Evaluation of 2017 Mitchell Institute Physics Enhancement Program (MIPEP) Summer Institute

Prepared by
Education Research Center
at Texas A&M University

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TEXAS A&M UNIVERSITY

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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 2017 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 2017 MIPEP Summer Institute was found to include the following strengths:

- The 2017 Summer Institute was successful in increasing participants' confidence in their physics content knowledge
- The 2017 Summer Institute was successful in increasing participants' confidence in their ability to guide and develop student learning in domains of science processing
- The 2017 Summer Institute was successful in increasing participants' confidence in their ability to implement specific teaching strategies in their physics instruction

Key Recommendations

Primary recommendations include the following:

- 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
- Include strategies for teaching students who have limited English proficiency

Results of this study indicate that MIPEP continues to demonstrate potential to significantly and positively impact physics teaching and learning in Texas schools. As was reported in prior evaluations, participants of the 2017 Summer Institute exhibited very positive opinions regarding their MIPEP experiences and reported confidence in their ability to implement specific teaching strategies, in guiding and developing their students' learning in science processes, and in teaching physics concepts, subsequent to the Summer Institute. In addition, findings revealed that program participants planned to

disseminate to their colleagues the physics content knowledge, and instructional strategies and tools for teaching physics, they had learned at the MIPEP 2017 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 2017 to conduct an external evaluation of the 2017 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, 2017).

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, a visit to the TAMU cyclotron, etc.

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, the 2014 Summer Institute was comprised of 17 teachers, and the 2016 Summer Institute involved 18 teachers. The 2017 MIPEP Summer Institute included 23 teachers from 23 high schools in 23 different districts and 9 Education Service Center Regional areas. Table 1.1 provides demographic information regarding the 2017 participants.

Table 1.1

MIPEP 2017 Participant Demographics

Characteristics	*n*
Sex	
Female	19
Male	4
Ethnicity	
White, not of Hispanic descent	15
African American	4
Latino(a)	3
Asian	2
Number of college physics courses completed	
0–2	18
3–5	1
More than 5	2
Physics courses currently taught	
Conceptual Physics	5
On-level, math-based physics	17
Pre-AP Physics	8
AP Physics B	1
AP Physics C	0

Source. *MIPEP Perceptions Pre-Survey*.

Note. Ethnicity totals more than 23 because respondents could choose more than one response. Physics courses currently taught totals more than 23 because participants could select more than one answer.

CHAPTER 2: Evaluation Methods

Evaluation Questions

The evaluation of the 2017 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 2.1 provides the specific evaluation questions related to each of the five objectives.

Table 2.1

Evaluation Questions for 2017 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 MIPEP Summer Institute will positively benefit their physics instruction?
Q1.2. What are potential barriers to implementation of the content learned at the 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 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 MIPEP Summer Institute laboratory experiences?
Q4.2. Do participants feel confident in their ability to teach physics concepts as a result of their MIPEP Summer Institute laboratory experiences?
Q4.3. What are potential barriers to implementation of the 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 MIPEP Summer Institute with colleagues on their individual campuses?

Source. 2017 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 2017 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 2017 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 2017 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 2017 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 2017 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 2017 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 2017 Summer Institute with their colleagues on their individual campuses.

CHAPTER 3: 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 2017 MIPEP Summer Institute on physics teaching and learning in Texas:

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

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

The following narrative discusses 2017 MIPEP Summer Institute participants' perceptions of potential changes in their physics instruction resulting from their experiences in the 2017 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 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 2017 Summer Institute. All of the 2017 Summer Institute's 23 participants 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 2017 Institute. All 23 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 seven items to determine if participants' perceptions significantly changed as a result of participation in the 2017 MIPEP Summer Institute. Mean scores on three of the seven items decreased significantly ($p < .01$), indicating that participants' perceptions of their professional development needs in several areas changed following the 2017 MIPEP Summer Institute. At the end of the Institute, summer 2017 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*, and *differentiating instruction for all students.* Participants' perceived professional development needs related to *using culturally responsive teaching strategies* showed a statistically significant increase following the institute, while *using technology for instructional purposes, assessing student learning,* and *teaching students who have limited English proficiency* did not show statistically significant differences. High standard deviations across all items indicates a large degree of variability in participants' responses. Table 3.1 illustrates the dependent *t*-test results for participants' perceived need for professional development.

Table 3.1

Dependent t-test Results for Perceived Professional Development Needs

	Pre-survey (n = 23)		Post-survey (n = 23)		
Item	*M*	*SD*	*M*	*SD*	*T*
Deepening content knowledge	3.35	0.59	2.20	0.83	5.510**
Using inquiry/investigation-oriented teaching strategies	3.45	0.61	2.05	0.69	6.658**
Using technology for instructional purposes	2.75	0.91	2.25	0.91	2.032
Assessing student learning	2.65	0.75	2.35	0.81	1.241
Differentiating instruction for all students	2.95	0.95	2.20	0.89	3.000**
Teaching students who have limited English proficiency	2.80	0.95	3.10	0.64	-1.301
Using culturally responsive teaching strategies	2.55	1.00	3.50	0.51	-3.866**

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*; **$p < .01$.

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 2017 Summer Institute resulted in statistically significant changes in participants' confidence levels. Participants' confidence levels showed statistically significant increases ($p < .001$) for each of the five teaching strategies after participation in the summer institute. Similar to the professional development items, high standard deviations across the teaching strategies items indicates that there was a large degree of variability in participants' responses. Table 3.2 displays the dependent *t*-test results for participants' confidence in using physics teaching strategies.

Table 3.2
Confidence in Using Physics Teaching Strategies

Item	Pre-survey (*n* = 23)		Post-survey (*n* = 23)		
	M	*SD*	*M*	*SD*	*T*
Providing in-depth coverage of fewer physics concepts rather than shallow coverage of more physics concepts	1.95	0.95	3.35	0.59	-5.984**
Developing students' conceptual understanding of physics	2.35	0.75	3.35	0.67	-4.595**
Making connections between physics and other disciplines	2.50	0.95	3.40	0.60	-4.158**
Engaging students in applications of physics in a variety of contexts	2.25	0.79	3.20	0.83	-3.707**
Applying physics concepts to real life scenarios	2.40	0.75	3.30	0.57	-4.158**

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*; **$p < .01$.

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 10 of the 16 domains following the 2017 MIPEP Summer Institute ($p < .05$). The five processes that increased, but not significantly, were *creating hypotheses, collecting data, interpreting data, working collaboratively,* and *communicating findings through writing.* The mean score for the laboratory safety item showed a statistically significant decrease (pre-survey $M = 3.45$, post-survey $M = 2.95$). This decrease could possibly be attributed to lack of participant confidence with new equipment introduced during the institute. High standard deviations across the science processes items indicates a large degree of variability in participants' responses. The dependent *t*-test results for confidence in guiding and developing student learning in science processes are found in Table 3.3.

Table 3.3

Confidence in Guiding and Developing Student Learning in Science Processes

	Pre-survey (n = 23)		Post-survey (n = 23)		
Item	*M*	*SD*	*M*	*SD*	*T*
Conducting observations	2.85	0.81	3.55	0.51	-3.621**
Creating hypotheses	2.85	0.75	3.15	0.67	-1.371
Collecting data	3.16	0.50	3.26	0.56	-0.697
Interpreting data	2.75	0.64	2.80	0.95	-0.181
Drawing conclusions based on the data	2.70	0.73	3.30	0.57	-2.698*
Designing physics investigations	2.00	0.80	3.55	0.69	-6.941***
Conducting physics investigations	2.50	0.83	3.75	0.44	-6.140***
Working collaboratively	3.20	0.62	3.15	0.67	0.252
Practicing laboratory safety	3.45	0.61	2.95	0.76	2.127*
Using scientific technology	2.35	0.88	3.00	0.80	-2.096*
Communicating findings through writing	2.60	0.94	2.90	0.91	-1.031
Communicating findings orally	2.55	0.95	3.20	0.70	-2.557*
Reading scientific literature	2.50	0.95	3.50	0.61	-3.684**
Using technology to conduct research	2.35	0.88	3.55	0.61	-4.857***
Making connections within science	2.74	0.87	3.32	0.58	-2.480*
Making connections from science to other disciplines	2.63	0.96	3.26	0.65	-2.272*

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 7 on the *MIPEP Final Reflections Survey* ("Please think about the physics instructional strategies you learned in the MIPEP Summer Institute. Which aspects of the instructional strategies were most effective in increasing your knowledge base of instructional strategies?") and to Question 10 on the same survey (Is there anything else that you were like to share regarding the MIPEP Summer Institute?") further indicated that respondents believed participation in the Summer Institute would have a strong, beneficial impact on their classroom teaching. One participant, for example, enthused; "I'm on fire about physics—I can't wait to implement all I learned here! So excited to back and teach it!" Other teachers agreed, although in a slightly less emphatic manner. "This has been so vital to encourage me to improve as a physics teacher. I want to get to the level to teach AP Physics I. This course has encouraged me and improved my knowledge and pedagogy," explained one, while a second participant shared the following: "Thank you so much for the opportunity to participate in such an awesome program. I learned so much, but the connections and relationships will shape my future! Thanks!"

Other teachers offered more specific details regarding potential impact of MIPEP on their teaching practices, as demonstrated by the following responses: "Demos. There were so many for each concept that surely I can engage even the most reluctant students!" "The many demos shown have given me many ideas for increasing student interest.," and "I have a goal of providing more hands-on learning and inquiry-based discussions. The labs we went over and mini lab stations/rotations will help me improve my classroom atmosphere. Less teacher focus, more student focus!" Finally, one participant elaborated on MIPEP's potential impact on his/her teaching thus:

> Always question students during instruction. Try to have a demo to show the concept if possible. Always show them how to do the math associated with the concept. Mostly, just remember practice really does make perfect. [Provide] lots of practice problems.

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 perceived the 2017 Summer Institute as having had a powerful impact on their physics knowledge, as demonstrated by the following comment:

> I am so gratified that I was able to participate. Not only do I feel more confident about teaching physics, I gained more understanding about the subject matter, attained tons of resources for teaching it, and had lots of fun learning and making new friends.

Other respondents to this question agreed. One teacher, for example, shared: "This has been so vital to encourage me to improve as a physics teacher. This course has encouraged me and improved my knowledge and pedagogy," and a second teacher explained, "Having worked in small schools, I have always felt like I had no one to turn to with questions about physics concepts….I don't feel overwhelmed anymore, which is a great relief." A final respondent commented enthusiastically, "I'm on fire about physics—I can't wait to implement all I gained here! So excited to go back and teach it!"

Perceived Barriers to Implementation of Physics Content

Qualitative data were collected and analyzed to determine possible challenges MIPEP participants believed they might face in transferring their new physics knowledge into their teaching practice on their home campus (Evaluation Question 1.2). Respondents to Question 6 on the Final Reflections Survey were asked 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.

As found in prior MIPEP evaluation studies, many participants from MIPEP 2017 believed their students' lack of mathematics skills would pose the greatest challenge to participants' successful transfer of new physics content knowledge "Math is difficult for a lot of my students. I need to find ways to simplify the formulas for my students to get the material," said one survey respondent, while others shared, "Many

of my students do not have the math background," and "My students have very poor math skills." Noting that his/her students' math deficit were problematic, a final respondent added that student lack of motivation was a bigger challenge than lack of content knowledge: "My biggest barrier will be the intrinsic motivation of my students to learn. They have math deficits that can be overcome, but they lack the desire and I don't know how to overcome that." Conversely, some participants were concerned about their own content and pedagogical knowledge. "Being able to effectively explain the math to others," one teacher responded to this question, while another elaborated on her/his concerns thus:

> My starting skill level. There is a large gap between my knowledge and what was presented these past two weeks. When I go through a physics textbook (college level), I hope to merge what I have learned these past two weeks with what I already know.

Some respondents were concerned that "time restrictions and curricular requirements by the district" would prove a barrier to their success in implementing their new physics knowledge in their classrooms. "Lack of time (for prep and also time with students)" said one, and a second agreed: "Not having enough time. I feel as if I learned so much here at MIPEP. I just hope I will have enough time to cover it all."

Finally, several respondents theorized that "lack of materials to do the demonstrations" and "lack of much of the equipment, which we used in the laboratory at A&M," might create challenges to their ability to transfer their new learning into their classrooms, as the following responses indicated: "Sometimes I just need more lab equipment," "Unsure of equipment available (force tables, oscilloscopes, etc.," and "Our school lacks some of the equipment, but it is helpful to have a group to help with substitute ideas for lab equipment."

Summary

Evaluators examined the 2017 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-Surveys* 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 dependent *t*-tests indicated that subsequent to the 2017 Summer Institute, participants perceived themselves as needing less professional development in three of the seven areas, with statistically significant differences found for *deepening content knowledge, using inquiry/investigation-oriented teaching strategies,* and *differentiating instruction for all students.* Summer 2017 participants perceived a statistically significantly greater need for *using culturally responsive teaching strategies* following the institute.

Survey respondents were also queried regarding their confidence in their abilities to implement five specific teaching strategies in their physics instruction. The results of dependent samples *t*-tests on these items showed statistically significant increases in participant's confidence levels for all five strategies as a result of the 2017 Summer Institute.

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 results indicated that participants' confidence significantly increased for 10 of the 16 domains subsequent to participation in the 2017 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 2017 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 individually described MIPEP as "a fantastic and extremely valuable program," "the experience of a lifetime," and "just what I needed, and more!" Some asserted that they intended to recommend MIPEP to other teachers: "Excellent experience! I will highly encourage others to come," while others said they would recommend the TAMU physics program to their own students: "I have a new-found respect for the program here at TAMU and I will definitely recommend it to my students." Many respondents freely expressed their appreciation for the experience, commenting, "Aggie hospitality at its best in every way!" "Thank you notes, etc. are not sufficient to express my gratitude to every single individual!" and "Everyone was so great!" 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 physics, and lack of time, as well as lack of equipment, as possible challenges.

Objective 2: Increase Participating Teachers' Understanding of Physics Concepts

The syllabus for the 2017 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 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 2017 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

Quantitative data used to examine changes in participants' confidence in their ability to teach physics concepts were collected using the *MIPEP Pre-* and *Post-Perceptions Surveys*. The perceptions surveys provided participants with a list of the 20 physics concepts taught during the 2017 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 16 of the 20 concepts after participating in the MIPEP Summer Institute. Participants' confidence in teaching two concepts, *conservation of energy* and *momentum, impulse, and conservation,* decreased following the institute, but the decrease was not statistically significant. High standard deviations across all confidence items indicates a large degree of variability in participants' responses. The dependent *t*-test results for confidence in teaching physics concepts can be found in Table 3.4.

Table 3.4

Dependent t-test Results for Confidence in Teaching Physics Concepts

Item	Pre-survey (n = 23)		Post-survey (n = 23)		
	M	*SD*	*M*	*SD*	*t*
Vectors	2.65	0.75	3.50	0.61	-4.073**
Kinematics and graph analysis	2.30	0.87	3.20	0.77	-3.943**
Newton's laws	2.75	0.55	2.90	0.64	-0.825***
Work, power, and energy	2.45	0.61	3.25	0.64	-5.141***
Work-energy theorem	2.15	0.59	3.15	0.67	-6.892***
Conservation of energy	2.56	0.51	2.33	0.59	1.166
Momentum, impulse, and conservation	2.60	0.68	2.55	1.05	0.162
Rotational motion: Kinematics and dynamics	1.55	0.61	3.30	0.66	-8.596***
Modern physics and technology	1.55	0.69	2.75	0.79	-5.64***
Gravity and Law of universal gravitation	2.37	0.83	3.26	0.56	-4.164**
Electrostatics	2.15	0.59	3.30	0.66	-7.667***
Current	2.25	0.72	2.45	0.69	-1.073
Ohm's Law	2.40	0.68	3.20	0.52	-4.292***
Capacitors	1.45	0.61	2.80	0.62	-7.429***
Series and parallel circuits	2.55	0.76	2.70	0.66	-0.767
Magnetic field	1.90	0.64	3.05	0.69	-5.205***
Electromagnetic induction	1.60	0.75	3.05	0.69	-7.31***
Oscillations and waves	2.05	0.83	2.65	0.88	-2.449*
Electromagnetic waves and optics	1.75	0.64	3.25	0.72	-7.55***
Atomic, nuclear, and quantum physics	1.55	0.69	3.15	0.67	-7.193***

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 2017 MIPEP Summer Institute offered topic sessions addressing each of the 20 physics concepts on which the institute focused. Following 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 with 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 to be appropriately rigorous, pedagogically sound, useful, and applicable to their teaching. 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. High mean scores across all sessions, along with relatively low standard deviations, indicates a great deal of consistency across sessions conducted by different MIPEP faculty. Results of the *Topic Session Post Surveys* are presented in Tables 3.5–3.8.

Table 3.5

Content Sessions Post-Survey Results for Topics 1-5

Topic	Vectors (*n* = 23)		Kinematics and graph analysis (*n* = 20)		Newton's laws (*n* = 23)		Work, power, and energy (*n* = 23)		Work-energy theorem (*n* = 23)	
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	3.91	0.29	4.00	0.00	4.00	0.00
The presenter used examples to make the material easy to understand.	3.26	0.92	3.87	0.34	3.39	0.72	3.52	0.59	3.35	0.65
The presenter answered questions carefully and completely.	3.70	0.47	3.83	0.49	3.52	0.51	3.65	0.49	3.70	0.47
The presenter provided a thorough explanation of the topic.	3.57	0.73	3.80	0.63	3.57	0.66	3.61	0.58	3.74	0.54
The presenter applied pedagogically sound teaching practices during the session.	3.70	0.47	3.70	0.56	3.17	0.72	3.17	0.89	3.17	0.78
Participants were encouraged to generate ideas and questions about the topic.	3.78	0.42	3.83	0.39	3.35	0.57	3.57	0.51	3.39	0.50
The time frame allotted for the topic was appropriate.	3.22	0.67	3.65	0.65	3.39	0.58	3.30	0.77	3.43	0.73
The materials supported interactive learning.	3.48	0.67	3.57	0.66	3.09	0.73	2.91	0.75	2.83	0.78
Materials provided were useful to me in learning about the topic.	3.43	0.73	3.70	0.47	3.39	0.78	3.17	0.78	3.35	0.65
The materials enhanced my understanding of the topic.	3.59	0.59	3.70	0.47	3.57	0.59	3.35	0.65	3.39	0.72
Overall, I still need more instruction regarding the topic.	2.96	0.88	2.83	0.94	2.96	0.88	2.96	0.88	3.00	0.80
Overall, the instruction provided regarding the topic increased my confidence in teaching the topic.	3.35	0.83	3.70	0.47	3.43	0.66	3.30	0.70	3.30	0.77
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.26	0.69	3.65	0.49	3.41	0.59	3.43	0.59	3.30	0.64

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 3.6

Content Session Post-Survey Results for Topics 6-10

Topic	Conservation of energy (*n* = 22)		Momentum, impulse, and conservation (*n* = 22)		Rotational motion: kinematics and dynamics (*n* = 22)		Modern physics and technology (*n* = 23)		Gravity and the law of universal gravitation (*n* = 23)	
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	3.91	0.29	3.86	0.35	4.00	0.00
The presenter used examples to make the material easy to understand.	3.86	0.35	3.77	0.43	3.68	0.48	3.50	0.51	3.87	0.34
The presenter answered questions carefully and completely.	3.82	0.40	3.77	0.43	3.64	0.49	3.55	0.60	3.83	0.49
The presenter provided a thorough explanation of the topic.	3.77	0.43	3.73	0.46	3.14	0.83	3.68	0.48	3.80	0.63
The presenter applied pedagogically sound teaching practices during the session.	3.82	0.50	3.64	0.66	3.41	0.73	3.36	0.73	3.70	0.56
Participants were encouraged to generate ideas and questions about the topic.	3.82	0.40	3.68	0.48	3.45	0.67	3.36	0.79	3.83	0.39
The time frame allotted for the topic was appropriate.	3.55	0.60	3.45	0.67	2.36	1.00	3.64	0.58	3.65	0.65
The materials supported interactive learning.	3.59	0.67	3.36	0.66	3.23	0.69	3.32	0.65	3.57	0.66
Materials provided were useful to me in learning about the topic.	3.68	0.72	3.77	0.43	3.59	0.59	3.45	0.51	3.70	0.47
The materials enhanced my understanding of the topic.	3.77	0.61	3.82	0.40	3.50	0.60	3.50	0.51	3.70	0.47
Overall, I still need more instruction regarding the topic.	3.09	0.75	3.09	0.87	3.32	0.65	3.09	0.81	2.83	0.94

Overall, the instruction provided regarding the topic increased my confidence in teaching the topic.	3.64	0.49	3.64	0.49	3.27	0.70	3.50	0.51	3.70	0.47
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.45	0.60	3.50	0.51	3.45	0.51	3.41	0.50	3.65	0.49

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 3.7

Content Session Post-Survey Results for Topics 11-15

Topic	Electrostatics (*n* = 23)		Current (*n* = 22)		Ohm's law (*n* = 22)		Capacitors (*n* = 22)		Series and parallel circuits (*n* = 22)	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
The presenter was knowledgeable about the topic.	3.96	0.21	3.95	0.21	3.91	0.29	3.91	0.29	4.00	0.00
The presenter used examples to make the material easy to understand.	3.78	0.52	3.82	0.40	3.39	0.72	3.68	0.48	3.82	0.40
The presenter answered questions carefully and completely.	3.91	0.29	3.86	0.35	3.52	0.51	3.77	0.43	3.95	0.21
The presenter provided a thorough explanation of the topic.	3.91	0.29	3.86	0.35	3.57	0.66	3.64	0.49	3.86	0.35
The presenter applied pedagogically sound teaching practices during the session.	3.74	0.45	3.64	0.49	3.17	0.72	3.55	0.51	3.73	0.46
Participants were encouraged to generate ideas and questions about the topic.	3.83	0.39	3.73	0.46	3.35	0.57	3.59	0.50	3.86	0.35
The time frame allotted for the topic was appropriate.	3.35	0.71	3.59	0.50	3.39	0.58	3.27	0.88	3.59	0.59
The materials supported interactive learning.	3.70	0.64	3.59	0.73	3.09	0.73	3.45	0.74	3.68	0.57
Materials provided were useful to me in learning about the topic.	3.83	0.39	3.82	0.40	3.39	0.78	3.59	0.50	3.77	0.43
The materials enhanced my understanding of the topic.	3.83	0.39	3.73	0.46	3.57	0.59	3.50	0.74	3.77	0.43
Overall, I still need more instruction regarding the topic.	3.09	0.85	2.95	0.95	2.96	0.88	3.23	0.69	2.82	0.91
Overall, the instruction provided regarding the topic	3.61	0.58	3.68	0.48	3.43	0.66	3.36	0.66	3.55	0.51

increased my confidence in teaching the topic.										
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.65	0.57	3.68	0.48	3.41	0.59	3.36	0.58	3.73	0.46

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 3.8

Content Session Post-Survey Results for Topics 16-20

Topic	Magnetic field (*n* = 22)		Electro-magnetic induction (*n* = 22)		Oscillations and waves (*n* = 22)		Electro-magnetic waves and optics (*n* = 23)		Atomic, nuclear, and quantum physics (*n* = 23)	
Item	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
The presenter was knowledgeable about the topic.	3.86	0.35	3.86	0.35	3.82	0.40	3.96	0.21	4.00	0.00
The presenter used examples to make the material easy to understand.	3.50	0.51	3.50	0.60	3.59	0.50	3.78	0.52	3.87	0.34
The presenter answered questions carefully and completely.	3.55	0.60	3.41	0.67	3.45	0.60	3.91	0.29	3.91	0.29
The presenter provided a thorough explanation of the topic.	3.68	0.48	3.59	0.50	3.68	0.48	3.91	0.29	3.78	0.42
The presenter applied pedagogically sound teaching practices during the session.	3.36	0.73	3.27	0.70	3.32	0.72	3.74	0.45	3.74	0.45
Participants were encouraged to generate ideas and questions about the topic.	3.36	0.79	3.32	0.78	3.36	0.73	3.83	0.39	3.83	0.39
The time frame allotted for the topic was appropriate.	3.64	0.58	3.27	0.83	3.50	0.60	3.35	0.71	3.13	0.87
The materials supported interactive learning.	3.32	0.65	3.23	0.75	3.32	0.72	3.70	0.64	3.64	0.66
Materials provided were useful to me in learning about the topic.	3.45	0.51	3.32	0.57	3.55	0.51	3.83	0.39	3.74	0.54
The materials enhanced my understanding of the topic.	3.50	0.51	3.41	0.67	3.59	0.50	3.83	0.39	3.70	0.47
Overall, I still need more instruction regarding the topic.	3.09	0.81	3.32	0.78	2.86	0.77	3.09	0.85	3.26	0.75
Overall, the instruction	3.50	0.51	3.27	0.70	3.45	0.51	3.61	0.58	3.52	0.67

provided regarding the topic increased my confidence in teaching the topic.										
Overall, I can incorporate the instructions provided regarding the topic in my classroom.	3.41	0.50	3.27	0.70	3.55	0.51	3.65	0.57	3.52	0.67

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*.

Qualitative data were also examined to address Objective 2, specifically to address question 2.3. Question 5 on the *Final Reflections Survey* asked participants to describe the aspects of the content instruction provided by MIPEP that they perceived as being the most effective in increasing their physics content knowledge. Many responses to this question focused specifically on the "knowledge of the lecturers," and "lectures on higher level physics" in response to this question. Other respondents were more detailed in their discussions regarding the lectures, as illustrated by the following examples: "Being able to sit in lectures, hear the physicists' explanation, and being able to ask questions for my own misconceptions helped me the most," "The lectures had a lot of impact within the context of vertical alignment. I am not sending my students equipped to be successful," and "Each professor explained how many of the physics topics were connected in conceptual terms and mathematically. They all made it not so difficult to make those connections for my students."

Many other respondents enthusiastically shared that the "detailed explanations of mathematical equations to add on to concepts" and "seeing how the math all ties together" had been "immensely helpful" to them. Moreover, the participants especially appreciated the opportunity to practice mathematical problems under the tutelage of the MIPEP instructors, as the following responses indicate: "Practicing problems on the board with the professors," "Doing problem after problem," and "Working through the example problems."

A few respondents identified demonstrations and labs at MIPEP as the most effective component in increasing their physics content knowledge. For example, one respondent noted, "The demos and labs were especially effective," while others pointed to "Demonstrations and materials from master teachers," "Demonstrations with explanations," and "The demos/labs that are cheap (easy on the budget!) and easy to make" in response to this question.

Finally, some participants praised the institute's focus on application of specific physics concepts in response to this question, as the following responses illustrate: "I learned more about vectors and especially electromagnetism," "The electric/magnet sessions were most helpful," and "I really felt that going through all of the topics—mechanics, electricity, etc., was beneficial. I can now see the relationships between each topic." One participant concluded thus:

> Going over topics, such as capacitors, flux, and quantum and atomic physics [was the most effective aspect]. I didn't know too much about those concepts, so I'm really glad we went over them. I also had no idea how important and relevant semiconductors are.

Summary

Objective 2 addressed the extent to which the 2017 MIPEP Summer Institute was successful in enhancing participants' understanding of physics concepts and in increasing participants' confidence in their ability to teach physics concepts. The MIPEP faculty taught 20 concepts over the 2-week Summer Institute, with reinforcement provided 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 participants' confidence in their ability to teach physics concepts changed over the course of the institute. Dependent samples *t*-test results demonstrated that participants' confidence increased significantly for the majority of the concepts addressed, with 16 of the 20 concepts showing statistically significant increases in mean confidence scores upon completion of the 2017 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 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 all items with the exception of one, indicating that most participants agreed or strongly agreed with the statements. The one exception to high mean scores was a mean of less than 3.0 in most cases for the statement, "Overall, I still need more instruction regarding [the topic]," indicating that most participants did not believe additional content session time for the majority of the concepts was necessary.

Participants completed the *MIPEP Final Reflections Survey* 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. Question 5 asked participants to describe aspects of the content instruction provided that they perceived as having been most effective. Although participants provided varied responses to this question, the responses addressed four separate features that they perceived as having been especially effective.

First, participants perceived the" lectures, history, content explanations from professors" as having been a valuable component of MIPEP, particularly the "lectures on higher level physics." Other participants

pointed to the experience of "working through physics problems" as the most helpful aspect of MIPEP, particularly in regard to "Professors reviewing concepts, giving us practice problems, and then answering questions." Finally, some respondents described the "demos and labs," as well as the Institute's focus on the application of specific physics concepts and the ways in which those concepts were linked, as the most effectual component of MIPEP 2017, as they made it easier "to make those connections for [their] students."

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

The 2017 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 MIPEP Summer Institute?

The following narrative discusses participants' perceptions of the potential effectiveness of the instructional strategies utilized and demonstrated during the 2017 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

Qualitative data were collected 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 2017 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.

Many respondents to this question enthusiastically identified the demos as an important instructional strategy that they planned to implement in their own classrooms. "I think probably the demos. I know many are simple but can cover many topics," one teacher responded, while a second teacher enthused, "The demonstrations were inspiring!" Some participants believed the demos would be especially helpful in illustrating physics concepts for their students. For example, one teacher explained, "Try to have a demo to show the concept if possible, and a second teacher agreed: "One of the best things is to be able to incorporate the concepts to the math and illustrate with demos." A third participant detailed how the use of demonstrations could help students recognize physics in their everyday lives:

> [The] formal physics labs are helpful but equally so are the Demo/cheap illustrations of physics concepts. I think using everyday materials draws students into the realm of physics with its familiarity and also assists students with connecting everyday events with physics.

Other respondents believed that using the demonstrations in their classrooms would increase student interest and engagement, as illustrated by the following comments: "The many demos shown have given me many ideas for increasing student interest," "I loved the demos and I feel those will help me engage and explain better," and "Demos. There were so many for each concept that surely I can engage even the most reluctant students!"

Some participants believed the focus on "stations" would be a valuable instructional strategy in their classrooms. For example, one participant shared, "I have a stronger feel for how to do stations," and a second participant agreed: "The…mini lab stations/rotations will help me improve my classroom atmosphere. Less teacher focus, more student focus!"

Finally, some respondents shared that "all the activities we went over" were valuable in increasing their knowledge of effective instructional strategies to implement in their physics classrooms. For example, one teacher asserted, "I felt everything we did was valuable. My understanding increasing will help my students' understanding increase," and a second teacher concurred: "All of them. It was good to hear of strategies each of us use, and the roadblocks we encounter." A final participant explained that experiencing the different strategies together had been key for him/her:

> For me, I needed the combination [of strategies] that was provided. I felt the lectures, demos, and labs together made the knowledge effective. Unfortunately, I cannot isolate one single component; for me, all strategies were inter- and intra-dependent. The symbiosis was key.

Perceived Barriers to Implementation of Instructional Strategies

Qualitative data regarding possible barriers MIPEP 2017 participants believed they might face in implementing new instructional strategies in their individual classrooms were collected via answers to

Question 8 on the *MIPEP Final Reflection Survey.* Some participants were confident that they would not encounter any challenges, as illustrated by the following responses: "N/A," "I don't see any barriers, really," and "None. The only barrier would be me." Sharing that personal insecurity might create a potential barrier, one respondent concluded that the Summer Institute had helped eliminate some of that self-doubt:

> Being absolutely sure that what I am doing is correct. So my fear is a potential barrier. I do have people to assist with the math, but I am less confident with the overall picture. However, the Institute has definitely helped to curtail some of my fears.

Some teachers however, believed they might encounter barriers in attempting to integrate the new strategies into their instruction. The "very different levels of math capabilities" among students was identified by many of these teachers as a potential roadblock. For instance, one teacher noted, "Some of the students are not as advanced to be able to implement certain mathematical problems," and another respondent explained, "Math capabilities. In a small, rural school, one will not find differentiation among AP—SPED separated into different classes. Each teacher must address all student levels in ~40 minutes." Admitting that "Obviously, the things we do as teachers to elicit interest in physics is paramount," a final teacher asserted: "I think the vast differences in student levels at school, as well as the interest by students in various subjects is problematic."

Finally, lack of materials and equipment, as well as lack of money to buy them, were also mentioned frequently as potential roadblocks. One respondent, for example, noted, "Obtaining all the materials. Most things I was shown I have, but some things I don't," while others pointed to the "Cost of some of the demos," and "Budget constraints for some equipment." Although concerned about budget constraints, still other teachers, however, believed that the Institute had demonstrated economical ways to acquire materials: "Demos on a budget will be key. School has no money; I have to buy my own supplies," declared one teacher, and another teacher concurred: "Cost of materials. My physics budget is $100.00. So the rest comes out of my pocket. The 'toybox' will help tremendously." Finally, one teacher asserted, "Normally, the answer to this question would be money, but MIPEP did an excellent job at providing zero-budget strategies."

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 2017 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 were "inspired by the instructors' enthusiasm" and believed the physics instructional strategies that they had learned would be very valuable to them in their classrooms. Some respondents specifically identified the demonstrations and "lab stations/rotations" would increase student engagement and interest, when implemented in the classroom. Others believed that learning how to use inexpensive, "every day materials" in their physics classes would enhance their teaching and help their students connect physics with their everyday lives.

When participants were asked to describe some possible barriers they believed they might face in implementing new instructional strategies learned at MIPEP 2017 into their practice, a few asserted that they anticipated few or no challenges. Some participants, however, expressed that the "vast differences" in student ability levels, and lack of materials and equipment—and money with which to purchase them—would create possible barriers to successful implementation of the new instructional strategies. Among the respondents who were concerned about budgets, however, were several who believed that the information on developing inexpensive demos and materials would help offset that concern.

Objective 4: Provide Laboratory-Based Learning Experiences

The 2017 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 2017 MIPEP Summer Institute:

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

Q4.2. Do participants feel confident in their ability to teach physics concepts as a result of their MIPEP 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 3.9.

Table 3.9
Perceived Impact of Laboratory Experiences on Physics Content Knowledge

	Post-survey	
Item	*M*	*SD*
The laboratory experiences increased my understanding of physics concepts.	3.33	0.58

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* focused on participant perceptions of the extent to which the laboratory-based experiences from the 2017 Summer Institute increased their confidence in teaching physics concepts. Similar to the prior question, 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. A mean of 3.29 indicates that summer 2017 participants were slightly less confident in their ability to teach the concepts than they were in their own knowledge of concepts. Similar to the previous item, a relatively high standard deviation indicates a large degree of variability across respondents. The mean score and standard deviation for this item are depicted in Table 3.10.

Table 3.10
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	0.64

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 2017 laboratory experiences had increased their ability to teach physics concepts. First, Question 53 on the *MIPEP Post-Perceptions Survey* asked respondents to describe lab experiences from the 2017 Summer Institute that were most effective in increasing their understanding of how to use labs to enhance their students' comprehension of physics concepts.

Some respondents to this question were unable to identify which individual lab experiences from MIPEP 2017 were more effective than others. For example, one teacher asserted, "All of them—seriously," and a second participant agreed: "Really, all of them helped. The formal labs as well as the time spent with the physics demos were mostly all new to me." A third teacher, who also believed that all of the labs were effective, elaborated thus:

> I found all of the labs helpful. As well as the demonstrations and the lectures and the tours, all was helpful to help me understand the concepts and connections between the concepts, so I can better explain it to my students.

One teacher, however, believed all the labs were effective but offered a suggestion for making them more transferrable to the secondary classroom: "We only have 50 minutes in which to conduct labs, so it might have been helpful to see how to break up a lab into smaller pieces."

A few participants, on the other hand, explained that although they had had access in their schools to equipment needed to conduct the labs, lack of knowledge and/or confidence had prevented them from teaching the labs prior to MIPEP. Their MIPEP experiences, however had given these participants skills and assurance to attempt the labs. One participant, for example, who had "tried to use multimeters before but couldn't get good results," reported that s/he had "enjoyed using the multimeter and oscilloscope," and a second teacher shared that s/he "appreciated getting to use all the different equipment," at the Summer Institute, and added, "I am pretty sure we have almost all of it [lab equipment], but I have not used all of it. This gave me a chance to know if I was using it correctly."

Many respondents to this question simply listed several different labs that they felt were most valuable, as the following responses demonstrate: "The force table and the torque lab;" "Motion labs, electricity, and magnetism;" and "Working with the logger probe and sensors, inputting data into Excel. Utilizing the oscillator and wave generator were interesting." Other respondents expanded on *why* they believed

certain labs were more valuable than others.; i.e., how the labs could be transferred to the respondents' classrooms. For example, one teacher explained, "I really enjoyed the electricity lab. The level of inquiry was such that I can easily incorporate it into the curriculum and will be doing so." Another participant concluded, "I think Week 1, force balance, was very helpful for students to practice adding component vectors," while a third teacher shared, "Many of the labs helped me to understand physics concepts. I think they will be helpful to my students, and I plan to implement as many as possible."

A final respondent detailed how the labs could be used to initiate class discussions:

> This last Friday we participated in a lab dealing with both parallel and series circuits. The data collected from both helped me understand the relationship between different kinds of circuits with current, voltage, and resistance. This would be a great intro lab before a discussion on formulas.

Barriers to Implementation of Laboratory Experiences

Qualitative data regarding potential barriers to replication of 2017 MIPEP lab experiences in participants' individual classrooms were collected via Question 54 on the *MIPEP Post-Reflections Survey.* Responses to this question primarily fell into two themes: (a) lack of resources and (b) student knowledge levels/abilities.

For many MIPEP participants, lack of resources, such as equipment and materials as well as money to purchase them, loomed as the greatest challenge to implementing the physics labs in their classrooms. The following responses are illustrative of these respondents' concerns: "Lack of funding for materials; i.e., power supply, oscillators;" "Not having the equipment available on my campus;" "The only real obstacle I foresee is lack of equipment;" and "Equipment/tools. Primarily computers for analysis. We have a set of monitors for motion, pH, temp., etc., but have no student laptops (or any computer) on which to graph and analyze data." A final respondent elaborated on his/her concerns related to lack of resources thus:

> Most definitely the biggest barrier will be related to the equipment. Hopefully, we will have the technology to run the experiments and collect data, but I will have to do a thorough inventory to check if we have all the equipment such as an Atwood machine, force table, and oscilloscope.

Some respondents who expressed concern about access to equipment and other resources, however, were optimistic that they could overcome those challenges. One participant, for example, explained, "Lack of equipment is usually a challenge. However, the few pieces of equipment that I did not know how to use will now be used, since I was able to learn a lab with them here." Other participants demonstrated the same confident attitude: "I don't have the equipment or the money to buy the

equipment to do the other labs. But I have found alternative ways to show the same concept," said one, while a second asserted, "Lack of equipment maybe, but for the most part, I could adapt these labs as needed for my students." And although his/her school didn't have the necessary equipment to replicate the labs, a final respondent believed the materials could obtained from another source: "No equipment. However, I did learn that my Regional Service Center is supposed to have a physics kit, so that may be available."

We found, also, that some of the survey respondents were concerned that their students' lack of knowledge and abilities would create a barrier to implementing the lab experiences in participants' classrooms. One teacher, for example, expressed concern with teaching the labs in classes with English learner students, noting, "I have no ELL experience in labs." A second teacher worried about his/her students' proficiency in mathematics, explaining, "The biggest barrier I see would be a math deficiency. My students just have not shown me they are capable of graphical analysis, and I worry about the time it would take to remediate them to that level." Still another participant expressed that his/her students' "lack of familiarity with lab procedures" would present a barrier to success implementation of the labs:

> Many see lab time as "fun," and getting them to make the connection between concepts/math at their desks with seeing the concepts in action is difficult. I struggle with getting students beyond the action of the labs to the "fun" of seeing put together with what they learned at their desks.

Summary

Hands-on laboratory experiences were an essential feature of the MIPEP 2017 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 2017 lab-based experiences had increased their confidence in their understanding of physics concepts. The mean score for this item (3.33) indicates that the majority of 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 ite
m (3.29) indicates that most 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. High standard deviations for both items indicate some variation in participants' levels of

confidence in their own knowledge of the topics, as well as in their confidence to teach the topics to students.

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, multimeter, torque, and meter stick center of gravity labs. Other participants, however, provided more detailed responses, expressing that all of the lab experiences had been effective, and that MIPEP had increased their skills and confidence to such an extent that they felt comfortable in their ability to implement the labs in their own classrooms. Finally, although participants identified the lack of resources and deficits in students' knowledge levels and abilities as two potential barriers to implementation of the MIPEP labs in their own classrooms, overall, they appeared confident in their ability to overcome those challenges.

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 2017 MIPEP Summer Institute with colleagues on their individual campuses?

In the following narrative, we examine MIPEP 2017 participants' intention 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 2017 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: "I will create demos and share with them. I will share lab ideas and instructional materials from Paula," "I will definitely share my new knowledge with our math teacher/coach. I hope to discuss vectors with him. I believe he and I can collaborate with no problem," and "Before I came to the Institute, I had informed my physics teammates of the program. I will definitely share material and information with them."

Other respondents, however, enthusiastically shared their goals for *how* and *when* they would disseminate their new knowledge to their peers. Some participants planned to disseminate learning from MIPEP during the different meetings in which educators on their campuses and in their districts participated. For example, some teachers planned to share during Professional Learning Community meetings on their campuses: "I will share my experience here with my colleagues during PLC meetings to help plan lessons," said one teacher, and a second teacher noted, "I will help give the same ideas during our PLC."

Some teachers planned to share during departmental meetings. "Our physics team meets every Wednesday to plan the next week (and/or unit). I plan on bringing up things I've seen or heard, explanations from MIPEP," explained one participant, and another teacher planned to "do a presentation to the science department and administration." Other teachers offered detailed plans to share materials and ideas within their departments. One teacher, for example, elaborated thus:

> During our in-service before school starts, I plan on sharing materials and ideas with my physics and AP physics people, especially in planning a mini-physics demo for our surrounding schools. As we begin planning each unit, I plan on presenting the pocket reviews and stations.

A second teacher joked that s/he would share MIPEP so frequently that her/his colleagues would "get sick" hearing about it:

> I can't wait to get back and share the Task Cards and Pocket Reviews. I will probably present them during Summer Professional Development Day. Within our physics team, they will probably get sick of me suggesting we do this (from MIPEP) instead of this (from 10 years ago).

Finally, one teacher, who was the sole physics teachers at his/her school, discussed ambitions to share MIPEP with the whole district:

We have a share day in our district where all physics teachers get together. I plan to share with them. I am the only physics teacher at my campus, but I plan to share the NIP Salt with the chemistry teacher.

Summary

Objective 5 of the evaluation of the 2017 MIPEP Summer Institute addressed 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 were very enthusiastic in their responses to this question. Describing *what* they would share, some respondents identified lab ideas and instructional materials from the master teacher, materials and information, and labs and demos. Other participants revealed that they intended to disseminate MIPEP learnings to their colleagues during PLC and departmental meetings, district professional development meetings of physics teachers, and one-on-one meetings with colleagues. Finally, one participant planned to set up a lab in his/her classroom, and "invite colleagues to visit during the lab."

CHAPTER 5: Summary and Recommendations for Future Practice

This chapter presents an overall summary of the results from the evaluation study of the 2017 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 of 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 2017 MIPEP Summer Institute was provided on the Texas A&M University campus in College Station, Texas. Participants comprised 23 high school teachers from across the state of Texas.

The current evaluation study investigated the impact of the 2017 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 2017 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 2017 Summer Institute, participants perceived themselves as needing less professional development in three 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,* and *using culturally responsive teaching strategies.* 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 2017 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 10 of the 16 domains following participation in the 2017 MIPEP Summer Institute.

Results from analysis of qualitative data collected via responses to open-ended questions on the *MIPEP Final Reflections Survey* indicated that participants believed the 2017 Summer Institute had increased their physics content knowledge to a great extent. Respondents described MIPEP as "a fantastic and extremely valuable program," and the "professors" and "lab assistants" as "excellent."

When asked about potential barriers to implementing their new physics content knowledge in their classroom, MIPEP 2017 participants identified their students' lack of mathematics content knowledge,

their own weaknesses in mathematics and physics, and lack of time and equipment as possible challenges.

Objective 2 of the 2017 MIPEP evaluation study focused on the extent to which participants perceived the Summer Institute as having been successful in enhancing 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 16 of the 20 concepts subsequent to their completing the 2017 Summer Institute.

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. Some participants, for example, identified the lectures—particularly the lectures addressing "higher level physics"—as an especially valuable component of the Summer Institute, while others believed the focus on higher level mathematics and opportunity to practice solving problems with the professors were the most helpful aspect of MIPEP. Some participants pointed to the demonstrations and labs at MIPEP as the most effective aspects of their experience, and finally, some praised the Institute's focus on specific physics concepts, and the ways in which these physics were linked, as having been extremely effective.

Objective 3 of the 2017 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 were "inspired" by the enthusiasm of the MIPEP instructors and identified the demonstrations and lab stations/rotations as strategies that would help them increase student engagement and interest. Respondents also believed that learning how to use inexpensive, "everyday materials" in their physics classrooms would enhance physics teaching and learning.

When asked to identify potential barriers to implementation of the instructional strategies they had learned in MIPEP 2017, some participants shared that unequal levels of student abilities and lack of

materials and equipment, as well as money to purchase them, would prove a barrier. Other participants, however, were confident that the information on developing inexpensive demos and materials would alleviate that challenge. Finally, a few respondents confidently expressed that they anticipated few or no challenges in integrating the new instructional strategies into their teaching.

Objective 4 of the evaluation addressed participants' perceptions of the effectiveness of the formal and informal laboratory experiences provided by the MIPEP 2017 team. Specifically, the evaluation team examined participants' post-laboratory confidence in their understanding of, and ability to teach, physics concepts. In addition, the evaluation explored participants' perceptions of challenges they anticipated they might face in implementing the laboratory experiences into the classroom.

The *MIPEP Post-Perceptions Survey* asked participants to share their perceptions of the extent to which the MIPEP 2017 lab experiences had increased their confidence in their understanding of physics concepts. The mean score for this item (3.33) indicates that the majority of respondents agreed with the item, indicating that the lab experiences were effective in increasing participants' physics content 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 scores for this item (3.29) indicates that most respondents believed the lab experiences were effective in strengthening their confidence in their ability to teach physics concepts.

Qualitative data were also collected via responses to open-ended questions on the *MIPEP Post-Perceptions Survey*. Analysis of the data indicated that overall, participants were quite enthusiastic about their lab experiences in the 2017 Summer Institute. 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, multimeter, torque, and meter stick center of gravity labs. Some respondents were more detailed, expressing that all the lab experiences had been effective and that MIPEP had increased their skills and confidence to such an extent that they felt confident in their ability to implement the labs in their own classrooms.

Objective 5 of the evaluation of the 2017 MIPEP Summer Institute examined the program's potential effectiveness in encouraging and facilitating collaboration among physics teachers across the state of Texas. Respondents to the *MIPEP Final Reflections Survey* were asked to discuss ways in which they anticipated sharing their learnings from the Summer Institute with their colleagues in their districts and on their campuses. Overall, responses to this question were very positive. Some participants identified specific components of the MIPEP program that they planned to share, such as demos, task cards, pocket reviews, labs, and materials and ideas. Other teachers revealed the different venues and times in which they anticipated disseminating MIPEP strategies and materials, such as during PLC meetings,

campus-wide and district-wide departmental meetings, and in-service days prior to the beginning of the school year.

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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