Evaluation of 2016 Mitchell Institute Physics Enhancement Program (MIPEP) Summer Institute

Prepared by
Education Research Center
at Texas A&M University

Prepared for
Department of Physics and Astronomy
December 2016

TEXAS A&M UNIVERSITY

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Credits

Texas A&M University
Education Research Center

The Texas A&M University Education Research Center (ERC) studies major issues in education reform and school governance in order to improve policy and decision-making in P-16 education.

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EXECUTIVE SUMMARY

The Mitchell Institute Physics Enhancement Program (MIPEP) Summer Institute was developed by Bhaskar Dutta, Alexey Belyanin, and Tatiana Erukhimova, faculty in the Department of Physics and Astronomy at Texas A&M University, and Paula Hiltibidal, a Region 15 Education Service Center High School Science Specialist. The program was designed with five objectives: (a) positively impact physics teaching and learning, (b) increase participants' physics content knowledge, (c) assist participants to develop and use research-based instructional strategies, (d) provide laboratory-based learning experiences, and (e) encourage collaboration among physics educators. Recruitment efforts target high school physics teachers with little or no physics background to participate in the Institute each year.

The current evaluation examined the impact of the 2016 MIPEP Summer Institute, including changes in participants' confidence in teaching, physics concepts. The mixed-methods study included pre-and post-perception surveys, post-session topic surveys, and participants' final reflections.

Key Findings

The 2016 MIPEP Summer Institute was found to include the following strengths:

- The 2016 Summer Institute was successful in increasing participants' confidence in their physics content knowledge
- The 2016 Summer Institute was successful in increasing participants' confidence in guiding and developing student learning in domains of science processing
- The 2016 Summer Institute was successful in increasing participants' confidence in implementing specific teaching strategies in their physics instruction

Key Recommendations

Primary recommendations include the following:

- Incorporate strategies for formally and informally assessing K-12 student understanding
- Focus recruitment efforts on district and/or campus teams of physics teachers, whenever possible, to promote successful transfer of knowledge
- Provide follow-up and support to participants in the field, as they implement the new teaching strategies and content knowledge in their classrooms

Results of this evaluation study indicate that MIPEP has the potential to significantly and positively impact physics teaching and learning in Texas schools. Findings indicate that, overall, 2016 Summer Institute participants had very positive opinions regarding their experiences and that their confidence in using specific teaching strategies, in guiding and developing their students' learning in science processes, and in teaching physics concepts increased subsequent to the Summer Institute. In addition, findings revealed that program participants planned to disseminate to their colleagues on their home campuses and districts the physics content knowledge, and instructional strategies and tools for teaching physics, they had learned at the MIPEP 2016 Summer Institute.

CHAPTER 1: Introduction

A significant need exists in U.S. high school classrooms for greater numbers of highly qualified physics teachers. Nationally, less than 50% of high school physics teachers have the equivalent of a physics or physics education major (MacIsaac, Henry, & Zawicki, 2004), and only 11% have a minor in the subject (Sabella, Van Ouzor, Passehl, & Weisenburger, 2012). Metzger (2011) reported that courses or major activities with a specific concentration in physics teaching are integrated in very few teacher preparation programs in the U.S., and the situation is exacerbated by the current curricular practice in which physics is usually offered as a 1-year course, taught by teachers who largely teach other courses as well (p. 3). In Texas, specifically, the documented lack of physics teachers relates to both number and qualifications (Mount, Marshall, & Fuller, 2013), with many high school physics teachers having completed no more than six credit hours of college-level physics courses (Dutta, 2012).

The Mitchell Institute Physics Enhancement Program (MIPEP) Summer Institute was initiated to address the need for greater numbers of qualified physics teachers in Texas. Underwritten by the Cynthia and George Mitchell Foundation and using funds provided through the Texas A&M Foundation, the Summer Institute is purposed to establish an outreach effort to improve Texas high school students' mathematics and science performance by providing exemplary professional learning opportunities for physics teachers across the state. Nearly a dozen faculty members from the Texas A&M Department of Physics and Astronomy volunteer their time to offer an intensive 2-week immersion in key physics content and instructional skills to MIPEP Summer Institute participants.

The Education Research Center at Texas A&M University (ERC at TAMU) was commissioned by MIPEP in May 2016 to conduct an external evaluation of the 2016 MIPEP Summer Institute. This report describes the findings from the MIPEP evaluation, which addressed research questions related to the following five project objectives:

1. Positively impact physics teaching and learning in Texas
2. Increase participating teachers' understanding of physics concepts
3. Assist participating teachers to develop and use research-based strategies that engage and provide differentiated instruction for their physics students
4. Provide rigorous laboratory-based learning experiences for participants
5. Facilitate collaboration of physics educators in Texas

Program History

The MIPEP Summer Institute was envisioned and designed by Dr. Bhaskar Dutta, Texas A&M physics professor and interim director of the George P. and Cynthia Woods Mitchell Institute for Fundamental Physics and Astronomy, and Ms. Paula Hiltibidal, a Region 15 Education Service Center High School

Science Specialist, in collaboration with Dr. Alexey Belyanin and Dr. Tatiana Erukhimova, faculty in the Texas A&M University Department of Physics and Astronomy. Dr. Mary Jane Head, physics teacher at Foster High School in Lamar Consolidated Independent School District, provides key content and pedagogical input. In addition, a select group of nearly a dozen top-notch faculty from the Department of Physics and Astronomy at Texas A&M University, with expertise in introductory physics teaching and outreach, volunteer their time to teach fundamental physics concepts during the 2-week institute. Content and materials provided during the Institute are centered around the physics TEKS (Texas A&M University Department of Physics and Astronomy, 2016). Participants completing the program receive Continuing Professional Education and Gifted/Talented credits.

The purpose of the MIPEP Summer Institute is to improve Texas high school students' mathematics and science performance by providing rigorous, college sophomore-level physics education (Physics 201 and 202) to high school physics teachers across the state of Texas. Recruitment efforts for the Summer Institute target current high school physics teachers who have little to no background in physics (i.e., completed fewer than three college-level physics courses).

The Summer Institute curriculum focuses on fundamental physics concepts and subjects such as mechanics, electricity, and magnetism. All instruction and laboratory-based work is provided on the Texas A&M University campus in College Station, Texas. Basing the program on the university campus allows program facilitators to include additional features such as a tour of the TAMU nuclear reactor, star gazing in the TAMU observatory, and a visit to the TAMU cyclotron.

The MIPEP Summer Institute is underwritten by the Cynthia and George Mitchell Foundation with funds provided through the Texas A&M Foundation. Program participants receive a certificate, as well as Continuing Professional Education credits (CPEs). Additionally, each participant receives lodging and meals.

The first MIPEP Summer Institute occurred in June 2012, with 15 teachers from 13 different school districts participating. The 2013 Summer Institute included 18 teacher participants from 18 high schools in 18 different districts and nine Education Service Center regional areas across Texas, and the 2014 Summer Institute was comprised of 17 teachers from 16 high schools in 14 different districts and 8 Education Service Center regional areas. For the 2016 MIPEP Summer Institute, 18 teachers from high schools across Texas participated.

Organization of the Report

The primary purpose of this report is to address the evaluation questions related to the Mitchell Institute Physics Enhancement Program (MIPEP) 2016 Summer Institute. The report is organized into five chapters. Chapter 1 provides the history and background information for MIPEP, Chapter 2 presents the MIPEP 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 Department of Physics and Astronomy at Texas A&M University established the Mitchell Institute Physics Enhancement Program (MIPEP) as an outreach effort to improve Texas high school students' mathematics and science performance. The program provides rigorous physics training to high school physics teachers from across the state of Texas through intensive, 2-week summer institutes that center on the physics TEKS and encompass interactive classes, problem solving, labs, and hands-on demonstrations. The Education Research Center at Texas A&M University (ERC at TAMU) was commissioned by MIPEP in May 2016 to conduct an external evaluation of the 2016 MIPEP Summer Institute.

MIPEP Program Objectives

The MIPEP Summer Institute was established with the following five objectives:

Objective 1: Positively impact physics teaching and learning in Texas

Objective 2: Increase participating teachers' understanding of physics concepts

Objective 3: Assist participating teachers to develop and use researched-based strategies that engage and provide differentiated instruction for all of their physics students

Objective 4: Provide authentic laboratory-based learning experiences

Objective 5: Facilitate and encourage collaboration of physics educators in Texas

Program Inputs

The 2016 MIPEP Summer Institute represents an outreach effort and goal of the Department of Physics and Astronomy in the College of Science at Texas A&M University, continuing the department's history of commitment to improve preK-12 science teaching and learning in Texas schools by providing exemplary professional learning opportunities for teachers.

Dr. Alexey Belyanin, Dr. Bhaskar Dutta, and Dr. Tatiana Erukhimova, faculty members from the Texas A&M University Department of Physics and Astronomy, facilitate the MIPEP Summer Institute and teach

different sessions. Additional organization, planning, and teaching expertise are provided by Ms. Paula Hiltibidal, a Region 15 Education Service Center High School Science Specialist, and Dr. Mary Jane Head, a physics teacher at Foster High School in Lamar Consolidated Independent School District.

The 2016 MIPEP Summer Institute was underwritten by the Cynthia and George Mitchell Foundation, with funds provided by the Texas A&M University Foundation. The George P. and Cynthia Woods Mitchell Institute for Fundamental Physics and Astronomy hosted the Summer Institute, with meals and accommodations for participants provided on the Texas A&M University campus in College Station.

Faculty members from Texas A&M University's Department of Physics and Astronomy volunteered their time to teach key physics content during the 2016 MIPEP Summer Institute. Classroom and laboratory facilities were provided on the Texas A&M campus in support of the program by the Department of Physics and Astronomy.

Program Outputs

The 2016 MIPEP Summer Institute had concluded at the time of this evaluation report. Stakeholders served by the program were comprised of the teachers who attended and participated in the 2016 Summer Institute.

The 2016 MIPEP Summer Institute provided an intensive 2-week physics experience for 18 physics teachers in Texas. Table 2.1 provides demographic information regarding the participants.

Table 2.1

MIPEP 2016 Participant Demographics

Characteristics	*n*
Sex	
Female	14
Male	4
Ethnicity	
White, not of Hispanic descent	12
African American	2
Latino(a)	3
Did not answer	1
Number of college physics courses completed	
Zero	2
One	5
Two	10
Three	1
Physics courses currently taught	
Conceptual Physics	5
On-level, math-based physics	17
Pre-AP Physics	3
AP Physics B	3
AP Physics C	0

Source. *MIPEP Perceptions Pre-Survey*.

Note. Physics courses currently taught totals more than 18 because participants could select more than one answer.

CHAPTER 3: Evaluation Methods

Evaluation Questions

The evaluation of the 2016 MIPEP Summer Institute was guided by questions related to five objectives: (a) positively impact physics teaching and learning in Texas, (b) increase participating teachers' understanding of physics concepts, (c) assist participating teachers to develop and use research-based instructional strategies, (d) provide rigorous laboratory-based learning experiences, and (e) encourage and facilitate collaboration among physics educators in Texas. Table 3.1 provides the specific evaluation questions related to each of the five objectives.

Table 3.1

Evaluation Questions for 2016 MIPEP Summer Institute Evaluation

Objective 1: Positively Impact Physics Teaching and Learning in Texas
Q1.1. To what extent do teachers perceive that participation in the 2016 MIPEP Summer Institute will positively benefit their physics instruction?
Q1.2. What are potential barriers to implementation of the content learned at the 2016 MIPEP Summer Institute, as identified by participants?
Objective 2: Increase Participating Teachers' Understanding of Physics Concepts
Q2.1. To what extent did participants' confidence in their ability to teach physics concepts increase as a result of their participation in MIPEP?
Q2.2. What aspects of the content instruction did participants identify as most effective in increasing their knowledge base?
Objective 3: Assist Participating Teachers to Develop and Use Research-Based Instructional Strategies
Q3.1. What aspects of the instructional strategies training did participants identify as most effective in increasing their knowledge base?
Q3.2. What are potential barriers to implementation of research-based instructional strategies, as identified by participants in the 2016 MIPEP Summer Institute?
Objective 4: Provide Laboratory-Based Learning Experiences
Q4.1. Do participants feel confident in their understanding of physics concepts as a result of their 2016 MIPEP Summer Institute laboratory experiences?
Q4.2. Do participants feel confident in their ability to teach physics concepts as a result of their 2016 MIPEP Summer Institute laboratory experiences?
Q4.3. What are potential barriers to implementation of the 2016 MIPEP Summer Institute laboratory experiences in participants' own classrooms, as identified by participants?
Objective 5: Encourage and Facilitate Collaboration of Physics Educators in Texas
Q5.1. To what extent do participants intend to share the information gained through the 2016 MIPEP Summer Institute with colleagues on their individual campuses?

Source. 2016 MIPEP Summer Institute Evaluation Plan.

Participants

Participants for this evaluation study included members of the MIPEP Planning/Facilitation Team, MIPEP presenters (TAMU physics professors and physics master teachers), and 2016 Summer Institute attendees.

Data Sources and Collection

The evaluation team employed a mixed-methods research design for this study. Quantitative and qualitative data were collected via (a) pre- and post-perception surveys, (b) topic sessions post-surveys, and (c) final reflections surveys.

Survey/Assessment Data

The evaluation team administered several surveys and assessments for this evaluation study. First, the *MIPEP Pre-Perceptions Survey* was administered to participants on the first day of the 2016 Summer Institute, and the *MIPEP Post-Perceptions Survey* was administered on the final day of the Summer Institute. Both surveys consisted of questions designed to measure participants' perceptions of their need for professional development in specific instructional strategies, as well as their confidence in their abilities to use certain specific strategies in physics instruction, their confidence in their abilities to teach certain physics concepts, and their confidence in their abilities to guide and develop student learning in specific domains of science processing. Data from these two surveys were analyzed and examined to measure changes in participants' perceptions in these areas. In addition to closed-ended, quantitative questions, the *MIPEP Post-Perceptions Survey* included two open-ended questions purposed to collect in-depth, qualitative data regarding participants' perceptions of the most effective laboratory experiences in the 2016 Summer Institute, as well as of possible barriers participants might face in implementing the labs in their individual classrooms.

The *MIPEP Topic Sessions Post Survey* was administered to participants subsequent to each topic session. The 13 questions on this instrument were designed to measure (a) participants' perceptions regarding pedagogical strategies employed by session presenters, (b) participants' perceptions of the value of materials and information provided regarding each specific physics topic, (c) participants' perceived knowledge level of the specific topic, and (d) participants' confidence in teaching the specific topic.

At the conclusion of the final day of the 2016 MIPEP Summer Institute, participants were asked to complete the *MIPEP Final Reflections Survey.* Consisting of six open-ended questions, this instrument asked participants to reflect on the 2016 Summer Institute as a whole and discuss (a) which aspects of the physics content instruction they had received were most effective in increasing their content knowledge, (b) which aspects of the 2016 Summer Institute were most effective in increasing their repertoire of effective physics instructional strategies, (c) barriers they perceived they might face in implementing their new knowledge of physics content and instructional strategies in their own individual classrooms, and (d) specific ways in which they anticipated sharing their learnings from the 2016 Summer Institute with their colleagues on their individual campuses.

CHAPTER 4: RESULTS

This chapter reports the results of the current study, organized by the objectives established in the evaluation plan. First, the results related to positive impacts on physics teaching and learning in Texas are reported. Second, the findings associated with strengthening participating teachers' understanding of physics concepts and with assisting participating teachers to develop and use research-based instructional strategies are provided. Next, results pertaining to efforts to provide laboratory-based learning experiences for MIPEP participants are described. Finally, findings related to efforts to encourage and facilitate collaboration of physics educators in Texas are reported. The discussion of each objective concludes with a summary of findings.

Objective 1: Positively Impact Physics Teaching and Learning in Texas

The overall goal of the Mitchell Institute Physics Enhancement Program (MIPEP) is to improve Texas high school students' mathematics and science performance by providing rigorous, college sophomore-level physics education to high school physics teachers from across the state of Texas. Examining perceptions of participating teachers regarding potential impact of the program on their instructional practices was an important component of the evaluation study.

Evaluation Questions

Researchers developed the following two evaluation questions related to impact of the 2016 MIPEP Summer Institute on physics teaching and learning in Texas:

Q1.1. To what extent do participating teachers perceive that the 2016 MIPEP Summer Institute will benefit their physics instruction?

Q1.2. What are potential barriers to implementation of the content learned at the 2016 MIPEP Summer Institute?

The following narrative discusses 2016 MIPEP Summer Institute participants' perceptions of potential changes in their physics instruction resulting from their experiences in the 2016 Institute. Participants' perceptions of possible barriers to successful implementation of the physics content into their individual classrooms are also reviewed.

MIPEP Pre-/Post-Perception Survey Results

The evaluation team developed and administered two instruments to examine MIPEP participants' perceptions of the extent to which the 2016 Summer Institute would benefit their physics instruction. The *MIPEP Pre-Perceptions Survey,* which included 48 Likert-type questions, was administered to participants on the first day of the 2016 Summer Institute. Of the 18 participants, 18 completed the survey, for a response rate of 100%. The *MIPEP Post-Perceptions Survey*, which included the same 48 Likert-type questions, plus two open-ended questions, was administered on the last day of the 2016 Institute. All 18 participants completed the post-survey for a response rate of survey of 100%.

First, seven items on the survey asked participants about their perceived need for professional development related to content knowledge, teaching strategies, and student-centered instruction. A dependent samples *t*-test was conducted on the items to determine if participants' perceptions significantly changed as a result of participation in the 2016 MIPEP Summer Institute. Mean scores on four of the seven items decreased significantly ($p < .05$), indicating that participants' perceptions of their professional development needs in these areas decreased following the 2016 MIPEP Summer Institute. Upon completion of the Institute, summer 2016 participants were significantly less likely to perceive a moderate to substantial need for professional development targeted at *deepening their content knowledge*, *using inquiry/investigation-oriented teaching strategies*, *using technology for instructional purposes*, and *differentiating instruction for all students.* Participants' perceived professional development needs related to *assessing student learning, teaching students who have limited English proficiency,* and *using culturally responsive teaching strategies* did not show statistically significant differences following the Summer 2016 Institute. Table 4.1 illustrates the dependent samples *t*-test results for participants' perceived need for professional development.

Table 4.1

Dependent Samples t-test Results for Perceived Professional Development Needs

	Pre-survey (n = 18)		Post-survey (n = 18)		
Item	*M*	*SD*	*M*	*SD*	*t*
Deepening content knowledge	3.33	0.59	2.50	0.86	2.64*
Using inquiry/investigation-oriented teaching strategies	3.44	0.62	2.28	0.57	8.01**
Using technology for instructional purposes	3.11	0.76	2.33	0.59	4.51**
Assessing student learning	3.00	0.77	2.67	0.77	1.30
Differentiating instruction for all students	3.28	0.89	2.72	0.83	2.76*
Teaching students who have limited English proficiency	3.17	0.92	3.17	0.51	.000
Using culturally responsive teaching strategies	3.06	0.73	3.33	0.49	-1.16

Source. MIPEP Pre/Post-Perception survey.

Notes. Values for survey items are based on a 4-point scale with 1 = *None needed*, 2 = *Minimal need*, 3 = *Moderate need*, and 4 = *Substantial need*; *$p < .05$, **$p < .01$.

Survey respondents were also asked about their confidence in their ability to integrate five specific teaching strategies into their physics instruction, including (a) providing in-depth coverage of physics content, (b) developing conceptual understanding, (c) making cross-curricular connections to physics, (d) engaging students in physics, and (e) applying physics concepts to real life. A dependent samples *t*-test was conducted on responses to these five items on the pre- and post-surveys to determine if participation in the 2016 Summer Institute resulted in statistically significant changes in participants' confidence levels. Participants' confidence levels showed statistically significant increases ($p < .001$) for all five teaching strategies after participation in the summer institute. Table 4.2 displays the dependent samples *t*-test results for participants' confidence in using physics teaching strategies.

Table 4.2

Confidence in Using Physics Teaching Strategies

Item	Pre-survey (*n* = 18)		Post-survey (*n* = 18)		
	M	*SD*	*M*	*SD*	*t*
Providing in-depth coverage of fewer physics concepts rather than shallow coverage of more physics concepts	1.94	0.54	3.22	0.43	-9.436***
Developing students' conceptual understanding of physics	2.06	0.73	3.44	0.51	-8.444***
Making connections between physics and other disciplines	2.17	0.62	3.44	0.51	-6.059***
Engaging students in applications of physics in a variety of contexts	1.78	0.55	3.44	0.62	-9.22***
Applying physics concepts to real life scenarios	2.33	0.49	3.44	0.62	-6.969***

Source. MIPEP Pre/Post-Perception survey.

Note. Values for survey items are based on a 4-point scale with 1 = *Not at all confident*, 2 = *Somewhat confident*, 3 = *Confident*, and 4 = *Extremely confident*; **$p < .01$, ***$p < .001$

Additionally, participants were asked about their confidence levels in relation to guiding and developing student learning in 16 domains of science processing. Dependent samples *t*-tests were conducted between responses on the pre- and post-survey in order to determine if participants' confidence levels changed significantly between completion of the two surveys. Participants' confidence showed statistically significant increases for 15 of the 16 domains following the 2016 MIPEP Summer Institute ($p < .05$). The only process that did not show a statistically significant increase was *practicing laboratory safety.* The mean score for the laboratory safety item was quite high on the pre-survey ($M = 3.44$). The lack of a significant pre- to post-survey change is likely attributable to regression to the mean. The dependent samples *t*-test results for confidence in guiding and developing student learning in science processes are found in Table 4.3.

Table 4.3

Confidence in Guiding and Developing Student Learning in Science Processes

	Pre-survey (n = 18)		Post-survey (n = 18)		
Item	*M*	*SD*	*M*	*SD*	*t*
Conducting observations	2.39	0.70	3.39	0.61	-4.675***
Creating hypotheses	2.28	0.67	3.39	0.70	-6.216***
Collecting data	2.78	0.81	3.33	0.69	-3.007**
Interpreting data	2.67	0.77	3.11	0.76	-2.406*
Drawing conclusions based on the data	2.56	0.70	3.56	0.51	-6.185***
Designing physics investigations	1.72	0.75	3.44	0.70	-8.841***
Conducting physics investigations	2.28	0.83	3.56	0.51	-5.326***
Working collaboratively	2.61	0.78	3.22	0.73	-2.500*
Practicing laboratory safety	3.44	0.62	3.06	0.73	1.686
Using scientific technology	2.33	0.91	3.33	0.59	-4.373***
Communicating findings through writing	2.33	0.69	2.89	0.68	-4.610***
Communicating findings orally	2.39	0.70	3.06	0.73	-3.117**
Reading scientific literature	2.22	0.81	3.22	0.55	-4.373***
Using technology to conduct research	1.94	0.80	3.22	0.55	-6.560***
Making connections within science	2.44	0.62	3.50	0.51	-4.486***
Making connections from science to other disciplines	2.33	0.59	3.39	0.70	-4.242**

Source. MIPEP Pre/Post-Perception survey.

Note. Values for survey items are based on a 4-point scale with 1 = *Not at all confident*, 2 = *Somewhat confident*, 3 = *Confident*, and 4 = *Extremely confident*; *p < .05, **p < .01, ***p < .001

Qualitative data collected via responses to Question 10 on the *MIPEP Final Reflections Survey* ("Is there anything else that you would like to share regarding the MIPEP Summer Institute?") further indicated that participants believed the 2016 Summer Institute had had a powerful impact on their physics knowledge, as the following comment illustrates:

> This program is nothing short of amazing! I can't truly put into words just how incredible it has been and how much I've grown in such a short time. The amount of resources we have been given is amazing, and while I haven't had time to fully digest everything while I've been here, I know I will upon my return home. There are no other opportunities like this out there. It really has changed me for the better.

Other respondents to this question agreed. One participant, for example, enthused, "I appreciate not only the knowledge shared, but how so many of the people involved shared pieces of themselves! This experience is above and beyond what I expected." Other participants were equally positive: "Thank

you! This is the only physics content training available. It is what I have begged for, for years!" said one, and a second agreed, "It was an amazing learning experience. I learned a lot and definitely feel more confident in my understanding of physics." A final respondent elaborated on the impact of the MIPEP Summer Institute on his/her physics content knowledge thus:

> I am grateful for this experience. I had no idea how much there was to learn. I could come back for 10 years and learn something new every time! I was so blessed by the amount of preparation, thought, and care each person put into what they presented to us.

Perceived Barriers to Implementation of Physics Content

Qualitative data were collected and analyzed to determine possible challenges MIPEP participants might face in transferring their new physics knowledge into their teaching practice on their home campus (Evaluation Question 1.2). Question 6 on the Final Reflections Survey asked respondents to identify some possible barriers they might face in implementing the physics content knowledge they had learned at the MIPEP Summer Institute in their individual classrooms.

Many participants perceived their students' lack of mathematics skills as the greatest challenge they would face in implementing their new physics content knowledge, as the following comments illustrate: "Most of my students are on-level, so it limits the level of information I can teach. The students haven't been exposed to calculus;" "Some of the content was well above my students' math levels. Much of what the professors discussed, even in terms of algebra, would not be feasible by the majority of my students;" and "We learned at such a high level here. I spend multiple days in kinematics just convincing my students that V at max height really is 0. Cognitive level is one factor; math skills are a second factor." One participant who expressed some concern about his/her students' mathematics content knowledge, however, expanded his/her response to this question to include ideas regarding how to overcome this challenge:

> Some possible barriers I might face in implementing the physics content knowledge I learned at MIPEP in my own classroom would involve the depth of the math we went through and the more in-depth parts of the concepts (to the level of gluons, for instance). On-level students, for me, have a math experience range of math models to dual-credit calculus, and they are all mixed together. Personalized instructor and special groups may be necessary.

Some respondents expressed reservations regarding their own mathematics content levels when addressing this question. One participant, for example, shared, "I feel like I might not remember all of it, or misunderstand parts of it," and a second admitted, "The calculus was very difficult and I'm not sure if that is something I would be able to teach in my own classroom." Other respondents who lacked confidence in their current mathematics knowledge, however, believed that they could become more

knowledgeable in time. "My calculus is not strong enough to fully grasp magnetic fields, flux, and Gauss' law. I just need to work with it more," said one. A second participant agreed: "I still don't fully understand everything we talked about, so there are still areas I'm not really comfortable with and I'm going to have to spend time with."

A few MIPEP participants expressed that "time," or lack thereof, would impede their success in implementing their new physics knowledge in their classrooms. One respondent explained, "I need to spend time going over the material and editing it to a level my students understand," and a second agreed: "The limited time will make it hard to put new things or deeper content knowledge into lessons." A third participant rather plaintively explained, "I would love to cover all concepts but there is never enough time."

Finally, a few participants described somewhat random challenges, such as the following: "The lack of buy-in by most of the students who feel that they are 'made' to take the class," "Limited technology, computers, probe ware, funding to purchase materials needed," administrators who opposed "activities that are more student based than teacher based," and "pushback" from other teachers.

Summary

Evaluators examined the 2016 MIPEP Summer Institute's potential impact on physics teaching and learning in Texas in response to Objective 1. Qualitative and quantitative data to address this objective were collected via three instruments developed for a prior evaluation study of the MIPEP Summer Institute: the *MIPEP Pre-Perceptions Survey,* the *MIPEP Post-Perceptions Survey,* and the *MIPEP Final Reflections Survey*.

The *Pre-* and *Post-Survey* each contained seven items designed to measure changes in participants' perceived need for professional development related to content knowledge, teaching strategies, and student-centered instruction. Results from a dependent samples *t*-test indicated that subsequent to the 2016 Summer Institute, participants perceived themselves as needing less professional development in four of the seven areas, with significant differences found for four of the items.

Survey respondents were also queried regarding their confidence in their abilities to implement five specific teaching strategies in their physics instruction. The results of a dependent samples *t*-test on these items revealed that participant's confidence levels increased significantly for all five strategies as a result of the 2016 Summer Institute.

Additionally, participants were asked about their confidence levels in relation to guiding and developing student learning in 16 domains of science processing. Results from a dependent samples *t*-test of these data indicated that participants' confidence significantly increased for 15 of the 16 domains subsequent

to participation in the 2016 MIPEP Summer Institute, with *practicing laboratory safety* the only process that did not demonstrate a statistically significant increase.

Open-ended questions on the *MIPEP Final Reflections Survey* asked participants about the extent to which the Summer Institute had increased their physics knowledge, as well as challenges they anticipated they might encounter in implementing their new physics content in their individual classrooms. Respondents described MEPEP as "an amazing learning experience," that had made them more confident in their understanding of physics; "the only physics content training available;" and "above and beyond what I expected." MIPEP professors were depicted as "entertaining," "helpful in answering questions," and "a special, incredible group of people!" In regard to perceived barriers in implementing their new physics content knowledge in the classroom, participants identified students' lack of mathematics content knowledge, participants' own weaknesses in mathematics, and lack of time as possible challenges.

Objective 2: Increase Participating Teachers' Understanding of Physics Concepts

The syllabus for the 2016 MIPEP Summer Institute included 20 physics concepts that were taught by TAMU physics professors in 1- to 3-hour blocks of time over the 2-week period: (a) vectors; (b) kinematics and graph analysis; (c) Newton's laws; (c) work, power, and energy; (d) work-energy theorem; (e) conservation of energy; (f) momentum, impulse, and conservation; (g) rotational motion; (h) modern physics and technology; (i) gravity and law of universal gravitation; (j) electrostatics; (k) current; (l) Ohm's law; (m) capacitors; (n) series & parallel circuits; (o) magnetic field; (p) electromagnetic induction; (q) oscillations and waves; (r) electromagnetic waves and optics; and (s) atomic, nuclear, and quantum physics. MIPEP master teachers reinforced the content instruction during *Discussion* and *Master Teacher Time* sessions.

Evaluation Questions

Researchers developed the following two questions related to increasing participating teachers' understanding of the physics concepts:

Q2.1. To what extent did participants' confidence in their ability to teach physics concepts increase as a result of their participation in the 2016 MIPEP Summer Institute?

Q2.2. What aspects of the content instruction did participants identify as most effective in increasing their knowledge base?

The following narrative discusses changes in MIPEP participants' knowledge levels in relation to the concepts that were taught during the 2016 Summer Institute, as well as changes in participants' confidence in their ability to teach these physics concepts. Participants' perceptions of the content instruction most effective in increasing participants' knowledge base are also examined.

Participants' Confidence in Their Ability to Teach Physics Concepts

Data used to examine quantitative changes in participants' confidence in their ability to teach physics concepts were collected using the *MIPEP Pre-* and *Post-Perceptions Surveys*. The perceptions surveys listed the 20 physics concepts taught during the 2016 Summer Institute and asked participants to rank their confidence levels in teaching those concepts, using a 4-point scale (1 = *Not at all confident*, 2 = *Somewhat confident*, 3 = *Confident*, and 4 = *Extremely confident*). Dependent samples *t*-tests were conducted to determine if participants' confidence levels changed significantly between administrations of the two surveys. Participants' confidence increased significantly for 15 of the 20 concepts after participating in the MIPEP Summer Institute. The dependent samples *t*-test results for confidence in teaching physics concepts can be found in Table 4.4.

Table 4.4

Dependent Samples t-test Results for Confidence in Teaching Physics Concepts

	Pre-survey		Post-survey		
Item	*M*	*SD*	*M*	*SD*	*t*
Vectors	2.50	0.92	3.61	0.50	-6.216***
Kinematics and graph analysis	2.56	0.70	3.44	0.62	-5.575***
Newton's laws	2.83	0.51	3.17	0.71	-1.558
Work, power, and energy	2.67	0.59	3.39	0.61	-3.424**
Work-energy theorem	2.22	0.65	3.39	0.61	-4.745***
Conservation of energy	2.56	0.51	2.61	0.85	-0.223
Momentum, impulse, and conservation	2.33	0.77	2.78	0.65	-1.641
Rotational motion: Kinematics and dynamics	1.67	0.69	3.39	0.50	-9.718***
Modern physics and technology	1.50	0.62	2.71	0.69	-5.996***
Gravity and Law of universal gravitation	2.29	0.92	3.17	0.71	-2.985**
Electrostatics	1.94	0.73	3.33	0.49	-8.444***
Current	2.28	0.75	2.39	0.61	-0.524
Ohm's Law	2.28	0.75	3.28	0.67	-5.532***
Capacitors	1.28	0.46	2.61	0.70	-8.246***
Series and parallel circuits	2.61	0.78	2.33	0.69	1.23
Magnetic field	1.83	0.79	3.11	0.68	-6.56***
Electromagnetic induction	1.44	0.51	2.89	0.58	-8.695***
Oscillations and waves	2.00	0.69	2.94	0.64	-4.274**
Electromagnetic waves and optics	1.83	0.79	3.50	0.51	-7.792***
Atomic, nuclear, and quantum physics	1.50	0.71	3.22	0.73	-6.803***

Source. MIPEP Pre/Post-Perception survey.

Note. Values for survey items are based on a 4-point scale, with 1 = *Not at all confident*, 2 = *Somewhat confident*, 3 = *Confident*, and 4 = *Extremely confident*; *p<.05, **p<.01, ***p<.001

Perceptions Regarding Effectiveness of Content Instruction

The 2016 MIPEP Summer Institute offered topic sessions encompassing each of the 20 physics concepts on which the institute focused. Subsequent to completing each topic session, participants were administered the *Topic Sessions Post-Survey,* a 13- question instrument that asked them to identify the extent to which they agreed to each statement regarding their perceptions of the session. Questions addressed presenters' effectiveness in discussing each topic; pedagogical rigor of session materials and

overall session timeframe; and participants' perceptions of the extent to which (a) they needed more instruction on the particular topic, (b) their confidence in teaching that particular topic had increased, and (c) they would able to incorporate that particular topic in their individual classrooms.

Responses to the questions were measured on a 4-point Likert-type scale (1 = *Strongly disagree,* 2 = *Disagree,* 3 = *Agree,* and 4 = *Strongly agree*). The mean scores for the majority of the survey items were between 3.0 and 4.0, indicating that the participants found the content sessions useful and applicable to their teaching. Two items, however, had mean scores slightly lower than 3.0 for many sessions, indicating participants were split between agreeing and disagreeing with those statements. These statements were related to whether the instructor used pedagogically sound teaching practices and whether the instructor used materials to support interactive learning. A mean score of less than 3.0 in most cases for the statement, "Overall, I still need more instruction regarding [the topic]," indicated that most participants did not believe additional content session time for the majority of the concepts was necessary. Of the 20 sessions, only one session had relatively low scores across post-survey items. Electrostatics had mean scores lower than 3.0 on six of the 13 items, indicating that participants were not in strong agreement regarding the overall quality of the session. The results of the *Topic Session Post Surveys* are presented in Tables 4.5–4.8.

Table 4.5

Content Sessions Post-Survey Results for Topics 1-5

Topic	Vectors (*n* = 18)		Kinematics and graph analysis (*n* = 18)		Newton's laws (*n* = 18)		Work, power, and energy (*n* = 17)		Work-energy theorem (*n* = 16)	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
The presenter was knowledgeable about the topic.	4.00	0.00	4.00	0.00	4.00	0.00	3.88	0.33	3.94	0.25
The presenter used examples to make the material easy to understand.	3.39	0.50	3.61	0.50	3.67	0.49	3.59	0.51	3.69	0.48
The presenter answered questions carefully and completely.	3.61	0.50	3.56	0.62	3.72	0.46	3.82	0.39	3.69	0.48
The presenter provided a through explanation of the topic.	3.50	0.62	3.78	0.43	3.83	0.38	3.59	0.51	3.81	0.40
The presenter applied pedagogically sound teaching practices during the session.	3.35	0.70	3.00	0.77	3.50	0.51	3.41	0.51	3.38	0.62
Participants were encouraged to generate ideas and questions about the topic.	3.78	0.43	3.56	0.62	3.72	0.57	3.53	0.51	3.63	0.50
The time frame allotted for the topic was appropriate.	3.39	0.61	3.22	0.65	3.61	0.70	3.12	0.86	3.19	0.75
The materials supported interactive learning.	2.94	0.94	2.94	0.80	3.13	0.96	3.41	0.71	3.31	0.60
Materials provided were useful to me in learning about the topic.	3.22	0.65	3.39	0.50	3.61	0.61	3.71	0.47	3.56	0.51
The materials enhanced my understanding of the topic.	3.35	0.49	3.50	0.62	3.67	0.59	3.53	0.51	3.60	0.51
Overall, I still need more instruction regarding the topic.	2.56	0.86	2.78	0.88	2.61	1.04	2.59	1.12	2.69	1.01
Overall, the instruction provided regarding the topic increased my confidence in teaching the topic.	3.28	0.57	3.17	0.86	3.44	0.62	3.47	0.51	3.38	0.72
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.11	0.83	3.11	0.90	3.44	0.62	3.59	0.51	3.38	0.72

Source. Content session post-survey.

Note. Values for survey items are based on a 4-point scale with 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, and 4 = *Strongly agree*.

Table 4.6

Content Session Post-Survey Results for Topics 6-10

Topic	Conservation of energy (*n* = 18)		Momentum, impulse, and conservation (*n* = 18)		Rotational motion: kinematics and dynamics (*n* = 18)		Modern physics and technology (*n* = 18)		Gravity and the law of universal gravitation (*n* = 18)	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
The presenter was knowledgeable about the topic.	3.94	0.24	3.89	0.32	3.83	0.38	4.00	0.00	3.93	0.26
The presenter used examples to make the material easy to understand.	3.72	0.46	3.61	0.50	3.33	0.59	3.61	0.50	3.67	0.49
The presenter answered questions carefully and completely.	3.78	0.43	3.61	0.50	3.44	0.51	3.61	0.50	3.72	0.46
The presenter provided a through explanation of the topic.	3.89	0.32	3.44	0.62	3.28	0.67	3.50	0.62	3.67	0.49
The presenter applied pedagogically sound teaching practices during the session.	3.67	0.59	3.39	0.61	3.28	0.57	3.17	0.62	3.22	0.65
Participants were encouraged to generate ideas and questions about the topic.	3.72	0.46	3.56	0.51	3.61	0.50	3.67	0.49	3.50	0.51
The time frame allotted for the topic was appropriate.	3.33	0.69	2.94	0.80	2.72	0.89	3.06	0.80	3.72	0.46
The materials supported interactive learning.	3.39	0.70	3.44	0.62	3.33	0.59	3.28	0.57	3.06	0.73
The materials provided were useful to me in learning about the topic.	3.67	0.49	3.44	0.62	3.28	0.67	3.28	0.57	3.39	0.61
The materials enhanced my understanding of the topic.	3.61	0.50	3.56	0.51	3.39	0.61	3.72	0.46	3.33	0.59

Overall, I still need more instruction regarding the topic.	2.50	1.25	2.72	1.13	3.44	0.62	3.33	0.59	2.50	0.86
Overall, the instruction provided regarding the topic increased my confidence in teaching the topic.	3.61	0.50	3.67	0.49	3.28	0.75	3.39	0.61	3.22	0.65
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.61	0.50	3.67	0.49	3.33	0.59	3.28	0.46	3.53	0.51

Source. Content session post-survey.

Note. Values for survey items are based on a 4-point scale with 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, and 4 = *Strongly agree*.

Table 4.7

Content Session Post-Survey Results for Topics 11-15

Topic	Electrostatics (*n* = 18)		Current (*n* = 18)		Ohm's law (*n* = 18)		Capacitors (*n* = 18)		Series and parallel circuits (*n* = 18)	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
The presenter was knowledgeable about the topic.	4.00	0.00	3.94	0.24	3.94	0.24	3.89	0.32	4.00	0.00
The presenter used examples to make the material easy to understand.	2.67	0.97	3.61	0.50	3.56	0.51	3.56	0.62	3.61	0.61
The presenter answered questions carefully and completely.	3.28	0.67	3.50	0.51	3.56	0.51	3.61	0.50	3.72	0.46
The presenter provided a through explanation of the topic.	3.22	0.65	3.50	0.51	3.72	0.46	3.56	0.51	3.61	0.50
The presenter applied pedagogically sound teaching practices during the session.	2.83	0.79	3.33	0.59	3.50	0.51	3.44	0.62	3.39	0.61
Participants were encouraged to generate ideas and questions about the topic.	3.33	0.69	3.50	0.51	3.61	0.50	3.44	0.62	3.61	0.50
The time frame allotted for the topic was appropriate.	3.06	0.73	3.50	0.51	3.56	0.51	3.50	0.51	3.61	0.50
The materials supported interactive learning.	2.50	0.79	3.28	0.75	3.39	0.61	3.06	0.73	3.00	0.97
The materials provided were useful to me in learning about the topic.	2.94	0.87	3.39	0.61	3.39	0.61	3.28	0.67	3.39	0.70
The materials enhanced my understanding of the topic.	3.00	0.84	3.47	0.62	3.56	0.62	3.39	0.50	3.39	0.61
Overall, I still need more instruction regarding the topic.	3.56	0.62	2.50	0.92	2.61	0.92	3.00	0.97	2.94	0.90
Overall, the instruction provided regarding the topic	2.67	0.91	3.50	0.62	3.50	0.62	3.39	0.70	3.50	0.71

increased my confidence in teaching the topic.										
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	2.89	1.02	3.44	0.62	3.44	0.62	3.33	0.69	3.39	0.70

Source. Content session post-survey.

Note. Values for survey items are based on a 4-point scale with 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, and 4 = *Strongly agree*.

Table 4.8

Content Session Post-Survey Results for Topics 16-20

Topic	Magnetic field (*n* = 17)		Electro-magnetic induction (*n* = 18)		Oscillations and waves (*n* = 17)		Electro-magnetic waves and optics (*n* = 17)		Atomic, nuclear, and quantum physics (*n* = 18)	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
The presenter was knowledgeable about the topic.	4.00	0.00	3.89	0.32	3.94	0.24	4.00	0.00	3.94	0.24
The presenter used examples to make the material easy to understand.	3.59	0.51	3.44	0.62	3.53	0.51	3.65	0.49	3.56	0.51
The presenter answered questions carefully and completely.	3.53	0.51	3.56	0.51	3.47	0.62	3.59	0.51	3.61	0.50
The presenter provided a thorough explanation of the topic.	3.65	0.49	3.61	0.50	3.65	0.49	3.53	0.51	3.61	0.50
The presenter applied pedagogically sound teaching practices during the session.	3.47	0.62	3.50	0.51	3.53	0.51	3.44	0.51	3.39	0.50
Participants were encouraged to generate ideas and questions about the topic.	3.53	0.51	3.50	0.51	3.65	0.49	3.53	0.51	3.72	0.46
The time frame allotted for the topic was appropriate.	3.35	0.49	3.33	0.69	3.35	0.61	2.94	1.03	3.06	0.94
The materials supported interactive learning.	3.47	0.51	3.33	0.77	3.53	0.62	3.35	0.49	3.17	0.62
The materials provided were useful to me in learning about the topic.	3.53	0.51	3.50	0.62	3.59	0.51	3.35	0.61	3.29	0.59
The materials enhanced my understanding of the topic.	3.59	0.51	3.44	0.62	3.53	0.51	3.53	0.51	3.35	0.49
Overall, I still need more instruction regarding the topic.	3.00	0.79	3.00	0.69	2.59	0.87	3.24	0.75	3.11	0.58
Overall, the instruction	3.41	0.62	3.22	0.81	3.47	0.51	3.56	0.51	3.44	0.51

provided regarding the topic increased my confidence in teaching the topic.										
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.35	0.70	3.22	0.94	3.53	0.51	3.44	0.51	3.39	0.50

Source. Content session post-survey.

Note. Values for survey items are based on a 4-point scale with 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, and 4 = *Strongly agree*.

In addition to the quantitative data, qualitative data were examined to address Objective 2, specifically question 2.3. One question on the *Final Reflections Survey* asked participants to describe aspects of the content instruction provided by MIPEP that they perceived as being most effective in increasing their physics content knowledge. Many responses to this question focused specifically on lectures, labs, or demos, while others identified a combination of features that made the experience effective in increasing participants' content knowledge.

One respondent to this question, for example, believed the lectures were the most valuable aspect of the MIPEP Institute:

> The aspects of the content instruction that were most effective in increasing my physics content knowledge were the lectures. It is hard to pinpoint lectures that had more effect than others, but the sheer amount of content in all of them was helpful. The ones that were most effective were the ones that came from topics that I enjoy covering, such as gravity, modern physics, and waves. However, the professor that put so much of their personality into the lectures made them effective (like Tatiana, Alexey, Toback, Macri, and Fry).

On the other hand, a second participant asserted as follows:

> The lectures were an excellent refresher of major concepts, which helped to clarify some misconceptions. But I think the demos and the teacher collaboration had the biggest impact because it gave me a chance to see implementation of the concepts.

Some participants expressed that the "labs" or "lab demos/experiments" were the most "helpful" aspect of the MIPEP experience. One respondent, for example, explained, "The labs were effective in having to apply the knowledge," and a second related, "The labs were useful because they stretched what we had brought with us and what we were learning, mainly because we were using different equipment and under someone else's instructions."

For some participants, the "meetings in the evening to discuss and collaborate," as well as the "master teacher time," when participants could "immediately implement those strategies," were the most valuable aspects of the institute. Other participants were enthusiastic regarding their opportunities to interact with the physics professors who "were very knowledgeable and helpful," who dealt effectively with "questions and misconceptions," and who "gave us time to work out a problem before going over it or would do it along with us." One respondent elaborated thus:

> The small group instruction with the various professors allowed for a dynamic conversation, which is how I learn best. I've read physics books over the years, but you cannot stop them in mid-argument and ask for clarification. Specifically, I learned a trig proof for incline problems I did not know, as well as expressions and derivations for electric fields in conductors.

Some participants described the institute's focus on application of physics concepts in response to this question, as the following responses illustrate: "Rotational motion and electrostatics, current. I really understand it . . . . I have the toolbox now to go forward on my own," "Magnetism and light, because I never knew anything about them," and "In depth information about magnetism and electricity. The reason behind specific notations in vectors, cross products, and dot products." One participant concluded, "The discussions of concepts was extremely helpful for me to get a deeper understanding to help explain things to my students.

Summary

Objective 2 addressed the extent to which the 2016 MIPEP Summer Institute was successful in enhancing participants' understand of physics concepts and in increasing participants' confidence in their ability to teach physics concepts. The TAMU physics professors taught 20 concepts over the 2-week Summer Institute, and the concepts were reinforced by the master teachers during informal discussion and master teacher sessions held in addition to the instructional sessions.

Data collected via the *MIPEP Pre-* and *Post-Perceptions Surveys* were examined to determine whether changes had occurred in participants' confidence in their ability to teach physics concepts. Results from a dependent samples *t*-test demonstrated significant increases in participants' confidence for 15 of the 20 concepts subsequent to participants completing the Summer Institute.

Following the completion of each topic session, participants were administered the *Topic Sessions Post-Survey* to examine their perceptions in regard to presenters' effectiveness, pedagogical rigor of session materials, the extent to which participants believed they needed more instruction on the particular topic, and participants' confidence in teaching that specific topic and in their ability to incorporate the topic in their individual classrooms. Responses were measured on a 4-point scale, with 1 = *Strongly disagree* and 4 = *Strongly agree.* The mean scores were between 3.0 and 4.0 for the majority of the

items, indicating that most participants agreed or strongly agreed with the statements, with the exception of the session on Electrostatics, which had mean scores below 3.0 on most items. In addition, a mean score of less than 3.0 in most cases for the statement, "Overall, I still need more instruction regarding [the topic]," indicated that most participants did not believe additional content session time for the majority of the concepts was necessary.

The *MIPEP Final Reflections Survey* was administered on the last day of the Summer Institute. This instrument consisted of open-ended questions designed to collect in-depth perceptual information from participants regarding their MIPEP experience. One survey question asked participants to describe aspects of the content instruction provided that they perceived as having been most effective. Responses to this question were divided, with participants primarily describing four separate features that they perceived as having been especially effective.

First, participants believed the lectures were a valuable component of MIPEP, specifically lectures provided by certain professors who "put so much of their personality into the lectures." Other participants pointed to the "lab demos/experiments" as the most helpful aspect of MIPEP, "stretching" participants' prior knowledge and providing opportunity for them to "apply the knowledge." Still other participants identified informal activities—such as "master teacher time," professors who "worked" problems along with the students," and evening meetings "to discuss and collaborate"—as particularly valuable. Finally, many respondents described the Institute's focus on the application of specific physics concepts as the most effectual component of MIPEP 2016, as this allowed them to gain "a deeper understanding" of how to effectively teach physics to their own students.

Objective 3: Assist Participating Teachers to Develop and Use Research-Based Instructional Strategies

The 2016 MIPEP Summer Institute curriculum included research-based instructional strategies to teach college-level physics topics, including lectures, demonstrations, and labs. In addition, master teachers provided pedagogical content strategies for the high school physics classroom.

Evaluation Questions

Researchers developed the following two evaluation questions related to assisting participating teachers to develop and use research-based instructional strategies:

Q3.1. What aspects of the instructional strategies training did participants identify as most effective in increasing their knowledge base?

Q3.2. What are potential barriers to implementation of research-based instructional strategies, as identified by participants in the 2016 MIPEP Summer Institute?

The following narrative discusses participants' perceptions of the potential effectiveness of the instructional strategies utilized and demonstrated during the 2016 MIPEP Summer Institute. In addition, participants' perceptions of possible challenges to implementation of research-based instructional strategies into the participants' own practices are described.

Instructional Strategies Identified as Effective

The evaluation team collected qualitative data to address Objective 3. First, Question 7 on the *MIPEP Final Reflections Survey* asked participants to reflect on the physics instructional strategies they had seen demonstrated during the 2016 Summer Institute and to describe the ones that they had found most effective in increasing their own knowledge base of instructional strategies to use in their individual physics classrooms.

The two master teachers demonstrated instructional strategies for teaching high school physics to students with a variety of ability levels, and many MIPEP participants believed these instructional strategies would be very valuable to them in their practice. One participant, for example, shared, "I loved learning about ways to help any students that seem to struggle with physics," and a second participant explained, "I believe that the diversity of ways that Paula and Janie and that the other teachers brought helped by showing [us] that there are 'many ways to skin a cat.'"

On the other hand, some respondents to this question enthusiastically pointed to "review aids for students," and "lab tools and toys," as physics instructional strategies that would be particularly helpful to them, as demonstrated by the following responses: "Paula did an awesome job giving us strategies such as the pocket reviews to help students study for physics," and "All of the ideas we were given about simple ways to verbally explain something and the 'toys' we were shown that we could use to physically/visually show our kids a certain topic. Stations and pocket reviews!" Finally, one participant elaborated thus:

> The content review stations will absolutely be a strategy that I will implement in my classroom. In addition, I've picked up "engage" ideas as well as discussions of specific lesson techniques with teachers who have more experience than I do.

In addition to the review aids and toys, many participants praised the "engagement ideas" and "common experiences" they were taught, as the following comments illustrate: "The pocket books, review strategies, lab tools and toys, and engagement strategies will be very effective in my classroom;" "The instruction strategies that were most effective was *[sic* the engagement part;" and "Paula and

Janie's engaging activities they showed us. They stressed the importance of creating a common experience." A final respondent explained:

> Paula and Janie were awesome about explaining the value of common experiences with us. I realized that I was relying on life experiences of my students to create connections instead of bringing an experience to my students, regardless of how simple or silly it may seem.

Some respondents believed the lectures were the most valuable instructional strategy demonstrated at MIPEP, with one participant simply stating, "Lecture! Wow!" Others, however, offered more illustrative comments, such as, "All the lectures putting all concepts in perspective," and the following testimony:

> I think that having the professors give us lectures on different physics topics was helpful because it helped me see what physics looks like in college, which I haven't really experienced. Having them explain these concepts really helped me develop my conceptual grasp of these topics, even if I couldn't understand everything they said.

Finally, many participants expressed that the labs and demos were the most valuable instructional strategy they had experienced during the 2016 Summer Institute. One participant, for example, praised both master teachers and professors for providing exemplary demos and labs:

> The incredibly large and diverse set of demos were most effective in increasing my knowledge base of instructional strategies, provided both by our wonderful master teachers and by the phenomenal professors. The labs done by Jonathan Perry were also incredibly helpful.

Other participants agreed with this statement. For example, one participant asserted, "[The] demos taught me a lot so I hope to bring that more into the classroom," and a final respondent enthused: "The demos were something I definitely think were effective. They explained the content while showing an application, something our students often need. Alexey and Tatiana were fantastic in instruction."

Perceived Barriers to Implementation of Instructional Strategies

Question 8 on the *MIPEP Final Reflection Survey* asked participants to discuss some possible barriers they believed they might face in implementing new instructional strategies from MIPEP 2016 into their individual classrooms. Some participants were confident that they would not encounter any challenges, as illustrated by the following responses: "None," "None, [I will] start using instructional strategies tools from Day 1," and "I think I can use almost everything!"

Some MIPEP participants, however, expressed that classroom management be a possible barrier to implementation of the instructional strategies learned at the Summer Institute. One respondent, for

example, shared a concern regarding employing stations in the classroom: "Keeping students on task when doing stations. Making sure students aren't moving forward or falling behind when changing from one station to another." Another respondent, however, who was also concerned about classroom management issues, related that s/he had learned some approaches to help if this problem should develop: "My class size will be increasing, and that is also a concern for implementing some of the strategies. However, I was given different behavioral modification ideas from Dr. Toback, the master teachers, and the other participants of MIPEP."

Other participants focused on challenges in implementing content from MIPEP, rather than implementing new instructional strategies, in response to this question. Most of these respondents were concerned about the availability of supplies and lack of funds with which to purchase them. "A possible barrier I might face in implementing the instructional strategies would come from monetary issues of getting the materials," said one respondent, and a second noted, "Just being able to get/make everything that we were shown (or a decent chunk of it at least)." A third participant, however, also concerned about lack of materials and equipment, ended on a more optimistic note:

> I'm at a very small school with limited resources. I furnished all of my classroom and lab supplies this year. I really believe my only barrier will be supplies to create these tangible experiences, and even then, Paula and Janie have given me an incredibly reasonably priced tool box to draw from.

Summary

Qualitative data from responses to open-ended questions on the *MIPEP Final Reflections Survey* were analyzed to address Objective 3. First, MIPEP participants were asked to reflect on the physics instructional strategies they had seen demonstrated during the Summer Institute and to describe the ones that they had found most effective in increasing their own knowledge base of instructional strategies to use in their individual classrooms.

Overall, participants believed the strategies that they had learned for differentiating instruction to meet the needs of students who "struggle with physics" would be very valuable to them in their practice. Some respondents specifically identified the "lab tools and toys," "review aids," and "engagement ideas" as strategies that would be valuable to them. Others, however, believed the "lectures on different physics topics," the "incredibly large and diverse set of demos," and the "incredibly helpful" labs were the most helpful strategies provided during the Summer Institute.

When asked to discuss some possible barriers they believed they might face in implementing new instructional strategies learned at MIPEP 2016 into their practice, some participants confidently asserted that they anticipated encountering no barriers. A few respondents, however, expressed that classroom

management might be a possible barrier to successful implementation of new instructional strategies, while others shared that limited money and other resources might negatively impact their ability to implement the instructional strategies learned at MIPEP into their individual classrooms.

Objective 4: Provide Laboratory-Based Learning Experiences

The 2016 MIPEP Summer Institute curriculum included laboratory-based learning experiences, led by physics faculty. In addition, summary and discussion sessions were provided, led by the master teachers.

Evaluation Questions

Researchers developed the following four evaluation questions related to the laboratory experiences provided by the 2016 MIPEP Summer Institute:

Q4.1. Do participants feel confident in their understanding of physics concepts as a result of their MIPEP 2016 laboratory experiences?

Q4.2. Do participants feel confident in their ability to teach physics concepts as a result of their MIPEP 2016 laboratory experiences?

Q4.3. What are potential barriers to implementation of the laboratory experiences in participants' own classrooms, as identified by participants?

In the following narrative, we discuss participants' post-laboratory experience confidence in (a) their understanding of physics concepts and (b) their ability to teach physics concepts. Finally, we explore participants' perceptions of potential challenges in the implementation of the laboratory experiences in participants' own classrooms.

Confidence in Understanding of Physics Concepts, Resulting from Laboratory Experiences

Question 51 of the *MIPEP Post-Perceptions Survey* asked participants to report their perceptions of the extent to which the laboratory-based experiences increased their self-confidence for understanding physics concepts. A mean score of between 3.0 and 4.0 indicates that participants agreed with this statement and implies that the laboratory experiences were effective in increasing participants' physics concept knowledge. The mean score and standard deviation for this item can be found in Table 4.9.

Table 4.9

Perceived Impact of Laboratory Experiences on Physics Content Knowledge

	Post-survey (n = 18)	
Item	*M*	*SD*
The laboratory experiences increased my understanding of physics concepts.	3.50	0.51

Source. MIPEP Post-Perception survey.

Note. Values for survey items are based on a 4-point scale: 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, and 4 = *Strongly agree.*

Confidence in Ability to Teach Physics Concepts, Resulting from Laboratory Experiences

Question 52 of the *MIPEP Post-Perceptions Survey* asked participants to share their perceptions of the extent to which the laboratory-based experiences from the Summer Institute had increased their confidence in teaching physics concepts. A mean score of between 3.0 and 4.0 indicates that participants agreed with this item and implies that the laboratory experiences were effective in increasing participants' confidence in teaching physics concepts. The mean and standard deviation for this item are depicted in Table 4.10.

Table 4.10

Impact of Laboratory Experiences on Confidence in Teaching Physics Concepts

	Post-survey (n = 18)	
Item	*M*	*SD*
The laboratory experiences increased my confidence in my ability to teach physics concepts.	3.39	0.70

Source. MIPEP Post-Perception survey.

Note. Values for survey items are based on a 4-point scale: 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Agree*, and 4 = *Strongly agree.*

Qualitative data were also examined to determine the extent to which participants believed the MIPEP 2016 laboratory experiences had increased their ability to teach physics concepts. Question 53 on the *MIPEP Post-Perceptions Survey* asked respondents to describe lab experiences from the 2016 Summer Institute that were most effective in increasing their understanding of how to use labs to enhance their students' comprehension of physics concepts. Many respondents to this question simply listed several different labs that they felt were most valuable, as the following responses demonstrate: "Force table, center of mass, kinematics minus the calculus derivation part, circuits. Essentially all were helpful;"

"Working with the power supply, oscilloscope, and Atwood machine;" and "The electrical measurements (circuits) lab and the center of mass lab and the force equilibrium lab."

Some participants, on the other hand, explained that although they had access in their schools to equipment to conduct the labs, lack of knowledge of how to use the equipment had prevented them from teaching the labs prior to MIPEP. Their MIPEP experiences, however, had given participants confidence and skills to attempt the labs. For example, one participant who believed the "force table activity" had been the most valuable, added, "We have the equipment, but I didn't know how to use it." A second teacher, who had "not been able to see the electronics labs EVER in action. Even in my college courses," bragged, "I have equipment, and I now know how to use it," and third teacher explained, "The labs also increased my confidence with the technology in the lab, since some of the equipment I was not familiar with or hadn't used since I was in high school." A final respondent enthused as follows:

> All of the labs were super helpful! I am excited about using the instruments from the first sets of labs that I know I have, but wasn't comfortable using before MIPEP, and I am excited about acquiring more equipment like was used in the second set.

Finally, some participants expressed that their MIPEP experiences overall had taught them how to use labs to teach physics concepts to their students. One participant, for instance, asserted, "[The experience] reinforced labs we already do. Helped with misconceptions/issues that might arise," while a second teacher noted, "The labs provided me an opportunity to talk through what I learned during the week and modeled for me how important it is to give students the same opportunity." A final respondent elaborated thus:

> I think that the labs helped me see what I know, what I didn't know, and what I thought I knew. Using different equipment and following someone else's instructions made me think through the activity differently than I would have on my own.

Barriers to Implementation of Laboratory Experiences

Question 54 on the *MIPEP Post-Reflections Survey* asked participants to identify potential barriers they believed they might face in replicating the MIPEP lab experiences in their own individual classrooms. As was the case in previous evaluations, responses to this question from the 2016 participants primarily fell into two categories: (a) lack of resources and (b) student knowledge levels/abilities.

Many participants expressed that the lack of resources, such as equipment and technology, in their schools and districts would create a barrier to implementation of MIPEP lab experiences in their individual classrooms. The following responses are illustrative of these participants' concerns: "Lack of equipment, resources to implement what I learned at MIPEP; for example, a multimeter;" "The second

lab day was frustrating. A lot of the equipment I just do not have access to;" and "Limited resources: Some of the technology is not available at my school."

Other respondents who expressed concern about access to equipment and other resources, however, were optimistic that they would be able to improvise. One participant, for example, explained, "Lack of equipment and a deeper understanding of the equipment. However, thanks to Jonathan's instructions and Paula's iTunes videos, that shouldn't be a problem if I acquire those instruments." A second respondent displayed the same can-do attitude: "Some possible barriers that I might face is the labs from Week 2: I don't have much of the equipment used. But I can do simple labs that Paula and Janie introduced to us, using minimal materials for circuits." Finally, one participant confidently asserted, "My main barrier is equipment, but I know that I can help students create connections with marbles and stop watches just as well as I can with PASCO cars and motion detectors."

Some MIPEP 2016 participants also expressed concern that their students' lack of knowledge and abilities would provide a barrier to implementing the lab experiences successfully. "There needs to be more labs that can be used for on-level students," one participant offered, while a second teacher said, "The labs are way above what my students are required to know. I would have liked an idea on how to make them more accessible to my students." Finally, one participant worried, "Careful planning and attention to detail is something my students do not really exhibit. As such, labs are not very effective if they are too complex or sensitive."

Summary

Hands-on laboratory experiences were an essential feature of the MIPEP 2016 Summer Institute. Objective 4 of the MIPEP evaluation study examined participants' confidence, subsequent to their laboratory experience, in (a) their understanding of physics concepts and (b) their ability to teach physics concepts. In addition, the evaluation explored participants' perceptions of potential challenges in the implementation of the laboratory experiences in participants' own classrooms.

The *MIPEP Post-Perceptions Survey* asked respondents to share their perceptions of the extent to which the MIPEP 2016 lab-based experiences had increased their confidence in their understanding of physics concepts. The mean score for this item (3.50) indicates that participants agreed with the item and implies that the lab experiences were effective in increasing participants' physics concept knowledge. A second question on the *MIPEP Post-Perceptions Survey* asked participants to share their perceptions of the extent to which the laboratory-based experiences had increased their confidence in teaching physics concepts. The mean score for this item (3.39) indicates that participants agreed with this item as well, and implies that the lab experiences were effective in strengthening participants' confidence in their ability to teach physics concepts.

When asked to identify specific laboratory-based experiences that were most effective increasing their understanding of how to use labs to enhance their students' comprehension of physics concepts, some participants listed a number of different labs, including the force table, center of mas, oscilloscope, and force equilibrium labs. Other participants, however, were more detailed in their responses, expressing that their MIPEP experience had given them the confidence to attempt the different labs or to use unfamiliar equipment and instruments. Finally, some participants asserted that the MIPEP experience overall had given them the skills to use labs as a tool for teaching physics concepts to their students.

Objective 5: Encourage and Facilitate Collaboration Among Physics Educators in Texas

The MIPEP program planners and facilitators strive to encourage a network of physics teachers across the state of Texas who collaborate and communicate with one another in order to enhance physics teaching and learning. The program utilizes a "train-the-trainer" model: The anticipated outcome is that teachers who attend the Summer Institute each year will return to their home campuses, confident in what they have learned and eager share their new knowledge with other physics teachers in their schools and districts.

Evaluation Question

Researchers developed the following evaluation question related to encouraging and facilitating collaboration of physics educators in Texas:

Q5.1. To what extent do participants intend to share the information gained through the 2016 MIPEP Summer Institute with colleagues on their individual campuses?

In the following narrative, we examine MIPEP 2016 participants' intents to disseminate their new understanding of physics concepts, as well as the labs and demos experienced at MIPEP, with colleagues at participants' home campuses.

Participants' Perceptions Regarding Intent to Collaborate

Question 9 on the *MIPEP Final Reflections Survey* asked the 2016 participants to describe ways in which they anticipated sharing what they had learned at the MIPEP Summer Institute with their colleagues. As the evaluation team found in previous MIPEP studies, some participants responded to this question by describing *what* they would share, rather than describing *how* they would share what they had learned,

as following comments demonstrate: "The videos of Tatiana's demos and some of the lecture videos will especially be helpful for the AP teachers;" "I am looking forward to. . .sharing techniques with other physics teachers at my school. The videos I recorded are definitely something I'd like to share;" and "Definitely the pocket reviews! The notes provided by the professors, for sure, since they have a lot of depth. All the ideas for how we can better show our kids physics with demos or visuals." Explaining that s/he was the only physics teacher on his/her campus, one respondent detailed plans to share what she had learned at MIPEP with teachers of other courses:

> I am the only teacher of physics at my school but I intend on showing the astronomy teacher the material we gained from lectures and the observatory, the teachers of IPC some of the demos for the physics portions of that class, and any teacher who will listen about how important getting students active and getting them talking is.

Other respondents excitedly shared their goals for *how* and *when* they would disseminate their new knowledge to their peers. One participant, for example, explained, "Sharing will be done during PLC time when we meet to plan our lessons," and a second enthused, "We meet during the summer and I plan to share all of it! The pocketbooks and stations will be the most applicable to my department." Other teachers offered comments such as, "Adapted Physics Shows—Vertical Teaming. This will go bigger than my campus. I plan to incorporate some of this into staff development," and "Specifically at my campus we lesson plan as a team; therefore, the MIPEP influence will make its way into the entire physics department lessons." A final participant elaborated on his/her anticipation of sharing MIPEP learning with colleagues thus:

> I can't wait to get back to school and share the importance of fun, excitement, and wonder with my colleagues. I look forward to modeling how to truly engage students and give them a chance to experience what we are learning.

Summary

Objective 5 of the evaluation of the 2016 MIPEP Summer Institute addressed the program planners' goal of encouraging and facilitating collaboration among physics teachers across the state of Texas. Qualitative data in response to this objective were collected via Question 9 on the *MIPEP Final Reflections Survey*: "What are some of the ways you anticipate sharing what you learned at the MIPEP Summer Institute with your colleagues on your campus?"

Overall, participants responded enthusiastically in response to this question. Describing *what* they would share, some respondents identified videos, pocket reviews, notes and lecture materials from professors, and demos. Other participants revealed that they planned to discuss MIPEP learnings with their colleagues during summer meetings and common lesson planning time and intended to

incorporate the new materials into staff development opportunities. Finally, some participants planned to use informal methods to share the MIPEP lessons with other teachers, as illustrated by the following comment: "[I'm] definitely going to get with my teachers and share as much as possible."

CHAPTER 5: Summary and Recommendations for Future Practice

This chapter presents an overall summary of the results from the evaluation study of the 2016 MIPEP Summer Institute, as well as recommendations for future practice.

General Summary

The Mitchell Institute Physics Enhancement Program (MIPEP) Summer Institute, initiated in 2012, was purposed to improve the mathematics and science performance of Texas high school students by providing rigorous professional learning opportunities for high school physics teachers from across the state. Representing an outreach effort and goal for the Department of Physics and Astronomy at Texas A&M University, coordinators and facilitators f the MIPEP Summer Institutes strive to recruit current high school physics teachers who have little to no background in physics.

All instruction and laboratory-based work for the 2016 MIPEP Summer Institute was provided on the Texas A&M University campus in College Station, Texas. Participants comprised 18 high school teachers from across the state of Texas.

The current evaluation study investigated the impact of the 2016 MIPEP Summer Institute, examining changes in participants' perceptions regarding their knowledge of, and confidence in teaching, physics concepts. Data for the mixed-methods study were collected via pre-and post-Institute perception surveys, post-session topic surveys, and final reflections survey.

Objective 1 of the 2016 MIPEP Summer Institute evaluation addressed the program's impact on physics teaching and learning in Texas. Qualitative and quantitative data to assess participants' perceptions of the extent to which the Summer Institute would benefit participants' physics instruction were collected through administration of three instruments developed for a prior evaluation study of the MIPEP Summer Institute: the *MIPEP Pre-Perceptions Survey,* the *MIPEP Post-Perceptions Survey,* and the *MIPEP Final Reflections Survey.* Although the *Pre-Perceptions Survey* and the *Post-Perceptions Survey* both contained the same 50 Likert-type questions, the *Post-Perceptions Survey* included two additional, open-ended questions.

The *MIPEP Pre-Perceptions Survey* and *MIPEP Post-Perceptions Survey* included seven survey items associated with participants' perceived needs for professional development related to content

knowledge, teaching strategies, and student-centered instruction. Results from a dependent samples *t*-test conducted on the seven items indicated that subsequent to the 2016 Summer Institute, participants perceived themselves as needing less professional development in four of the seven areas, with statistically significantly lower post-survey mean scores for professional development needs related to *deepening content knowledge, using inquiry/investigation-oriented teaching strategies, using technology for instructional purposes,* and *differentiating instruction for all students.* Results from a second dependent samples *t*-test conducted on the five survey items related to respondents' confidence in using specific teaching strategies revealed that participants' confidence had increased significantly for all five strategies subsequent to the 2016 Summer Institute. Finally, results from a dependent samples *t*-test conducted to determine if participants' confidence levels changed in relation to guiding and developing student learning in 16 domains of science processes indicated that participants' confidence significantly increased for 15 of the 16 domains following participation in the 2016 MIPEP Summer Institute. The only science process that did not show a statistically significant increase was *practicing laboratory safety,* which had a high pre-survey mean score.

Results from analysis of qualitative data collected via responses to open-ended questions on the *MIPEP Final Reflections Survey* indicated that participants believed that the 2016 Summer Institute had increased their physics content knowledge to a great extent. Respondents described MIPEP as "an amazing learning experience" and MIPEP professors as "a special, incredible group of people." MIPEP 2016 participants' perceptions regarding potential barriers to implementing their new physics content knowledge in the classroom were identified as students' lack of mathematics content knowledge, participants' own weaknesses in mathematics, and lack of time.

Objective 2 of the 2016 MIPEP evaluation study focused on the extent to which participants perceived the Summer Institute as having been successful in increasing their knowledge of physics content. Results from a dependent samples *t*-test of data collected via the *MIPEP Pre- and Post-Perceptions Surveys* demonstrated that participants' confidence in their ability to teach physics concepts had increased significantly for 15 of the 20 concepts subsequent to their completing the 2016 Summer Institute. Physics concepts that did not show a statistically significant pre- to post-survey increases were Newton's laws, conservation of energy, momentum/ impulse/conservation, series/parallel circuits, and current.

Subsequent to completing each topic session, participants were administered the *Topic Sessions Post-Survey* to examine their perceptions in regard to presenters' effectiveness, pedagogical rigor of session materials, the extent to which participants believed they needed more instruction on the particular topic, and participants' confidence in teaching that specific topic and ability to incorporate the topic in their individual classrooms. Responses indicated that, overall, most participants agreed or strongly agreed with the survey statements. A mean score of less than 3.0 in most cases for the statement, "Overall, I still need more instruction regarding [the topic]," indicated that most participants did not believe additional content session time for the majority of the concepts was necessary.

Question 5 of the *MIPEP Final Reflections Survey* asked participants to describe aspects of the content instruction provided by the Summer Institute that they perceived as having been most effective in increasing their physics content knowledge. Responses to this question were diverse, with four separate features primarily identified as having been particularly effective.

Some participants identified the lectures—particularly the lectures provided by certain professors—as an especially valuable component of the Summer Institute, while others believed the lab demos and the experiments were the most helpful aspect of MIPEP. Still other participants believed the informal MIPEP activities, such as "master teacher time" and evening meetings were especially valuable. Finally, many respondents indicated that the Institute's focus on specific physics concepts was the most valuable aspect in terms of increasing their content knowledge in physics.

Objective 3 of the 2016 MIPEP Summer Institute evaluation focused on the program's effectiveness in assisting participants to develop and use research-based instructional strategies in their own classrooms. Participant responses to open-ended questions on the *MIPEP Final Reflections Survey* provided data to address participants' perceptions regard the program's effectiveness in achieving this objective. Overall, participants believed that the strategies they had learned for differentiating instruction would be especially valuable to them in their teaching. In addition, some participants specifically identified "review aids," "lab tools," and "engagement ideas," as well as lectures on specific topics, the demos, and labs, as the instructional strategies that would be most useful to them.

MIPEP Final Reflections Survey respondents were also asked to identify potential barriers to implementation of the instructional strategies they had learned in MIPEP 2016. Some participants shared that limited money and lack of access to resources might be a challenge to overcome in successful implementation of the new strategies in their classrooms, as well as classroom management issues. Others, however, confidently expressed that they did not anticipate encountering any implementation challenges.

Objective 4 of the 2016 Summer Institute addressed participants' perceptions of the effectiveness of the formal and informal laboratory experiences provided by the TAMU physics professors and the master teachers. Specifically, evaluators examined participants' post-laboratory confidence in their understanding of, and ability to teach, physics concepts. Additionally, the evaluators explored participants' perceptions of challenges they anticipated they might face in the implementation of the laboratory experiences in their own teaching.

The *MIPEP Post-Perceptions Survey* asked respondents to share their perceptions of the extent to which the lab experiences had increased their confidence in their understanding of physics concepts. The mean score for this item (3.50) indicates that participants believed the laboratory experiences were effective in increasing their physics concept knowledge. A second question on the *Post-Perceptions*

survey queried respondents about their perceptions regarding the extent to which the laboratory-based experiences had increased their confidence in *teaching* physics concepts. The mean score for this question (*M* = 3.39) indicated that participants also believed the lab experiences increased their confidence in teaching physics concepts.

Analysis of the qualitative data collected via responses to *MIPEP Post-Perceptions Survey* open-ended questions indicated that, overall, participants were very enthusiastic about their lab experiences. Specific laboratory-based experiences that respondents believed were most effective in increasing their understanding of how to use labs as a strategy for increasing their students' comprehension of physics concepts included the force table, center of mass, oscilloscope, and force equilibrium labs. Some participants provided detailed responses, sharing that their MIPEP experiences had given them the self-assurance to attempt different labs in their teaching or had provided them with the self-confidence to use unfamiliar equipment and instruments.

Objective 5 of the 2016 MIPEP evaluation examined the program's potential effectiveness in encouraging and facilitating collaboration among physics teachers statewide. Question 9 on the *MIPEP Final Reflections Survey* asked respondents to share ways in which they anticipated sharing their learnings from the Summer Institute with their colleagues in their districts and on their campuses. For the most part, responses to this question were very positive. Some participants identified specific components of the MIPEP program that they planned to share, such as videos, pocket reviews, notes and lecture materials, and labs. Other participants revealed the different venues and times in which they anticipated disseminating MIPEP strategies and materials, such as pre-academic year meetings, common lesson planning times, and during staff development. Other respondents to this question planned to share their knowledge via informal methods.

Recommendations for Future Practice

Recommendations for future practice include the following:

- Incorporate ideas on how to formally and informally assess student understanding of physics content
- Include strategies for teaching students who have limited English proficiency
- Focus recruitment efforts on district and/or campus teams of physics teachers, whenever possible, to promote successful transfer of knowledge
- Provide follow-up and support to participants in the field, as they implement the new teaching strategies and content knowledge in their classrooms
- Encourage participants to explore effective ways to disseminate MIPEP learnings with their colleagues.

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