 provides the history and background information for DEEP, Chapter 2 presents the DEEP program components, Chapter 3 describes the research methods used in the current evaluation, and Chapter 4 addresses the results of the evaluation. Finally, Chapter 5 offers a summary and conclusions.

CHAPTER 2: Description of Key Program Components

The Discover, Explore, and Enjoy Physics and Engineering (DEEP) Program was envisioned as an opportunity to enhance undergraduate and graduate students' learning and research experiences by integrating active learning, service learning, and teamwork activities. Teams of undergraduate students, led by graduate mentors from the Departments of Physics & Astronomy and Aerospace Engineering, research, design, and develop demonstrations that are presented during outreach events. The Education Research Center at Texas A&M University (ERC at TAMU) was commissioned by DEEP in February 2014 to conduct an external evaluation of the DEEP 2013-14 program.

DEEP Program Objectives

The DEEP Program was established with the following six objectives:

1. Increase undergraduate student participants' knowledge of physics and engineering concepts
2. Positively impact undergraduate student participants' analytic and hands-on skills in conducting research
3. Enhance undergraduate student participants' communication skills
4. Encourage undergraduate student participants' teamwork skills
5. Improve graduate student participants' leadership skills
6. Increase graduate student participants' teambuilding skills

Program Inputs

The DEEP Program exemplifies outreach efforts in the Department of Physics and Astronomy in the College of Science at Texas A&M University, by providing a venue to engage students in physics and engineering outreach to the university and the greater community. The hands-on demonstrations are built in the TAMU Physics laboratories, machine shop, and electronic shop.

Dr. Tatiana Erukhimova and Dr. Edward Fry, faculty members from the Department of Physics and Astronomy, facilitate the program and are co-PIs for the project. Approximately 25 faculty from the

Department of Physics and Astronomy interact with the DEEP teams and provide feedback on their projects during the fall and spring Physics Showcases.

The DEEP Program was funded in 2012 by a 3-year, $300,000 Tier I grant from Texas A&M University. Grant funds support the development of the physics demonstrations, specifically by paying for materials and supplies needed for the demonstrations. In addition, undergraduate and graduate students who participate in the DEEP Program for two full semesters are awarded stipends.

Program Outputs

At the time of this evaluation report, the 2013-14 DEEP Program had concluded. Stakeholders served by the program were comprised of the undergraduate and graduate students who participated as members of teams during the 2013-14 program. Table 2.1 provides demographic information regarding the participants.

Table 2.1
DEEP Participant Demographics

	Characteristics	
	Undergraduates	Mentors
Sex		
Female	11	4
Male	48	13

Source. DEEP program records.

CHAPTER 3: Evaluation Methods

Evaluation Questions

The overall goal of the DEEP 2013-14 program is to enhance undergraduate and graduate experiences at Texas A&M University by incorporating active learning, service-oriented learning, and teamwork activities. The evaluation of the DEEP 2013-14 program was guided by questions related to participants' perceptions of the overall effectiveness of the program, as well as the program's success in addressing the six objectives supporting the program goal to enhance undergraduate and graduate students' learning and research experiences: (a) increase undergraduate student participants' knowledge of physics and engineering concepts, (b) positively impact undergraduate student participants' analytic and hands-on skills in conducting research, (c) enhance undergraduate student participants' communication skills, (d) encourage undergraduate student participants' teamwork skills, (e) increase graduate student participants' leadership skills, and (f) augment graduate student participants' teamwork skills. Table 3.1 provides the specific evaluation questions.

Table 3.1
Evaluation Questions for the DEEP 2013-14 Program Evaluation

Questions related to overall effectiveness of the program:
Q1.1. What were the strengths (beneficial aspects) of the DEEP 2013-14 Program?
Q1.2. What were the weaknesses of the DEEP 2013-14 Program?
Q1.3. What aspects of the DEEP Program should be changed?
Q1.4. How likely are current undergraduate and graduate student participants to recommend DEEP to their classmates?
Q1.5. Did undergraduate and graduate student participants believe the time commitment they made to DEEP activities was appropriate?
Q1.6. Did participation in DEEP increase undergraduate participants' engagement in the academic community?
Questions related to impact on undergraduate student participants' knowledge of physics and engineering concepts:
Q2.1. To what extent did the undergraduate participants' believe they increased their understanding of the physics and engineering concepts behind the demonstrations they built?
Q2.2. To what extent did undergraduate student participants believe the knowledge they gained in creating their DEEP project(s) will be applicable to their future academic courses?
Q2.3. What are some specific ways in which undergraduate student participants applied knowledge gained in creating their DEEP project(s) to their academic courses?
Questions related to impact on undergraduate student participants' analytic and hands-on skills in

conducting research:
Q3.1. How many hands-on demonstrations were designed and built by the 2014 DEEP undergraduate teams?
Q3.2. To what extent did the undergraduate participants believe they increased their analytic and hands-on skills in conducting research?
Questions related to impact on undergraduate student participants' communication skills:
Q4.1. Were undergraduate participants comfortable in their ability to explain their experiments to the general public during the Physics and Engineering Festival?
Q4.2. Were undergraduate participants comfortable in their ability to explain their experiments to their peers during the DEEP Showcases?
Questions related to impact on undergraduate student participants' teamwork skills:
Q5.1. In what ways did individual undergraduate participants contribute to the development of the team demos?
Q5.2. To what extent were undergraduate participants satisfied with the level of collaboration on their individual teams?
Q5.3. To what extent were undergraduate participants satisfied with the communication between other members of their team and themselves?
Q5.4. To what extent did undergraduate participants identify the feedback received at the spring Showcase from other teams as supportive?
Questions related to impact on graduate student participants' leadership skills:
Q6.1. To what extent did the mentors believe the weekly meetings with their colleagues and DEEP program staff provided support for the mentors in their role as team leader?
Q6.2. Were the mentors successful in providing leadership to their project team?
Q6.3. To what extent did the mentors believe that their mentoring responsibilities contributed to their own leadership skills?
Q6.4. Did mentors establish effective lines of communication between themselves and the members of their team?
Q6.5. Did mentors provide effective levels of guidance between them and members of their team?
Questions related to impact on graduate student participants' teamwork skills:
Q7.1. Did the mentors encourage collaboration among their team members?
Q7.2. To what extent did the mentors believe that their mentoring responsibilities contributed to their own teamwork skills?
Q7.3. To what extent did mentors believe their DEEP experiences enhanced their understanding of team processes necessary to complete an academic research project?

Source. DEEP 2013-14 Program Evaluation Plan.

Participants

Participants for this evaluation study included members of the DEEP Planning/Facilitation Team, DEEP 2013-14 undergraduate student participants, and DEEP 2013-14 graduate student participants (mentors).

Data Sources and Collection

The evaluation team employed a mixed-method research design for this study. Quantitative and qualitative data were collected from the following sources: surveys of undergraduate student participants, interviews with undergraduate student participants, surveys of graduate mentor students, and interviews with graduate mentor students.

Survey Data

The evaluation team administered two surveys to DEEP participants. First, the *DEEP Undergraduate Participant Survey* was administered as a paper-and-pencil instrument to DEEP undergraduate participants (n=34), subsequent to the final DEEP Showcase. The survey had an overall response rate of 57.6%. Consisting of 30 Likert-type and open-ended questions, the *DEEP Undergraduate Participant Survey* was designed to examine the extent of individual participants' involvement in the development of DEEP physics demonstrations, as well as participants' perceptions regarding support provided by the DEEP mentors, and the program's influence on participants' research abilities, physics and engineering knowledge, communication skills, and teamwork proficiencies. The survey also collected general demographic information about the undergraduate participants. Open-ended questions provided opportunities for the respondents to offer feedback regarding ways in which they were able to apply knowledge gained from the DEEP participation in their academic classes and suggestions for ways in which the overall program could be improved. At the end of the survey, respondents were given the option of providing their email addresses for the purpose of volunteering as an interview participant. Table 3.2 illustrates demographic information regarding the *DEEP Undergraduate Participant Survey* respondents.

Table 3.2

DEEP Undergraduate Participant Survey Respondent Demographics

	n	***%***
Sex		
Female	6	82.4
Male	28	17.6
Ethnicity		
African-American	1	2.9
Asian/Pacific Islander	5	15.2
Latino(a)	12	36.4
White, not of Hispanic descent	15	45.5
Number of demos participated in		
1-3	26	92.9
More than 3	2	7.1

Source. DEEP Undergraduate Participant Survey.

The *DEEP Graduate Participant Survey*, consisting of 20 Likert-type and open-ended questions, was administered as a paper-and-pencil instrument to DEEP graduate mentors (*n*=15), also subsequent to the final DEEP Showcase. Overall response rate for the survey was 88.2%. Questions on this instrument were designed to measure graduate mentors' perceptions of the value of the program in increasing the mentors' teambuilding and leadership skills, as well as the mentors' overall satisfaction with the experience of serving as a DEEP Mentor. Open-ended questions provided opportunities for the respondents to offer feedback regarding the most and least attractive aspects of DEEP, as well as suggestions for ways in which the overall program could be improved. At the end of the survey, respondents were given the option of providing their email addresses for the purpose of volunteering as an interview participant. Table 3.3 depicts demographics of the *DEEP Graduate Participant Survey* respondents.

Table 3.3

DEEP Graduate Participant Survey Respondent Demographics

	n	***%***
Gender		
Male	11	73.3
Female	4	26.7
Ethnicity		
African-American	1	6.7
Asian/Pacific Islander	1	6.7
Latino(a)	2	13.3
White, not of Hispanic descent	11	73.3
Number of undergraduate students mentored		
1-3	6	42.9
4-6	8	57.1

Source. DEEP Graduate Participant Survey.

Interview Data

The evaluation team conducted semi-structured, face-to-face and telephone interviews with undergraduate participants in order to collect in-depth knowledge of the program. Of the 16 undergraduate participants who had volunteered to be interviewed, a convenience sample (*n*=4) was selected to participate in interviews during May 2014. The interviews, which lasted about 20 minutes each, consisted of 10 questions related to individual respondents' participation in development of the team demos, in the annual Physics Festival, and the Physics Showcases; respondents' interactions with the DEEP mentors; and respondents' recommendations for ways in which the DEEP program could be improved. Interviews were recorded and transcribed at a later date.

The evaluation team also conducted semi-structured, face-to-face and telephone interviews with graduate mentor participants in order to collect in-depth knowledge of their perceptions of the program. Of the nine mentor participants who had volunteered to be interviewed, a convenience sample (*n*=3) was selected to participate in interviews during May 2014. The interviews, which lasted about 25 minutes each, consisted of 10 questions related to interactions among the mentors, DEEP undergraduate participants, and DEEP program faculty; growth in the mentors' teambuilding and team leadership skills; and mentors' recommendations for ways to improve the program. These interviews were also recorded and transcribed at a later date.

Data Analysis

Data analyses for all data were conducted in May–June 2014. This section provides an overview of the data analyses completed.

Explanation of analysis for *DEEP Undergraduate Participant Survey* responses

The evaluators surveyed undergraduate DEEP participants to determine their perceptions of various aspects of the DEEP program. The *DEEP Undergraduate Participant Survey* included a series of 22 Likert-type questions related to aspects of the DEEP program, such as the extent to which undergraduates participated in certain aspects of the program, time required by program activities, the impact of the program on undergraduates' experiences, collaboration between team members and the graduate mentor, and levels of confidence in various presentation formats. In addition, the survey included five open-ended questions addressing the undergraduate participants' overall experiences with the program. For purposes of analysis, a 4-point rating scale was used to determine the extent to which undergraduates participated in various aspects of the program, with 1 = *no contribution,* 2 = *minimal contribution,* 3 = *moderate contribution,* and 4 = *substantial contribution.* For the remaining Likert-type items, a 4-point scale was also used, with 1 = *strongly disagree,* 2 = *disagree,* 3 = *agree,* and 4 = *strongly agree.* The means and standard deviations of participants' perceptions of the DEEP program are reported for each Likert-type item.

Explanation of analysis for *DEEP Graduate Participant Survey* responses

Evaluators surveyed graduate mentors to determine their perceptions of various aspects of the DEEP program. The *DEEP Graduate Mentor Survey* included a series of 12 Likert-type questions related to aspects of the DEEP program, such as the time commitment required of mentors, the impact of the program on mentors, and perceived impacts on the undergraduate students with whom the mentors worked. In addition, the survey included five open-ended questions addressing the graduate mentors' overall experiences with the program. For purposes of analysis, a 4-point rating scale was used, with 1 = *strongly disagree,* 2 = *disagree,* 3 = *agree,* and 4 = *strongly agree.* The means and standard deviations of participants' perceptions of the DEEP program are reported for each Likert-type item.

Explanation of analysis for qualitative data from interviews and open-ended survey questions

Qualitative data were collected via face-to-face and telephone interviews with undergraduate DEEP participants and with the DEEP mentors. We began the analysis of the qualitative data by reading and re-reading interview and survey responses multiple times. As we read, we marked phrases and passages that we considered interesting or important in the context of our study, trusting our judgment regarding the significance of the selected passages and our experience in internalizing and interpreting interview data (Seidman, 2006). In the next phase of the analysis, we assigned codes to the data bits, recording

working definitions of the codes in a code list. We next sorted and re-sorted the coded data bits into categories (Merriam, 2009), using a constant comparison method to examine data within and across categories (Goetz & LeCompte, 1984). We performed this process inductively, allowing categories to emerge from participants' own words, rather than beginning with a hypothesis or theory to substantiate. The meaningful passages thus sorted and categorized formed the nucleus of the narrative text that was written to provide an in-depth discussion related to the evaluation questions. As we wrote, we remembered always that the thick, rich description so critical for a qualitative study depends on an accurate interpretation of a participant's own words. Open-ended survey responses from the *DEEP Undergraduate Participant Survey* and the *DEEP Graduate Participant Survey* were also analyzed in this format.

Limitations of the Study

We noted two important limitations in regard to this study. First, since the evaluation was not commissioned until late in the program cycle, researchers were only able to collect post-program data. This limited our ability to examine changes in mentors' or participants' attitudes and practices attributable to the program.

Second, we were only able to collect perceptual data from DEEP undergraduate participants and graduate mentors regarding the program objectives. Although perceptual data is extremely valuable in a program evaluation such as the current one, the opportunity to triangulate perceptions by collecting other forms of data related to DEEP undergraduate participants' learning and application of knowledge, such as course grades, might have added a significant component to this evaluation.

CHAPTER 4: RESULTS

This chapter reports the results of the current study, organized by objectives established in the evaluation plan. First, results related to participants' perceptions of overall effectiveness of the DEEP program are reported. Next, findings associated with increasing undergraduate participants' knowledge of physics and engineering concepts, positively impacting undergraduate participants' analytic and hands-on skills in conducting research, enhancing undergraduate participants' communication skills, and encouraging undergraduate participants' teamwork skills are described. Finally, findings related to improving graduate mentors' leadership skills and augmenting graduate mentors' teambuilding skills are discussed. Each objective concludes with a summary of findings.

Overall Effectiveness of the Program

The goal of the Discover, Explore, and Enjoy Physics and Engineering (DEEP) Program is to enhance undergraduate and graduate students' learning and research experiences by integrating active learning, service learning, and teamwork activities. Examining participants' perceptions of the overall effectiveness of the program was an important component of the evaluation study.

Evaluation Questions

Researchers developed the following six evaluation questions related to participants' perceptions of the overall effectiveness of the 2013-14 DEEP Program:

Q1.1. What were the strengths (beneficial aspects) of the DEEP Program?

Q1.2. What were the weaknesses of the DEEP Program?

Q1.3. What aspects of the DEEP Program should be changed, as identified by participants?

Q1.4. How likely are current undergraduate and graduate student participants to recommend DEEP to their classmates?

Q1.5. Did undergraduate and graduate student participants believe the time commitment they made to the DEEP activities was appropriate?

Q1.6. Did participation in DEEP increase undergraduate participants' engagement in the academic community?

The following narrative discusses 2013-14 DEEP undergraduate and graduate participants' perceptions of the overall effectiveness of the program, including opinions regarding the strengths and weaknesses of the program, recommended changes to the program, and impact of DEEP participation on undergraduates' engagement in the TAMU academic community.

Undergraduate Participant Perceptions Regarding Program Effectiveness

The evaluation team collected quantitative and qualitative data to explore undergraduate participants' perceptions regarding overall effectiveness of DEEP. First, the *DEEP Undergraduate Participant Survey* was administered as a paper-and-pencil instrument, consisting of 30 Likert-type and open-ended questions. Of the 59 DEEP undergraduate participants, 34 agreed to participate in the *DEEP Undergraduate Participant Survey*, for an overall response rate of 57.6%. The majority of respondents to the *DEEP Undergraduate Participant Survey* were male (82.4%), which was not surprising, considering that 81.4% of undergraduate participants overall were male.

Undergraduate participants were asked the extent to which they agreed that they would recommend the DEEP program to other undergraduate students, if given the opportunity. Of the 34 respondents, 30 *strongly agreed* with this statement (see Table 4.1).

Table 4.1
Undergraduate Participant Intent to Recommend the Program

	M	***SD***
If given the opportunity, I will recommend DEEP to other undergraduate students.	3.88	0.33

Source. DEEP Undergraduate Participant Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

The *DEEP Undergraduate Participant Survey* also included two items that asked participants to reflect on time commitment requirements as a factor related to their overall experience as a DEEP undergraduate participant. In regard to time commitments, few survey respondents agreed that *DEEP required too much of a time commitment* (*M*=1.76); in fact, some wished they had *devoted more time to the program* over the course of the year (*M*=2.82). Table 4.2 demonstrates respondents' perceptions of time commitment to the DEEP program across the academic year.

Table 4.2
Undergraduate Participant Perceptions of Time Commitment Required

	M	***SD***
My participation in DEEP required too much of a time commitment.	1.76	0.66
Looking back at my participation in DEEP over the past year, I wish that I had devoted more time to the program.	2.82	0.66

Source. DEEP Undergraduate Participant Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Questions 11 and 12 on the *DEEP Undergraduate Participant Survey* asked participants about the impact of DEEP program activities on their feelings of engagement in the academic community at TAMU. As Table 4.3 illustrates, for many respondents, participation in DEEP made them *feel more connected to the academic community at TAMU* (*M*=3.29). Other respondents agreed that their DEEP experiences *encouraged them to develop a network of friends and colleagues at TAMU* (*M*=3.33).

Table 4.3
Undergraduate Participant Perceptions of Engagement

	M	***SD***
My participation in DEEP helped me to feel more connected to the academic community at Texas A&M University.	3.29	0.52
My experiences as a member of a DEEP team encouraged me to develop a network of friends and colleagues at Texas A&M University.	3.33	0.48

Source. DEEP Undergraduate Participant Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Qualitative data were also collected via open-ended questions on the *DEEP Undergraduate Participant Survey* and undergraduate participant interviews, to address overall effectiveness of the program. First, on the *DEEP Undergraduate Participant Survey,* participants were asked to identify what they liked best about the program. Undergraduate survey respondents across the board referred to the "building of the demos" as the most enjoyable part of the program, as the following comments illustrate: "The satisfaction of building something awesome from scratch," "Creating something that is interesting out of nothing," and "Actually building and designing demos."

Some undergraduate survey respondents were enthused about the opportunities DEEP provided for them to increase their learning. One participant, for example, explained that the thing s/he liked best about participating in DEEP was "Being able to work with smart people and learning from them. It also motivates me to learn more." Other participants identified "Learning about new scientific principles,"

"Learning how to build and wire things," and "The experience to learn something new" as the best part of the program for them.

Other respondents believed the program's emphasis on self-directed learning, or as one participant said, "Building any project we want," was what they liked most about DEEP. An undergraduate student elaborated thus:

> I liked that we got to decide what to do (for the most part) and that the mentors let us take as much initiative as we wanted. I liked that my mentor let me do as much work on it as I wanted, but he was there in case we got stuck or needed help.

Finally, survey respondents pointed to the opportunity to share their love of physics, particularly with children, as the most enjoyable component of DEEP. "I loved making and presenting demos, particularly showing them to kids," a participant replied to this question, and second concurred: "I enjoyed the tangible results in both the physical demo and in presenting the concepts to interested children." Finally, one respondent said simply, "I love helping to inspire a love of physics in others."

Undergraduate interview participants were also asked to describe what they liked best about participating in DEEP. Interview responses to this question, analogous to survey responses to the same question, substantiated that undergraduate students particularly valued the opportunity to be self-directed in terms of their projects, although they also valued the support of their mentors. One undergraduate participant who "really liked the freedom that was associated with it," explained: "I felt like we were really given a lot of leeway as far as, you know, time constraints, what we wanted to do with the project. I felt like there wasn't much oversight and I liked that." Describing supervision from the mentor as "a good thing that sort of kept us on track," the student continued: "He [the mentor] was really helpful, but I felt like as a group, we were really free to move in any direction we wanted."

A second interview respondent described his/her mentor's attitude as follows: "I've had, like, three mentors. . . . How they did it is like, you know, 'It's up to you. . . .We'll help you, if you have questions.'" Elaborating on the team's responsibilities, the respondent explained:

> For the most part, it was up to us to decide, like, what projects we wanted to do, what are the parts, order the parts, get them, make sure they're all there and start actually building the things that we could build. Some of it we had to, like, send off to the machine shop because it required expert machining, but for the most part, it was up to us to fix it, and if it didn't work, we had to figure out why.

Conversely, respondents to the *DEEP Undergraduate Participant Survey* were asked to describe what they liked least about the program. Many responses to this question were associated with resource availability. One student explained, "My group encountered some resistance from the resources we

should have had available," while another complained that "Waiting for parts to come back from the machine shop" was what s/he liked least about DEEP. A third respondent, new to DEEP, grumbled, "My first time, so I felt a little lost and didn't know the full extent of resources I had available." Finally, one respondent explained in detail:

> I would like for the program to take advantage of the school's resources more as far as labs, machine shops, etc., go. It seems like some of these departments are somewhat reluctant to provide assistance, but I'd feel more connected with the academic community if we'd interact with them more. Especially the engineering departments.

Respondents also identified "the time crunch" or "the time commitment" as a less positive aspect to the program. "[No] time for food! Specifically at demo times!" one student complained, while another noted, "It was hard finding time for it." A third respondent elaborated on the time constraints s/he encountered: "The amount of time I had to spend learning to program in new languages to complete the complex build in time." Conversely, other respondents appeared to feel that they would have liked to spend more time on the program. "That we did not meet more times and perhaps make a second demo," said one, while another succinctly explained, "The time required—I wanted more." Finally, one respondent shared, "Sometimes we'd go a while without meeting, and I'd start to feel that I didn't know what was happening."

Undergraduate interview participants were also asked to discuss what they like least about participating in DEEP. The data from the interview responses revealed only one theme, time commitment required, which was also a theme in undergraduate survey responses. For the most part, however, respondents either had no complaints or felt their complaints were in regard to minor issues. One participant, for example, explained in response to this question, "The only time that all of us could meet together was, like, Friday evening, so sometimes I had to miss some things for that." S/he went on to add, however, "But it's really not a huge complaint."

A second participant also felt that his/her team didn't have time to meet often enough: "Everybody was busy, so sometimes we'd go a couple of weeks. . . .so sometimes I had no idea what's happening with the other parts…or when we were going to implement the research I was doing." When encouraged to identify any other components of DEEP that were less than attractive, this participant responded, "Not really. I really liked it."

Finally, when asked this question, one interviewee replied, somewhat incredulously:

> Least? I mean, to be honest, I didn't really dislike any of it. I liked doing everything. I don't know, I'm weird. I would—there would be times when I would be here until, like, 4:00 in the morning, and you know, I enjoyed doing that. It was lots of fun. . . .For me, it's all—it's all good."

Question 29 on the *DEEP Undergraduate Participant Survey* asked participants to provide recommendations for changes they would like to see made to the program. Some participants pointed to resource issues in responding to this question. "Inventory the DEEP room so we have a full list of resources," one participant recommended, while another proposed, "More things (resources) available." A third respondent explained, "The work load for the machine shop workers seemed a bit steep, so more machine shop workers to work with the teams would be nice."

Providing more opportunities for DEEP participants to share their demonstrations was a second suggestion offered by several respondents. " I would be interested in one or two more opportunities to showcase our demonstrations. Right now we have two main events; one more would be nice," one participant advocated, while a second respondent believed the department should "offer the Physics Festival twice a year."

Overall, however, undergraduate respondents to the *DEEP Undergraduate Participant Survey* appeared very satisfied with the current program, as indicated by many responses to this question such as "Nothing," "None, really," and "Not really, it was great."

Undergraduate interview participants were also asked to suggest changes that they believed would improve the DEEP program. Overall, participants recommended that some way be found to increase follow-through for members of all the teams. Praising the fact that the mentors "sort of let everyone be as creative as possible," one undergraduate mused, "I think if the mentors hadn't been as good as they were, that could have been an issue." Another undergraduate suggested, "A couple of groups either didn't get their project done or had to change their project, so maybe . . . have the groups submit, like, their project ideas at the beginning of the program and how they plan to accomplish it." Finally, one undergraduate expounded on possible program improvements thus:

> The only issues that I've seen is that sometimes, because, you know, you do get these undergrads, some of them are flakey and they don't ever show up. Like, one of my groups had eight people in September, and when it was time to actually do something, there were three. . . .I don't know if there's any way for the program, like, to change that. . . .It's just the people who sign up and then don't ever do anything that make me angry.

The final question on the *DEEP Undergraduate Participant Survey* asked respondents if they would like to share anything else about their experiences in DEEP or about the program itself. Responses to this question were overwhelming positive, as the following comments illustrate: "I think this is a fantastic program, one of my favorite things at A&M so far," "I really liked the experience, all of it," "I really enjoyed it. It was one of the highlights of my year," and "It was awesome!" One respondent shared that his/her DEEP experience had led to a job offer: "I talked about my LIDAR design in job interviews, and the employers were very impressed at my skills and hired me!" Finally, one respondent succinctly

summed up his/her opinion thus: "Great program, great networking experiences, great hands-on research practice!"

The final undergraduate interview question also asked respondents if they wanted to share anything about their experiences in DEEP or about the program itself. Generally, interview respondents provided positive responses to this question, but one respondent was particularly articulate about the program's overall impact on him/her:

> The first year I did it [DEEP], I was really depressed and I had to go to, like, counseling and stuff, and I didn't even care about my classes anymore, but at least—but being in DEEP, like, working on those demos, that was probably, like, the only thing I cared about that year was getting it done. And, like, I don't know, I like to finish things. And so it—that kept me motivated throughout that year, and it kept me in school, I guess.

Mentor Perceptions Regarding Program's Effectiveness

The evaluation team also explored graduate mentors' perceptions regarding the overall effectiveness of DEEP, collecting both quantitative and qualitative data. First, the *DEEP Graduate Participant Survey* was administered as a paper-and-pencil instrument, consisting of Likert-type and open-ended questions. Of the 17 DEEP Graduate Mentors, 15 agreed to participate in the *DEEP Graduate Mentor Survey*, for an overall response rate of 88.2%. The majority of respondents to this survey were male (73.3%) and had primarily worked with a total of two to five students (86.7%).

Question 4 on the *Graduate Participant Survey* asked mentors the extent to which they agreed that they would recommend the DEEP program to other graduate students in the department, if given the opportunity. Of the 15 graduate respondents, 15 *strongly agreed* with this statement (see Table 4.4).

Table 4.4

Mentor Intent to Recommend the Program

	M	***SD***
If given the opportunity, I would recommend DEEP to other graduate students in the department.	4.00	0.00

Source. DEEP Graduate Mentor Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

The mentors were asked on two survey items to reflect on the time commitment required by the program as a factor related to their overall experience as a DEEP graduate mentor. As depicted in Table

4.5, with regard to time requirement, the graduate mentors did not feel that the *program required too much of a time commitment* (*M*=1.80). In fact, some wished they had *devoted more time to the program* over the course of the year (*M*=2.47).

Table 4.5

Mentor Perceptions of Time Commitment Required

	M	***SD***
My participation in DEEP required too much of a time commitment.	1.80	0.56
Looking back at my participation in DEEP over the past year, I wish that I had devoted more time to the program.	2.47	0.74

Source. DEEP Graduate Mentor Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

The *DEEP Graduate Participant Survey* also asked mentors to reflect on their individual impact on the overall undergraduate experience of students with whom they worked in DEEP. As Table 4.6 illustrates, mentors believed they were able to make significant contributions to the undergraduate participants' university experience.

Table 4.6

Mentor Perceptions of Impact on Undergraduate Experiences

	M	***SD***
In my role as a DEEP mentor, I was able to make important contributions to the overall undergraduate experience of the students with whom I worked.	3.47	0.52

Source. DEEP Graduate Mentor Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Qualitative data also were collected to examine this component, via open-ended questions on the *DEEP Graduate Participant Survey* and interviews with the mentors. Question 16 on the survey asked mentors to identify what they liked best about the program. The evaluation team identified two themes in mentors' responses to this question: influencing undergraduate students and developing leadership skills.

Mentors across the board believed their participation in DEEP provided important opportunities to have "a positive impact on incoming freshmen," and to be "a positive influence to the freshman undergraduates who are just beginning their science careers." Others responses to this question included, "I enjoyed providing a fun weekly activity for freshmen. I feel that we accomplished exactly what we wanted in terms of projects," "I like interacting with students and the problem-solving aspect,"

and "I enjoyed getting to know my students and working with them to reach their goals for our projects." One mentor elaborated thus:

> It is an amazing experience to help them develop an idea and turn it into a working experiment. Teaching students how to work as part of a team on developing and troubleshooting skills are important aspects students should develop as undergrads, and many times classes don't teach that well.

In addition, some mentors believed the positive impact on their leadership skills was one of program's greatest strengths. "The teaching and leadership skills I gained over the year were invaluable," explained one mentor. Others simply replied, "The opportunity to develop my mentoring and leadership skills," and "Improving my leadership skills," in response to this question.

Mentors were also asked during interviews to describe what they liked best about participating in DEEP. Mentors' responses to this question addressed three themes: leadership opportunities, giving back, and reciprocal learning.

Similar to respondents on the *DEEP Graduate Participant Survey,* Mentors who were interviewed believed their participation in DEEP offered experiences of "learning to be a good leader." One respondent asserted, "I'd say it absolutely puts us in leadership skills—or leadership positions." Expanding on this theme, another mentor explained:

> Depending on how your research goes. . .you may have some idea of what it feels like to work in a group. And then, all of a sudden, you are the one in charge of the group whenever you come to DEEP, so you're on top of them [the undergraduate participants], not only making sure that they're on task, but that what they're doing is actually going to lead to something that will succeed.

The mentors who were interviewed also saw their experiences in DEEP as an opportunity to "give back" by sharing their knowledge and expertise with undergraduate students and with the community overall. One mentor explained, "I got to impart my knowledge, my expertise, to a couple of undergraduate students and help them—that will help them grow, and that helped one of the undergraduate students find a summer research position as well." Sharing that s/he found participation in DEEP to be "really satisfying," one mentor expounded:

> There's not a ton of opportunities to give back to the community, so I like being able to do that. It's—honestly, it's something I like a lot, too. It's a lot of fun, this kind of lower-level, kid-focused physics is—I just find it enjoyable. I mean, the Physics Festival itself is always a blast. Seeing little kids come in and smile and stuff like that.

Finally, interview respondents believed their participation in DEEP offered opportunities for them to increase their own learning through professional interactions with the undergrad students. "I liked interacting with these two people. I mean, it's always nice to talk to and interact with competent and smart individuals," one interviewee stated, and another concurred: "You know, the undergrads bring, like, an interesting point of view, stuff that I wouldn't see. So they get me thinking in a kind of different way, which I like too." A third respondent enthusiastically explained:

> You actually really get to learn a lot in terms of just doing things. You run experiments that you've heard about, you learned about in classes, or that you've always looked at, and you know how it works but you've never actually done it. This gives you a chance to do it hands-on, this gives you a chance to work with someone else on it and maybe explain things that you never really thought about before. The questions they have about how experiments work are different from the ones that I have, so it challenges you to look at everyday things in a different light and try to explain it to them. I feel it's mutual growth, actually; they learn a lot of basic physics and we learn, "Oh, that was how that worked!"

Question 17 on the *DEEP Graduate Participant Survey* asked the mentors to identify features of the program that they liked the least. Two themes were identified in the mentors' response to this question: undergraduate lack of motivation and time constraints.

Student lack of motivation is a critical issue in any learning situation, and the DEEP program was no exception, according to the mentors. "It is very hard to motivate students when they seem not to care about their own project," one mentor said, and a second mentor agreed: "I felt some students were unmotivated at times when their project was not working." A third mentor explained that when students were unmotivated to complete their projects, "The workload ends up being mostly on the DEEP mentor."

Issues related to time constraints were also identified as a least-favorite aspect of the program, as the following comments attest: "The weekly DEEP mentor meetings were too long sometimes," "I was frustrated that I did not have more time to commit," and "Not having more time to work on my projects." One mentor noted, "Scheduling time to meet with group members was challenging at times, given everyone's schedules, and this probably hurt productivity."

Mentors who participated in interviews were also asked to describe what they liked least about DEEP. Analysis of the data revealed only one theme in mentors' responses: the time commitment required. "It did require a certain amount of time constraint, which . . . from time to time was hard to keep, especially when classes were ramping up, research was ramping up," one participant responded. Acknowledging that, "This [DEEP] is not anyone's primary goal here," a second respondent also discussed the constraints caused by other time commitments: "I would say it's hard to get much done when you meet so infrequently. . . . I can understand you can only put so much time into it, but it

makes it a little challenging to do what you want to do." A third mentor explained that when the undergraduate participants failed to complete a project, for whatever reason, it was up to the mentor to step in, which required even more of a time commitment:

> It's one thing that you commit to weekly, and if the experiment isn't going as expected, or the students don't have the skills to be able to finish it, then . . . I have to make sure that it gets done. Every now and then. . .the students don't see the results that they want and it's up to me to make sure that it all gets done. So as a result, you spend a lot of time working on your own research as well as working on their research, even when they're not working on it. So it ends up being more than just a few hours a week.

Question 19 on the *DEEP Graduate Participant Survey* asked mentors to describe programmatic changes they would recommend for the program, if given the opportunity. Some mentors responded by offering suggestions to improve undergraduate student motivation. "Have each team write a project timeline, so that they do not procrastinate," one mentor recommended. Others recommended offering course credit to undergraduate students to increase their motivation: "Allow it to count for 1 hour of credit to encourage consistent participation," said one, while another mentor concurred: "Maybe give it a course so they could get credit hours out of it = more motivation."

Many mentors responding to the survey believed DEEP could be improved by repairing and upgrading old demos, rather than building new ones. "We now have a very large collection of demos. I feel it would be useful to spend some of our future resources on revamping some of the older demos that could use some repair work," said one mentor. Additional suggestions included, "Maybe have groups select an old demo to upgrade instead of always adding new ones," and "[Provide] a list of existing demos and demos which need to be fixed."

Some survey respondents, however, believed the DEEP program was functioning effectively, as the following comment attests:

> Great job! Tatiana does an amazing job at keeping us motivated. The weekly meetings are a MUST and should never change. With the program growing as much as it is, it is hard to know what experiments still need to be done. I would encourage continued communication about what experiments seem like they would be beneficial to the program.

Mentor interview participants were also asked what changes they would suggest for the program, if given the opportunity to provide recommendations. Responses to this question were categorized into two themes: participant incentives and mentor preparation.

Noting that the undergraduate students receive a stipend for DEEP participation, interview respondents expressed that the undergraduates might be more motivated if they received "some credit hours or

something like that." Noting that at the beginning of the semester, undergraduate participants are "really reliable, come in a lot, work, and everything like that," another mentor explained that as the semester progressed and participants became more busy, attendance decreased. Academic credit was this mentor's solution to incentivizing undergraduate participants: "It's not a class or anything, there's not much you can do about it. . . .If there was just some way to say, 'Hey, this is worth an hour, you know, you're going to get a grade on it.'"

Mentor preparation was a second theme identified in the responses to this interview questions. Most of the mentors know each other prior to joining DEEP. In fact, as one mentor explained, new mentors accepted to the program each year often join the program because "somebody that's in the mentor group recommended them." This leads to what this interview respondent described as "a little bit of mentoring [the mentors] already going on." Some mentors, however, felt that it would be helpful, "having, like, an official training. . .[during] the first lunch meeting, just telling them so that everybody's on the same page."

DEEP mentor interview participants were asked to reflect on the different kinds of interactions they had had with undergraduate DEEP participants over the academic year and to describe ways in which the mentors believed they had impacted undergraduate student's overall experiences at Texas A&M University. Overall, interview participants believed they had influenced their mentees both on a professional level and on a personal level.

Mentors expressed that they had frequent opportunities to give professional advice to their undergraduate mentees. One mentor explained: "If they had any questions on their [physics] classes, they sometimes emailed me or texted me to see if I can offer some input. . . .I did give them some guidance on their classes." Another mentor elaborated thus:

> I was on the same path as [one of the mentees] when I was an undergraduate. So I was able to offer some advice, pointers on what she should do, what she can do, what she should not do, and things like that. Also give her some pointers on how she should handle some of the classes and some of the subjects.

A third mentor, who described himself/herself as "Not shy with my advice," revealed that s/he had counseled some undergraduate participants on possible career paths other than academia, if that was their goal:

> I don't plan to stay in academia or anything. . . .and I think that's kind of an interesting point of view. I'm not trying to convince anyone to go into industry, but if they have questions about their path through school, I feel like I'm not going to give them the typical answer that most grad students are. . . .I'm not trying to impose my ideas, but, like, I'm giving them an alternate view.

Finally, one mentor shared that his/her goal had been to prepare the undergraduate participants for practical applications of the theories they learned from the textbooks and to ready them for "what research would be like," once they reached that point in their academic timelines:

> I feel that, hopefully, whenever now they're going through their classes, they can think back on part of what they did at the Physics Festival and part of all the different physics concepts that we talked about, and possibly not just look at the text and say, "I have to memorize this," but ideally, get that sense of, "Oh! I have an idea of how this would apply and why this is important and how this relates to the real world," and hopefully give their classes a little bit more value because they've seen it in action already.

Some mentors also expressed opinions that they had affected their mentees in more personal ways. One mentor, for example, stated, "I like to think I served as, like, a general life mentor, not that I have all the answers, you know?" Other mentors believed they and their mentees became friends: "I got to be friends with them, you know, not just—it wasn't just a mentor/mentee relationship. By the end, they were my friends, and I think they also plan to be in the group with me next year." Finally, one mentor carefully described the limits of the friendship s/he share with the undergraduate participants: "I would consider myself friends, definitely with the people in my group, but not, like, to hang out with outside of this so much friends."

Summary

The DEEP evaluation study began by examining the overall effectiveness of the program. Quantitative and qualitative data were collected from four sources and examined to address this objective. First, the *DEEP Undergraduate Participant* Survey, consisting of Likert-type and open-ended items, was administered to undergraduate participants subsequent to the spring Physics Showcase in April 2014. Second, the *DEEP Graduate Participant Survey,* also consisting of Likert-type and open-ended items, was administered to the mentor participants, also subsequent to the spring Physics Showcase. Items on the two instruments were designed to examine participants' perceptions of the overall program. Finally, the *DEEP Undergraduate Participant Interview Protocol* was developed for semi-structured interviews with the undergraduate participants, and the *DEEP Mentor Participant Interview Protocol* was developed for semi-structured interviews with the DEEP mentors. Both instruments were designed to elicit in-depth information from respondents regarding their perceptions of the DEEP program.

The *DEEP Undergraduate Participant Survey* included questions related to undergraduate's perceptions regarding various aspects of DEEP. Analysis of the quantitative data from the survey revealed that in regard to time commitment required for participation in the program, undergraduate survey

respondents disagreed with the statement that DEEP required too much of a time commitment; in fact, some respondents wished that they had contributed more time to the project over the course of the year. Two questions on the survey asked respondents about the impact of their participation in DEEP on their feelings of engagement within the TAMU community. For some respondents, DEEP participation made them feel connected to others in the university, while many respondents believed that had they developed a network of colleagues through their DEEP experience. Finally, most undergraduate respondents strongly agreed that, if given the opportunity, they would recommend DEEP to their peers.

Qualitative data from the open-ended questions on the *DEEP Undergraduate Participant Survey* and the *DEEP Undergraduate Participant Interview Protocol* were analyzed inductively. When asked what they liked best about participating in DEEP, survey respondents identified the building of the demonstrations, the opportunity to increase their learning, the freedom to choose what demonstrations they wanted to develop, and the chance to share their enjoyment of physics with others. Undergraduate interview participants agreed with survey respondents that the opportunity to be self-directed in terms of their projects was an attractive feature of DEEP.

Conversely, respondents to the *DEEP Undergraduate Participant Survey* were asked to discuss the aspects of DEEP that they liked the least. Some participants reported problems with "resources we should have had available," not being clear about the "extent of resources" that were actually available to them. Survey respondents also discussed time when answering this question: Some reported that it was "hard finding time for it," but others shared that they would have liked to have more time devoted to DEEP. Although some undergraduate interview participants identified the time commitment required as a drawback to participation in DEEP, others revealed that they had few or no complaints.

When asked to provide recommendations for changes they would like to see made to DEEP, some respondents to the *DEEP Undergraduate Participant Survey* referred again to issues with resource availability, while others wished for more opportunities to share their demos. Most survey participants were satisfied with the program as currently offered however, providing responses such as, "Nothing" and "None, really." Undergraduate interview participants, who were asked the same question, suggested only that some way be found to provide follow-through for all members of the teams.

The final question on both the *DEEP Undergraduate Participant Survey* and the undergraduate interviews asked respondents if they had anything else they would like to share about the program. Overall, responses were extremely positive, including the following: "It was awesome!"

The *DEEP Graduate Participant Survey* also included questions designed to examine mentors' perceptions regarding the overall effectiveness of DEEP. Analysis of the quantitative data from survey responses revealed that mentors did not feel that the program entailed too much of a time commitment, and in fact, some mentors wished that they had dedicated more time to the program

during the 2013-14 academic year. Moreover, mentors believed they were able to make a significant impact on the undergraduate participants' university experience.

Qualitative data from responses to the open-ended questions on the *DEEP Graduate Participant Survey* and the mentor interviews were analyzed inductively. When asked what they liked best about participating in DEEP, survey respondents shared that they believed their participation in the program provided them with valuable opportunities to interact with undergraduate students and have a positive influence on them. Mentors also believed that one of DEEP's greatest strengths was its positive impact on their leadership skills. Mentor interview respondents agreed that their participation in DEEP offered opportunities for them to increase their skills in leadership, while providing them an occasion to "give back" by sharing their love of physics with the undergraduate students and with the community overall.

Mentor survey and interview respondents were also asked to describe what they liked least about their participation in DEEP. *DEEP Graduate Participant* Survey respondents pointed to undergraduate lack of motivation, explaining that when the undergraduates were unmotivated to complete their projects, the mentors had to take up the slack. Time constraints was a second negative feature of DEEP, according to mentor survey respondents, who discussed meetings that ran too long, scheduling difficulties, and insufficient time to complete their projects. Mentor interview respondents agreed that the time commitment required was a challenge for them in completing their DEEP responsibilities.

When mentor survey participants were asked to describe their recommendations for changes to DEEP, they offered ideas to improve undergraduate participant motivation, as well as suggestions that DEEP focus on upgrading and repairing current demos rather than building new ones. Interview respondents also offered recommendations to improve undergraduate participant motivation. In addition, some mentors believed it would be helpful if DEEP were to provide official training to new mentors each year. Overall, however, mentors expressed that the program was already functioning effectively.

Finally, mentor interview participants were asked to describe ways in which they believed they had impacted undergraduate participants' overall experiences at Texas A&M over the academic year. Interview respondents believed they had influenced their mentees, first, on a professional level; e.g., helping with their physics classes, providing pointers on how to handle certain classes and subjects, and counseling on career paths. Mentors also believed they had impacted the undergraduate participants on a personal level, offering them friendship and "general life" mentoring.

Impact on Undergraduate Participants' Knowledge of Physics and Engineering Concepts

With support and encouragement from their DEEP mentors, the undergraduate participant teams researched, designed, and built 30 hands-on demonstration projects during academic year 2013-14.

These demos were constructed in TAMU physics laboratories and machine and electronic shops. The demos were subsequently shared with faculty in the Department of Physics and Astronomy and with individuals from K-12 schools and the general public through Physics Shows, the Physics and Engineering Festival, and the Physics Showcases. Increasing undergraduates' understanding of the physics and engineering concepts behind the demos was a key objective of the program.

Evaluation Questions

Researchers developed the following questions related to the program's impact on undergraduate participants' knowledge of physics and engineering concepts:

Q2.1. To what extent did the undergraduate participants believe they increased their understanding of physics and engineering concepts behind the demos they built?

Q2.2. To what extent did undergraduate student participants believe the knowledge they gained in creating their DEEP project(s) will be applicable to their future academic courses?

Q2.3. What are some specific ways in which under graduate participants applied knowledge gained in creating their DEEP project(s) to their academic courses?

The following narrative discusses 2013-14 DEEP undergraduate participants' perceptions of the extent to which their participation in DEEP resulted in increased knowledge of physics and engineering concepts, as well as the extent to which participants anticipate applying the new knowledge to their academic courses. Specific ways in which the undergraduate participants applied their knowledge to current courses are also discussed.

Undergraduate Participant Perceptions of DEEP's Impact on Knowledge of Physics and Engineering Concepts

Quantitative and qualitative data were collected via responses to the *DEEP Undergraduate Participant Survey* and interviews with undergraduate participants to examine undergraduate participants' perceptions regarding the DEEP Program's impact on undergraduates' knowledge of physics and engineering concepts. Survey items asked participants the extent to which they perceived that their understanding of physics and engineering concepts had increased as a result of their DEEP participation and the extent to which that knowledge was applicable to their academic courses. As Table 4.7 demonstrates, respondents felt that *building demonstrations increased their understanding of both physics and engineering concepts* (*M*=3.30). Moreover, respondents agreed that the DEEP program *provided a set of knowledge and skills that would be applicable to future academic courses* (*M*=3.24).

Table 4.7

Undergraduate Participant Perceptions of Impact on Knowledge and Skills

	M	*SD*
My understanding of physics and engineering concepts increased as result of my experiences building demos.	3.30	0.64
Knowledge and skills I gained through participation in DEEP will be applicable to my academic courses.	3.24	0.61

Source. DEEP Undergraduate Participant Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Undergraduate Participant Perceptions of Application of Knowledge to Their Academic Courses

Question 28 on the *DEEP Undergraduate Participant Survey* asked respondents to identify specific ways in which they had applied the knowledge they gained from creating their DEEP demonstrations in their academic classes. Most responses to this question referred to specific topic areas in which participants believed they had increased their knowledge as the following responses illustrate: "My knowledge of optics and waves is stronger," " I understand the mechanics of water/air pressure," and "I used my circuits knowledge I gained in DEEP in Phys 225." Other respondents referred to more general skills in response to this question. "[DEEP] helped me learn research and organizing," said one, while another noted, "I used my knowledge of thinking innovatively in my classes." A third participant answered broadly, "I'm a physics major, so everything kind of helped."

Undergraduate interview participants were also asked to discuss ways that they had applied knowledge acquired from building the DEEP projects to other situations. Overall, respondents felt their skills from DEEP had been applicable for them in situations in which they had to apply problem-solving techniques. One undergraduate participant, for instance, stated: "It sort of helped me look at a problem—like when we first built our project, it didn't work, so it helped me go through the process of figuring out what's wrong with it and how to fix it." Another undergraduate participant, describing how s/he had applied knowledge and skills from DEEP in other classes said, "Definitely the problem solving. Like, I was in another class working on a project and I was thinking about working on this, the demonstration, as I was doing that project." Finally, explaining that often demos didn't work when they were first completed, one undergraduate participant described the process used to identify and solve problems in DEEP, which s/he had applied in other classes:

> You're just like, "I don't know why this doesn't work; we did everything exactly how we were supposed to." And then you spend hours, like, going off a list of what could be wrong and how we could fix it, and that's kind of just like, I guess, the biggest thing that we have to do in DEEP in general. Pretty much the biggest thing I've learned is just, like, "This is wrong. Something's wrong. I don't know what's wrong. Let's start figuring it out."

Summary

The first program objective of DEEP focused on increasing undergraduate participants' understanding of physics and engineering concepts. Qualitative and quantitative data were collected via survey and interview responses and examined to address undergraduate participants' perception of the extent to which the program was able to achieve this objective.

Items on the *DEEP Undergraduate Participant Survey* asked participants to discuss their perceptions of the extent to which participation in DEEP had increased their knowledge of physics and engineering concepts. The majority of survey respondents either agreed or strongly agreed that building the demos had resulted in increased understanding of both concepts. Moreover, in response to a question regarding application of knowledge, respondents also believed that participation in the DEEP program had given them knowledge and skills they could apply to future academic courses.

Respondents to the *DEEP Undergraduate Participant Survey* were also asked to provide specific examples of ways in which they had applied, or anticipated applying, knowledge gained from building their DEEP project to their academic classes. In response to this question, many survey respondents identified specific topic areas in they believed they had increased their knowledge, such as optics and waves or mechanics of water and air pressure. Others referred to general skills such as organization. Asked the same question, undergraduate interview respondents primarily discussed skills related to identifying and solving problems.

Impact on Undergraduate Participants' Analytic and Hands-on Skills in Conducting Research

Increasing undergraduate participants' analytic and hands-on skills in conducting research was also an important component of the DEEP program. Team members were expected to research the underlying concepts for the demonstrations they built, and in the process, hone their research skills. Most DEEP undergraduate participants were involved in the research behind the demos, at least to some extent.

Evaluation Questions

Researchers developed the following two evaluation questions related to impact on undergraduate students' analytic and hands-on skills in conducting research:

Q3.1. How many hands-on demonstrations were designed and built by the 2013-14 DEEP undergraduate teams?

Q3.2. To what extent did undergraduate participants believe they increased their analytic and hands-on skills in conducting research?

The following narrative discusses 2013-14 DEEP undergraduate participants' perceptions of the extent to which their participation in DEEP resulted in increased understanding of analytic and hands-on skills necessary in conducting research.

Undergraduate Participant Perceptions of Impact on Research Skills

DEEP undergraduate participants researched, designed, and built 30 demonstration projects during the 2013-14 program. Enhancing participants' analytic and hands-on skills in conducting research was a key component of the program. Quantitative data were collected to examine participants' perceptions of the impact of their participation in DEEP on their research skills.

On the *DEEP Undergraduate Participant Survey*, Question 15 asked participants about the extent to which they believed DEEP participation had increased their research skills. As Table 4.8 illustrates, respondents believed participation in the DEEP program *increased their understanding of research processes* (*M*=3.15).

Table 4.8
Undergraduate Participant Perceptions of Impact on Their Understanding of Research Processes

	M	***SD***
My understanding of the processes necessary for conducting research increased as result of my participation in DEEP.	3.15	0.51

Source. DEEP Undergraduate Participant Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Summary

Increasing undergraduate participants' understanding of the analytic and hands-on skills essential in conducting researching was an important component of the program. This section of the DEEP evaluation study examined the extent to which undergraduate participants perceived that the experience of collectively researching, designing, and building 30 demonstration projects had contributed to their research skills. One item on the *DEEP Undergraduate Participant Survey* addressed this evaluation question, and analysis of the data revealed that respondents believed that participation in DEEP had had a positive impact on their research skills.

Impact on Undergraduate Participants' Communication Skills

Enhancing undergraduate student participants' communication skills is an important objective of the DEEP program. Undergraduate participants were expected to present the demos they developed, through outreach activities such as the Physics and Engineering Festival and Physics Showcases. Presenting their projects and explaining the underlying physics concepts to an audience largely unfamiliar with the subject required students to demonstrate an in-depth understanding of the concepts, as well as personal attributes such as poise, confidence, and responsibility. Quantitative and qualitative data were collected via undergraduate participant survey and interview responses and examined to address this component of the evaluation study.

Evaluation Questions

The evaluation team developed the following two evaluation questions related to program impact on undergraduate participants' communication skills:

Q4.1. Were undergraduate participants comfortable in their ability to explain their experiments to the general public during the Physics and Engineering Festival?

Q4.2. Were undergraduate participants comfortable in their ability to explain their experiments to their peers during the DEEP Showcases?

The following narrative discusses DEEP undergraduate participants' perceptions of increased communication skills resulting from their experiences in the 2013-14 DEEP program. Specifically, it discusses factors as related to participants' confidence in explaining their demonstrations to their peers and to the general public consisting of audiences of different ages and varied levels of knowledge.

Undergraduate Participant Perceptions of Communication Skills Related to DEEP Experiences

DEEP undergraduate teams presented their demonstrations at the TAMU Physics and Engineering Festival, at DEEP Showcases, and during other outreach events during the 2013-14 academic year. Two items on the *DEEP Undergraduate Participant Survey* asked participants about their levels of confidence related to aspects of presenting their demonstrations. Respondents *felt confident modifying their explanation of scientific principles for various audiences at the Physics and Engineering Festival* (*M*=3.41), but they felt slightly more *confident explaining experiments to peers during DEEP Showcases* (*M*=3.53). Table 4.9 illustrates participants' responses to these two questions.

Table 4.9

Undergraduate Participant Perceptions of Confidence During Demo Presentations

	M	***SD***
I felt confident in modifying explanations of scientific principles underlying my project, based on ages and knowledge level of audience at Physics and Engineering Festival.	3.41	0.50
I felt confident in explaining my experiments to my peers during DEEP Showcases.	3.53	0.51

Source. DEEP Undergraduate Participant Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Qualitative data were also collected via in-depth interviews to address this objective. First, interview participants were asked to discuss their comfort level in sharing their work at the Physics and Engineering Festival with people of different ages and knowledge levels and their confidence in responding in an appropriate manner to each. Overall, participants' responses to this question indicated that they enjoyed the experience of presenting their projects at the festival and felt very confident in their ability to communicate clearly with different audiences.

Interview respondents relished the opportunity to share their demos with audiences of different ages. One participant, for example, said, "It was fun. I mean, some people were really blown away by it, and you're just like, 'Yes, you know, I did something and they liked it and they're impressed!'" Another participant agreed:

> It was a lot of fun, actually. It got a little tiring explaining the same thing over and over again, but it was really fun, especially when the kids were really into it. Actually, there was a professor there that was really interested in it, and so it—like, explaining it to him was really cool.

In discussing their comfort level in discussing their work with audiences of different ages and knowledge levels, interview participants described a process of checking for prior understanding of their audiences, particularly in relation to their younger audiences. One participant, for example, said, "It was good to kind of get an idea of where most people were at in terms of their understanding of, you know, something as basic as, like, a radio." S/he went on to explain how this was accomplished:

> A lot of times, before I started giving the presentation, I would ask people—I actually do this whenever I present my research, too—I would ask people kind of what their background was in and I felt like that would give me a lot more leeway in terms of, "Oh, I could talk about this but I shouldn't talk about this." Things like that.

Another undergraduate participant expressed it thus:

> It was sort of hard at first, explaining to younger kids who didn't necessarily have the attention span or, like, required understanding of other physics concepts to really know what was going on. So I sort of had to figure out what was the best way to explain it in a way they would understand and be interested in.

Most undergraduate interview respondents appeared confident in their ability to respond in an appropriate manner to audiences of all levels at the festival. One participant shared that s/he was only part way through Physics 208, "So I felt like I couldn't explain fully sometimes, but I did feel fairly confident in my ability to adjust my language to anticipate who I was talking to." A second respondent who felt "pretty confident," elaborated:

> I think there's kind of a pretty quick learning curve. You know, the first five or six times you present your demo, you're kind of figuring out exactly what the best way to explain something is, but after that, I think it comes really naturally.

Finally, one respondent shared that s/he felt confident sharing the demo, "especially when it was working really well." S/he went on to explain, "It made me feel smart, I guess, and like, I really wanted to show this off because it was—you know, because we had been working on it so long, so it was really satisfying, too."

Interview participants were also asked to describe the feedback they provided to their peers, as well as the feedback they received from their peers and from faculty, at the 2014 Spring Showcase. In terms of the feedback given to, and received from, peers at the Showcase, most interview participants described rather general comments, as illustrated by the following responses: "Mainly people being impressed, honestly," "It was nice to hear, but it didn't really affect our plans a whole lot," and "They're just like, 'Oh, that's really cool,' you know, 'Good job, You finished it.'" One respondent's demo wasn't working correctly on the day of the Showcase, which impacted the feedback s/he received: "Obviously, the feedback I got was, 'Oh, it's not working.' And you know, 'Got it. I know that.' But in terms of which demos looked good and which ones looked the best, that was good feedback."

Some interview participated reported being too absorbed in their own demos during the Showcase to give valuable feedback to their peers. For example, the respondent whose demo had not been working properly that day pointed out, "I would say that I was probably pretty invested in trying to fix my own demo at that point." Another participant shared that s/he provided very little feedback to colleagues during the Showcase: "I went around and looked and I gave my opinion about, you know, 'This is cool,' and I'm sure I gave one or two suggestions, but I can't remember. I wasn't concentrating a whole lot on evaluating everybody's demonstrations then."

The feedback received they received from their professors appeared to be the most intimidating, yet helpful, for the undergraduate participants. One participant noted, "Honestly, some of the professors

there were a little bit discouraging, but I think it was helpful realizing that we still needed to work on our knowledge and demonstration of our project." Another participant appeared to be somewhat intimidated by faculty feedback, describing the experience thus:

> It's like a mini Physics Festival, except instead of having a bunch of young children and their parents, you have professors, and so when they ask you questions, like, you better know what you're saying. Because some of them—they're not mean—but they'll be like, "Yeah, you're not right. That's not how this works." And you're just like, "Oh.". . . .And if they suggest something, you just kind of—it's like, "Yeah, I guess we could try doing that," and sometimes what they suggest, we end up doing.

Summary

One of the program's expectations for the DEEP undergraduate participants was that they would present the demos they developed, through outreach activities such as the Physics and Engineering Festival and the Physics Showcases. An in-depth understanding of the physics concepts underlying their projects was essential for the presenters, as well as poise and confidence.

Audiences to whom the undergraduates presented were composed of individuals of all age groups and a wide level of knowledge, requiring the presenters to be able to modify their explanations as needed. Items on the *DEEP Undergraduate Participant Survey* asked participants about their levels of confidence related to presenting their work. Survey respondents reported that they were confident in modifying their explanations for the various audiences at the Physics and Engineering Festival, but they felt slightly more confident in explaining their experiments to their peers during the DEEP Showcases.

Qualitative data were also collected to address participants' perceptions of their comfort level in sharing their work at the Physics and Engineering Festival, via undergraduate participant interviews. Overall, interview respondents reported that sharing their demos with audiences of different ages was an enjoyable experience for them, and they felt confident in their ability to respond in an appropriate manner to audiences of all levels. Some respondent used a process of checking for understanding prior to beginning a presentation, to understand the extent to which they needed to modify their explanation.

Undergraduate interview respondents appeared rather nonchalant when asked to describe the feedback they gave to, and received from, their peers at the Physics Showcase. Most interview respondents reported providing and receiving general comments from peers. Feedback from their professors, however, was described as helpful, although intimidating at times.

Impact on Undergraduate Participants' Teamwork Skills

The 2013-14 DEEP Program evaluation also addressed the program's impact on undergraduate students' skills in conducting research projects as members of a team. The DEEP undergraduate teams were varied in terms of number of members and task assignments per team. Some undergraduates, moreover, participated as a member of more than one team, and undergraduate participants reported that team processes differed, depending on the mentor of a particular team. The DEEP expectation, however, was that the undergraduate participants would work in teams in the design and fabrication of the demonstrations.

Quantitative and qualitative data were collected via undergraduate participants' survey and interview responses and examined to address this evaluation question.

Evaluation Questions

Researchers developed the following evaluation questions related the DEEP Program's impact on undergraduate participants' teamwork skills:

Q5.1. In what ways did individual undergraduate participants contribute to the development of the team demos?
Q5.2. To what extent were undergraduate participants satisfied with the level of collaboration on their individual teams?
Q5.3. To what extent were undergraduate participants satisfied with the communication between other members of their team and themselves?
Q5.4. To what extent did undergraduate participants identify the feedback received from other teams at the Spring Showcase as supportive?

The following narrative discusses DEEP undergraduate participants' perceptions of their teamwork skills resulting from their experiences in the 2013-14 DEEP Program, specifically as related to their individual contributions to the various demos on which they worked, their level of collaboration with other members of their team(s), and the communication among team members.

Undergraduate Participant Perceptions of Teamwork Skills

The DEEP evaluation study included four questions related to the program's impact on undergraduate participants' skills in working as members of a team. Quantitative and qualitative data were collected to address this component of the evaluation. Item 3 on the *DEEP Undergraduate Participant Survey*

asked respondents to indicate the number of demos in which they were involved in constructing, in any capacity, during 2013-14. A majority of respondents (64.7%) reported participating in one to two demos. Almost one fifth of the participants (17.6%) did not indicate the number of demonstrations in which they had participated.

Next, DEEP undergraduate respondents were asked to indicate the extent of their contribution to developing their teams' demos. Respondents reported that they contributed least to designing and creating demonstration posters, with over one half (58.9%) reporting minimal or no contribution to this aspect of the demo. The research, design, and building components elicited higher levels of contribution, with over 70% of respondents contributing moderately or substantially to each of these three components (70.6%, 76.5%, and 83.5% respectively). Table 4.10 summarizes the degree to which respondents contributed to different components of the demonstrations.

Table 4.10
Summary of Percent of Participant Contribution by Demonstration Component

Demonstration component	No contribution	Minimal contribution	Moderate contribution	Substantial contribution
Poster	32.4	26.5	14.7	26.5
Research	5.9	23.5	32.4	38.2
Design	5.9	17.6	44.1	32.4
Building	8.8	17.6	23.5	50.0
Overall	13.3	21.3	28.7	36.8

Source. DEEP Undergraduate Participant Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *no contribution*, 2 = *minimal contribution*, 3 = *moderate contribution*, 4 = *substantial contribution*.

During the DEEP interviews, participants were asked to specifically describe the ways in which they participated in design and development of their team's demo. In responding to this question, each DEEP undergraduate student each seemed to have an experience that was unique to him or her. One student's team, for example, actually built three different demos, and the student's experience was different with each. For the first demo, s/he explained:

> Our graduate student already had the design sort of planned out, so. . . at first I worked on, like, ordering. Finding and ordering the materials we needed, figuring out what we needed. And then I worked on actually constructing the project. And then once we had it built, I worked a lot on trouble-shooting what was wrong with it and coming up with ways to solve different problems that arose when we built it.

For a second demo, this student reported being more involved in design. S/he narrated, "So I worked on the design of one of those, and like, we had the basic idea but we needed the dimensions and everything, and then I worked on getting the materials and constructing that as well."

Another interview respondent had worked with several different mentors, but the mentor with whom s/he worked in 2013-14 was "the most hands-on about it because he was like, 'This is what we're going to do … and, you know, do it that way.'" Despite having a managing-type mentor, however, this student reported that ultimately, "We all still had to, like, figure out how it worked and it didn't work for the longest time, so we all had to, like, spend hours in the DEEP room trying things and seeing what would make it work."

In contrast, some respondents reported being involved in all aspects of developing a specific demo:

> So I basically did everything for one particular demo. . . .So I really started from ground one, you know, I figured out how—you know, basic circuit design, where I could do that, and then I went and got all the parts and I built it.

Developing the poster was the final step before presenting a demo at the Physics and Engineering Festival or a Physics Show. Only one interview respondent reported working on a poster, but s/he described it as a difficult part of the process:

> We can't just be like, "There's a spark." You have to say, "This is why it works," but you have to say it in such a way that a child could understand it, or at least, like, get some picture on the poster that's like, okay, that's how kind of that works … That was actually really hard to do.

Undergraduate Participant Perception of Extent of Collaboration

Several items on the *DEEP Undergraduate Participant Survey* focused on the impact of collaboration among respondents' team members and with other teams. Respondents reported that they *felt comfortable asking questions of other team members* (*M*=3.44) and also that *feedback from other teams was courteous and supportive* (M=3.35). Most felt that *regularly communicating with other team members increased their understanding of the project* (*M*=3.09). Additionally, respondents agreed that *collaborating with team members increased their motivation to learn* (*M*=3.21). Table 4.11 illustrates respondents' perceptions regarding the value of the teamwork aspect of DEEP.

Table 4.11

Undergraduate Perceptions Regarding Impact of Working in Teams

	M	*SD*
Collaborating on the project with the other members of my team increased my motivation to learn.	3.21	0.69
I felt comfortable asking questions of other members of my team.	3.44	0.56
Communicating regularly with other members of my team helped me to understand our team project.	3.09	0.62
The feedback our team received from other teams during the spring DEEP Showcase was offered in a courteous, supportive manner.	3.35	0.65

Source. DEEP Undergraduate Participant Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Summary

The DEEP undergraduate participant teams were varied in terms of the number of participants per team and the determination of task assignments per team. Moreover, some undergraduates participated as members of more than one team.

Asked to indicate the number of demos in which they were involved in constructing in any capacity, a majority (64.7%) of the *DEEP Undergraduate Participant Survey* respondents reported participating in one to two demos. Respondents also reported contributing moderately or substantially to the research, design, and building components of their team's demos. Undergraduate interview participants were asked to specifically describe the ways in which they had contributed to their team's demo; responses to this question reflected experiences that were somewhat unique to each participant, with one reporting involvement in all aspects and others reporting involvement in one or two aspects of the design, development, and building of the demos.

Several items on the *DEEP Undergraduate Participant Survey* focused on participants' perceptions of the impact of collaboration among the different teams. Overall, responses to these questions were positive, with participants reporting that they felt comfortable asking questions of their team members, that feedback from other teams was courteous and supportive, and that their understanding of the project was enhanced by regular communication with other members of their team. They also reported that collaborating with their team members increased their own motivation to learn.

Impact on Mentors' Leadership Skills

DEEP mentors were all graduate students in the Department of Physics and Astronomy. The teams they mentored differed in the number of undergraduate participants, and some mentors worked with more than one team. The expectation for all mentors was that they would provide leadership to their team in its efforts to develop and present its research products, and the program was envisioned as an opportunity for the graduate students to increase their leadership skills.

Quantitative and qualitative data were collected via undergraduate and graduate survey and interview responses and examined to address this feature of the program.

Evaluation Questions

Q6.1. To what extent did the mentors believe the weekly meetings with their colleagues and DEEP program staff provided support for the mentors in their role as team leaders?

Q6.2. Were the mentors successful in providing leadership to their project team?

Q6.3. To what extent did the mentors believe that their mentoring responsibilities contributed to their leadership skills?

Q6.4. Did mentors establish effective lines of communication between themselves and the members of their team?

Q6.5. Did mentors provide effective levels of guidance between members of their team and themselves?

The following narrative discusses DEEP mentors' perceptions of their skills in leading teams, resulting from their experiences in the 2013-14 DEEP Program. Specifically, this section of the evaluation study examines mentors' perceptions as related to the mentors' success in providing leadership to the team(s) they mentored and as related to the extent to which their responsibilities as a mentor contributed to their own leadership skills. Undergraduate participants' perceptions of their mentors' success in providing effective leadership to individual projects is also examined.

Mentors' Perceptions of Leadership Skills Related to DEEP Experiences

The *DEEP Graduate Participant Survey* included several items that addressed this objective (see Table 4.12). Question 8 asked respondents to reflect on the weekly DEEP program meetings with their colleagues and with DEEP faculty, specifically considering whether the meetings were useful to the mentors in honing their leadership skills. The graduate mentors found *the discussions during weekly meetings to be beneficial in developing their leadership as a DEEP mentor* (*M*=3.13). Two questions asked participants about the impact of DEEP program responsibilities on their leadership skills. Overall, the mentors surveyed felt strongly that the program activities increased their leadership skills (*M*=3.47) and that the mentors' *leadership was successful* (*M*=3.33). Finally the graduate mentors who were surveyed strongly believed that they had been available to undergraduate DEEP students as needed, for both *team questions* (*M*=3.60) and *guidance on the group project* (*M*=3.60).

Table 4.12
Mentor Perceptions Regarding Program Impact on Their Leadership Skills

	M	***SD***
The discussions during weekly meetings with DEEP faculty and other DEEP mentors supported me in my role as a leader of the team I mentored.	3.13	0.64
The responsibilities I carried out as a DEEP mentor had a positive impact on my leadership skills.	3.47	0.64
I was successful in providing leadership for the project team I mentored.	3.33	0.61
I was readily available to respond to any questions or concerns that members of the team might have had.	3.60	0.51
I was readily available to provide guidance on the group project to members to the team I mentored.	3.60	0.51

Source. DEEP Graduate Mentor Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Qualitative data to address this objective were collected via interviews with the mentors and open-ended questions on the *DEEP Graduate Participant Survey.* First, mentor interview participants were asked to describe the regular lunchtime meetings held between them and the DEEP program faculty, specifically describing any assistance they may have received from their colleagues regarding issues with their individual teams or with participants on those team.

Overall, the mentors were positive about this component of the program. Discussing the conversations at the meeting, one mentor noted, "Whenever we're stuck, we get ideas … and then we get support, knowing it's not just me and my students, it's a small community of other people that are also working on this." Some mentors emphasized the meetings were an opportunity to build on others' experience,

especially from mentors who had participated in DEEP the previous year. One interview respondent, for example, explained, "Some of them [other mentors] gave advice on time management, some of them gave advice on managing, you know, some of the specific students that they worked with before, and things like that." Another mentor had learned "general leadership skills" during the meetings, as well as management skills from talking with a colleague who was adept at encouraging members of his team to be independent:

> I didn't think I was a bad leader before this, but maybe not a great one either. Knowing [the other student] and he had a really, really self-sufficient group and I was really impressed with that. . . .He really had them working on their own projects and he seemed pretty hands-off. I wouldn't say I learned exactly how he did it, but I was getting a better idea of seeing what could be done, thinking about it a little more when I would talk to him.

Mentor interview participants also described ways in which their overall responsibilities as a DEEP mentor had contributed to augmentation of their leadership skills. Some mentors believed participation in the program had helped them learn to manage the undergraduate participants, which increased mentors' leadership skills. One said, for example, "It [DEEP] improved my leadership. I mean, for one thing, it gave me a better sense of how to manage people. . . .It's given me a better sense of how to work with undergraduates. . .and you know, guide them through."

Other mentors believed DEEP had helped them learn that an important part of being a leader lies in structuring experiences in which the undergraduate participants were encouraged to learn from their mistakes:

> All of a sudden, I have these two undergraduates who really don't know what they're doing, and so I'm having to think multiple steps ahead. And not just, "How are they going to do what they want?" but, "What types of problems are they going to encounter?" And letting them encounter their problems so that I can teach them out of it. And it just feels that I'm having to organize everything in a way that makes sense, and I feel that that's part of what a leader is. It's just they [leaders] make sure that they take you down the right path, but they're also making sure that every step you take, you learn from that. And so, it just made me a lot more self-aware of what steps am I taking so that I can make sure that I don't lead them down a path that they're just going to waste a lot of time. And if they do make a wrong turn, then making sure that they learn from that wrong turn, so that it's not a waste of time, so that they gain something even out of failures.

One mentor, who shared that s/he had thought, prior to DEEP, that s/he was "a pretty good leader," explained how her ideas of team leadership had changed as a result of her DEEP experiences:

> My M.O. was always, "If someone's having trouble, show them really how to do it." I'm not a pro at it yet, or anything, but I'm getting a lot better at letting people kind of try to figure it out for themselves. . . .I wouldn't consider myself type A, but if someone's struggling something, I really want to get in there and be like, "Oh, here's how you do it," you know? But you don't learn as much from that, and so I previously thought I was a good leader, but really what I was, was a good doer. And now I'm getting better at letting other people do.

Communication is an important component of effective team leadership. Mentor interview and survey respondents described a variety of methods they used to communicate with their teams. Many mentors reported relying, to a great extent, on face-to-face meetings. Some meetings were regularly-scheduled, "weekly meetings in the lab," and others were more impromptu. One mentor, whose team had a regular hour-long meeting once a week, also frequently met with individual undergraduates in his/her office: "I work in the Physics Department, and I ran into them more often than not. . . .They usually ask me when they can see me, or they just drop by my office. I kept that open, as well, for them."

Mentors also described using "a combination of emails and text messages, and occasionally phone calls" for communication between them and members of their teams. One mentor, for example, said, "[I] scheduled all our meetings via email, and if I didn't hear back from anybody, like, pestering would be by text, usually." Another mentor described his/her communication techniques thus:

> Text messaging they seem to respond to most immediately. But there's some things that you can't just explain to them via text, it's just the text would be too long. So I'd send them an email and I'd follow-up with a text message saying, "Please check your email and respond."

Other mentors agreed that undergraduate students prefer text messaging to emails:

> Some students don't answer to emails, so it took me a while to figure out that's why they weren't responding to me. . . .So I started texting them, and I started having to call them. . . .I realized that I just have to do everything I can to be able to make sure that I got the results that I wanted out of the team, and so that included communication, that included calling them, that included organizing schedules with them together.

Still other mentors established Google Group Posts and Drop Box folders for sharing "online documents that could be modified by all group members," and Facebook pages where "We would share results, ideas, set up meeting times, etc."

Finally, all mentor interview participants reported responding to their team members in a timely fashion, as the following comments attest: "Depending on what the communication was, I pretty much

responded to it in a timely manner," "I'm generally, like, pretty quick about getting back to them," and "I usually respond within the same day."

Undergraduate Participant Perceptions of Mentors' Leadership Skills

Undergraduate participants' perceptions regarding leadership provided to their team was also considered in regard to this evaluation objective. Quantitative data were collected via responses to the *DEEP Undergraduate Participant Survey,* and qualitative data were collected via undergraduate participant interviews. Respondents to the *DEEP Undergraduate Participant Survey* were asked to reflect on the leadership provided by their DEEP mentor in responding to several survey items. The statements with the highest means were centered around mentor availability to undergraduate participants, both in *answering group members' questions* (*M*=3.59) and in *providing groups with guidance* (*M*=3.59). Mentors were also seen as a factor in *reducing team members' anxiety* (*M*=3.50) about the projects. Table 4.13 illustrates undergraduate perceptions of the leadership provided by their mentor(s).

Table 4.13
Undergraduate Participant Perceptions Regarding Mentors' Leadership

	M	***SD***
Our DEEP mentor was readily available to respond to any questions or concerns that other members of my team or I might have had.	3.59	0.66
Our DEEP mentor was readily available to provide guidance on the group project to my team.	3.59	0.56
Support from our DEEP mentor helped reduce anxiety among members of my team.	3.50	0.62

Source. DEEP Undergraduate Participant Survey.
Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

In regard to effective communication between the mentors and their team members, similar to the mentors, the undergraduate participants identified email, text messaging, face-to-face meetings, and Facebook as the communication methods used in their teams to communicate with their mentors and with each other. Undergraduate interview participants also agreed to some extent that their mentor(s) were prompt in responding to questions and requests for help, as illustrated by responses such as, "It wasn't immediate, like some professors, but I would say it was pretty good overall," and "They were always there if I needed them. Like, none of them took more than a day, I would think, to answer back."

Summary

DEEP mentors in the 2013-14 program were all graduate students in the Department of Physics and Astronomy. The expectation for all mentors was that they would provide leadership to their team in its efforts to develop and present its research products. Quantitative and qualitative data were collected via survey and interview responses from both undergraduate and graduate participants.

The *DEEP Graduate Participant Survey* included several items designed to measure mentors' perceptions related this objective. In response to a question addressing the extent to which the mentors perceived the regular lunch meetings with their peers and with the DEEP faculty to be useful in sharpening their leadership abilities, respondents reported that the discussions during the meetings were helpful to them in supporting their role as a team leader. The mentors strongly believed that their leadership skills were increased by their participation in DEEP and that they were successful in providing leadership to their teams. Finally, mentor survey respondents strongly believed that they had been available to the undergraduate participants, for questions and for guidance on the team project.

Qualitative data to address this objective were collected via responses to open-ended questions on the *DEEP Graduate Participant Survey* and mentor interviews. Asked to describe the lunchtime meetings, specifically in regard to any assistance received from their colleagues, mentors were positive in their responses. Some mentors described receiving ideas and support when they were "stuck," and others emphasized that the meetings were an opportunity to learn from others' experiences. Interview respondents also believed their overall responsibilities, such as managing the undergraduate participants, had positively impacted their leadership skills—particularly in regard to structuring the team to offer the greatest opportunity for undergraduate participants to learn from their experiences. Finally, interview and survey respondents described a variety of methods they utilized to communicate with members of their teams, including email, text messaging, and Facebook and believed they responded to questions and concerns of their team members in a timely fashion, generally within the same day.

Undergraduate participants' perceptions of the leadership provided by their mentor were also examined in regard to this evaluation objective. Respondents to the *DEEP Undergraduate Participant Survey* strongly agreed that their mentors were available to respond to group members' questions and to provide guidance regarding the projects. Mentors were also seen as a factor in reducing the undergraduate participants' anxieties about the team projects. Finally, the undergraduate participants described a variety of methods used by their mentors to communicate with group members, also including email, text messaging, and Facebook. Undergraduate participants also agreed that the mentors were "pretty good" at replying in a timely manner to questions and requests for help.

Impact on Mentors' Teamwork Skills

The final objective of the 2013-14 DEEP program evaluation study addressed the program's impact on mentors' teambuilding skills. The undergraduate teams they mentored differed in the number of students included, and some mentors worked with more than one team. The expectation for mentors was that they would encourage collaboration among all members of their teams in developing and building the demos.

Quantitative and qualitative data were collected via undergraduate and graduate survey and interview responses and examined to address this objective.

Evaluation Questions

Q7.1. Did the mentors encourage collaboration among their team members?

Q7.2. To what extent did the mentors believe that their mentoring responsibilities contributed to their own teamwork skills?

Q7.3. To what extent did the mentors believe their DEEP experiences enhanced their understanding of team processes necessary to complete an academic research project?

The following narrative discusses DEEP mentors' perceptions of their skills in developing effective teams, resulting from their experiences in the 2013-14 DEEP Program. Specifically, this section of the report discusses mentors' perceptions of their success in fostering collaboration among team(s) they mentored, and the extent to which their responsibilities as a mentor contributed to their own leadership skills and to their understanding of the team processes necessary to complete an academic research project. Undergraduate participants' perceptions of the mentors' success in effectively creating a learning environment conducive to collaboration among team members is also examined.

Mentor Perceptions of Teambuilding Skills Related to DEEP Experiences

Three items on the *DEEP Graduate Participant Survey* addressed mentors' perceptions of the impacts of DEEP program activities on the mentors' teambuilding skills. As Table 4.14 illustrates, each item had a mean above 3.00, indicating that DEEP mentors believed their teambuilding skills increased as a result of participation in the program. Specifically, the mentors surveyed felt strongly that DEEP participation positively impacted their *teamwork skills* (*M*=3.73) and resulted in an *increased understanding of*

teamwork required to complete research projects (*M*=3.73). Respondents also agreed that they were able to *encourage DEEP project team members to rely on one another for success* (*M*=3.13).

Table 4.14

Mentor Perceptions of DEEP's Impact on Their Teambuilding Skills

	M	***SD***
My experiences as a DEEP mentor increased my understanding of important team processes involved in successfully completing an academic research project.	3.73	0.46
The responsibilities I carried out as a DEEP mentor had a positive impact on my teamwork skills.	3.73	0.46
I encouraged members of the team I mentored to rely on each other's knowledge and skills to successfully complete their project.	3.13	0.64

Source. DEEP Graduate Mentor Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Questions on the DEEP mentor interview protocols also addressed mentors' teambuilding skills. First, mentor interview participants were asked to describe ways in which they had encouraged collaboration among members of the teams they mentored. Mentors' responses to this question indicated that mentors were somewhat uncertain regarding their abilities to support collaboration in their teams. One mentor, for example, shared, "I wasn't necessarily terrific at fostering, like, this collaborative thing, but by the end, I was getting better, I would say." A second mentor explained his/her strategy for encouraging collaboration in this way:

> Even though I had one experiment assigned specifically to each person, I told everybody that I wanted everybody to be able to run the experiment, so every now and then, [I would] try and switch the people and say, "Alright, you're on this today."

For some teams, collaboration appeared to be happenstance, rather than actively encouraged, as explained by one mentor:

> I told them [the undergraduate participants] they should come up with a problem they would like to work on, and once they did that, it just so ended up happening that those projects weren't exactly very trivial, so they had to collaborate with not just me, but the other students as well. And it happened that the students I had, they shared a couple of classes together, so they knew each other and they relied on each other for some of the projects.

Mentor interview participants were also asked to describe ways in which they believed their DEEP experiences had a positive impact on their teamwork skills. Mentors who believed they were not innately skilled at participating as members of a team themselves, perceived the DEEP experience as valuable in increasing their teamwork skills. One mentor, for instance, described his/her growth in this way:

> I'm sort of a—not like someone with OCD, but I like to control every single detail of what I'm doing, and I don't like to delegate or micromanage, so you know, when team projects usually roll around, I essentially do all the work myself. However, with the DEEP program, I had to delegate. I mean, I could have done the projects myself faster, and you know in a more timely manner, but that was not a thing that—the purpose of that [DEEP] was to delegate and you know, guide a couple of other people through the projects. I definitely had to learn how to do that, and I've been able to do that by the end.

Another mentor, who also believed participation in DEEP had strengthened his/her teamwork skills, expounded on his/her experiences:

> As a member of a team, I would be probably—and I'm not that Type A kind of person, but I would be tempted to, you know, do everything I could and whatever. Now, I'm becoming better about being like, "Okay, I am going to do this and you know, we'll work together and you can do other parts of it," kind of thing. So I think that's—I would say I was a decent team member before and now maybe I'm just less critical of how other people are doing their parts of the project. But probably I made less progress in that area than in being a leader, I would say.

Undergraduate Participant Perceptions of Mentors' Teambuilding Skills

Respondents to the *DEEP Undergraduate Participant Survey* were asked to reflect on the extent to which their DEEP mentor had promoted collaboration among the members of their team in developing the team project(s). As depictured in Table 4.15, undergraduate responses indicated that the mentors were seen as a factor in *encouraging team members to rely on others' knowledge and skills for successful project completion* (*M*=3.26).

Table 4.15

Undergraduate Participant Perceptions of Mentors' Skills in Promoting Collaboration

	M	***SD***
Our mentor encouraged members of my team to rely on each other's knowledge and skills in order to successfully complete the project.	3.26	0.62

Source. DEEP Undergraduate Participant Survey.

Note. Mean values for survey items are based on a 4-point scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*.

Qualitative data were also collected from undergraduate participants to address this component of the program. Undergraduate interview respondents were asked to describe specific ways in which their DEEP mentor encouraged and supported collaboration among all members of the team. Responses to this question were mixed.

For some respondents, the mentor appeared to leave it up to the team to decide how and if the team members would collaborate. One participant, who was involved in building two different demonstrations, noted that his/her mentor "sort of organized" the first demo. On the second demo, however, the mentor instructed the team to "figure it out between yourselves" how to effectively

distribute tasks and responsibilities—which resulted in greater collaboration among team members: "So I felt like on that smaller demonstration, I collaborated a lot more with the people in my subgroup in order to figure out how to do it, how to put it together, what we needed to do, and everything." Another interview participant explained, "We got put into two teams, and we would, you know, we would all have to figure—like, the teams would have to figure out how our part is going to be done."

Other mentors took an active role in assigning tasks to ensure that all members of a team were involved in a project. One interview participant described his/her mentor thus: "She [the mentor] would put everything together. . . .It was pretty much just asking her, you know, 'What needs to be done?' and then she would tell us, you know, 'Oh, work on this part with this person.'" Another interview participant shared that his/her mentor did a "pretty good job" of encouraging team members to work together:

> For example, if one project was going slow or, you know, had finished their task that they were working on, asking people [to help] on the other projects. To, you know, go, for example, get them electronics that they needed or help them, you know, drill holes or just any small task. So I think he was pretty good at facilitating who was helping who.

Summary

This section of the evaluation report addresses DEEP's impact on the mentors' teambuilding skills. Quantitative and qualitative data were collected via responses from four sources: (a) the *DEEP Graduate Participant Survey*, (b) DEEP mentor interviews, (c) the *DEEP Undergraduate Participant Survey,* and undergraduate participant interviews.

The *DEEP Graduate Participant Survey* included three items that addressed mentors' perceptions of the impacts of the DEEP program activities on the mentors' skills in teambuilding. Mentor survey respondents strongly believed that DEEP participation positively impacted their teamwork skills, resulting in a greater understanding of the teamwork required for successful research projects. Respondents also reported that they were able to inspire the undergraduate team members to rely on one another for success.

Mentor interview participants were asked to describe specific ways in which they were able to foster collaboration among their team members. Mentor respondents, however, appeared uncertain regarding their abilities to encourage collaboration on their teams. In at least one case, collaboration seemed to be a fortuitous accident. Mentor interview participants were also asked to describe ways in which their DEEP experiences had positively impacted their own teamwork skills. Mentors shared that although participating as a member of a team did not come naturally to them, they believed that their participation in DEEP had created opportunities for them to strengthen their team abilities.

The undergraduate participants perceptions of their mentors' teambuilding skills were also examined. The *DEEP Undergraduate Participant Survey* asked respondents to reflect on the extent to which they believed their mentors had promoted collaboration among members of their teams. Survey respondents indicated that undergraduate participants believed the mentors had been successful in encouraging team members to rely on each other for successful completion of their projects. When asked to describe specific ways in which their mentors had fostered collaboration among their team members, undergraduate interview responses were mixed. For some teams, the mentor appeared to leave it up to the team members as to the extent they wished to collaborate, while mentors for other teams assumed an active role in ensuring that all team members worked together.

CHAPTER 5: Summary and Conclusions

This chapter presents an overall summary of the results from the 2013-14 DEEP program evaluation.

General Summary

The DEEP program was established as an outreach effort by the Department of Physics and Astronomy at Texas A&M University. The present evaluation examined the impact of the 2013-14 DEEP program, including its effect on undergraduate participants' (a) knowledge of physics and engineering concepts and (b) analytic and hands-on skills in conducting research, and on graduate mentor participants' skills in leading and facilitating research teams. Designed as a mixed-methods study, the evaluation included undergraduate participant post-perceptional surveys, graduate mentor participant post-perceptual surveys, undergraduate participant interviews, and graduate mentor participant interviews.

The evaluation of the DEEP 2013-14 program was guided by questions related to participants' perceptions of the overall effectiveness of the program, as well as the program's success in addressing the six objectives supporting the program goal to enhance undergraduate and graduate students' learning and research experiences. The *DEEP Undergraduate Participant Survey* included eight questions related to participants' perceptions of the various aspects of the program. Analysis of quantitative data from the survey revealed that participants did not believe that participation in the program required an unreasonable time commitment. Moreover, survey respondents believed their DEEP participation had led to greater feelings of connection to the university and a network of friends and colleagues.

Analyses of qualitative data from the *DEEP Undergraduate Participant Survey* disclosed that building the demonstrations and the opportunity to learn new things and share their enjoyment of physics with others were features that respondents liked best about participating in the program. Conversely, the lack of resources and time were features respondents liked least about participating in the program.

When asked to provide recommendations for program improvements, some undergraduate participants suggested more resources and more opportunities to share their demos, but overall, most respondents were satisfied with the program as it was currently offered. A final question on both the undergraduate survey and interview asked respondents if they had anything else they would like to share about the program. Comments in response to this question were extremely positive.

The *DEEP Graduate Participant Survey* included several questions to examine mentors' overall perceptions of the program. Analysis of quantitative data from the survey disclosed that mentors did

not feel that participation in the program required an extreme time commitment; moreover, some mentors wished they had spent even more time on the program. Finally, mentors agreed they were able to enhance undergraduate participants' university experience.

When asked to describe what they best about participating in DEEP, respondents to the *DEEP Graduate Participant Survey* and the mentor interviews shared that their opportunities to positively interact with the undergraduate participants was a program strength, as well as DEEP's emphasis on leadership skills. Mentor survey respondents believed time commitments required for the program and undergraduate participants' lack of motivation were aspects of the program that they like least; correspondingly, when asked to provide recommendations for changes to the program, some mentors offered suggestions for increasing undergraduate motivation. Finally, mentor interview respondents reported that they had positively impacted undergraduates' experiences at TAMU on both a professional level, such as offering advice on classes, and on a personal level, by providing friendship.

Increasing undergraduates' understanding of the physics and engineering concepts behind the demos participants built was a key objective of the DEEP program. The majority of respondents to the *DEEP Undergraduate Participant Survey* either agreed or strongly agreed that the program had been successful in achieving that objective. Moreover, they believed that the knowledge and skills they had gained could be applied to future academic courses. Many undergraduate survey respondents identified specific topics in which they had increased their knowledge, while undergraduate interview respondents primarily believed participation in the program had increased their problem-solving skills.

Increasing undergraduate participants' analytic and hands-on skills in conducting research was also an important component of the DEEP program. Most undergraduate participants were, to some extent, involved in the research behind their demos, and respondents to the *DEEP Undergraduate Participant Survey* reported that their participation in DEEP had led to increased skills in conducting research.

DEEP undergraduate participants were expected to present the demos they built, through outreach activities such as the Physics and Engineering Festival, Physics Shows, and DEEP Showcases. Respondents to the *DEEP Undergraduate Participant Survey* reported that they were confident in their ability to present their demos and answer questions with audiences composed of different age groups and knowledge levels. Undergraduate interview participants concurred, sharing that they enjoyed sharing their demos with the different audiences and felt confident about their ability to do so. Although undergraduate interview respondents reported that feedback from their professors at the DEEP Showcases was helpful, they did not report receiving or giving significant feedback to their colleagues at those events.

The DEEP program evaluation also addressed DEEP's impact on undergraduate students' teamwork skills. A majority of respondents to the *DEEP Undergraduate Participant Survey* reported that they contributed primarily to the research, design, and building of their demos. Regarding collaboration

among their team members, respondents overall reported that feedback from their peers was offered in a courteous, supportive manner, and that their own motivation to learn was positively impacted by collaborating with their team members.

The DEEP program was envisioned, in part, as an opportunity for graduate mentors to increase their leadership and teambuilding skills. Analyses of quantitative data from the *DEEP Graduate Participant Survey* indicated that mentors believed their participation in DEEP had increased their leadership skills, enabling them to be effective leaders of their team(s), available to provide support and guidance to the team members. Mentor survey respondents also described the regular meeting among the DEEP program staff and mentors as being a positive influence on the their leadership skills. Finally, mentors believed they had communicated effectively and in a timely manner with the members of their teams. Undergraduate survey respondents strongly agreed that the mentors were available to respond to group members' questions and concerns in a timely manner and were a factor in reducing undergraduates' anxieties about the projects.

In regard to DEEP's impact on their team building skills, respondents to the *DEEP Graduate Participant Survey* perceived the program as having positively impacted their understanding of the teamwork required for a successful research project. Mentors appeared uncertain, however, of their abilities to encourage collaboration among their team members. Moreover, although many mentors reported that typically they were not good at working as members of a team, they believed their DEEP participation had increased their skills in teamwork. Finally, respondents to the *DEEP Undergraduate Participant Survey* indicated that their mentors had successfully encouraged them to rely on each other in completing their projects, although undergraduate interview respondents struggled to describe ways in which their mentors had actively fostered collaboration among members of their teams.

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