The Mitchell Institute Physics Enhancement Program (MIPEP) was organized by the Mitchell Institute for Fundamental Physics and Astronomy with gracious funding from the Mitchell Foundation in order to improve physics education in the state of Texas. Fifteen teachers from high schools across Texas went through rigorous theoretical and experimental training provided by fourteen TAMU faculty members and three Master Teachers. This report addresses the various aspects of MIPEP.

MIPEP SUMMER SCHOOL REPORT 2012

Prepared for the Mitchell Foundation

Prepared by: Bhaskar Dutta

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The MIPEP program is made possible by funds from the Mitchell Foundation and tremendous support and encouragement from Ms. Sherdian Lorenz and Dr. Marina Walne.

We thank the organizing committee for executing this innovative idea and putting together this program. Special thanks are due to the Master teachers, Evelyn Restivo and Mary Jane Head for providing valuable assistance in organization and coordination during the planning phases of the summer program. We also thank Beverly Guster, the administrative assistant of MI, for help with the organizational planning and administrative support.

The Mitchell Institute sincerely thanks the participant teachers for joining the program and for providing valuable feedback for future replication, scaling up and possible improvements. Our sincere thanks are also extended to the TAMU physics faculty for contributing their valuable time and effort to teach in this program. We thank Mr. Tony Ramirez for all his help to make the laboratory component of the program very fruitful and Prof. Lynn Burlbaw from Texas A&M's Department of Education for spending enormous time meeting the program participants during the summer school and implementing a robust, social scientific evaluation design to effectively assess the impact of the MIPEP.

Our grateful thanks and sincere appreciation also go the Cook’s Branch staff for their gracious help during implementation to make this summer program a success. The exemplary wild life conservation setting and beautiful views of the Cook's Branch added a great atmosphere for the implementation of the program.

The final words of thanks need to be conveyed to Dr. Alexey Belyanin and Dr. Lynn Burlbaw who made helpful contributions to this report.

EXECUTIVE SUMMARY

In summer 2012, the Mitchell Institute hosted the Mitchell Institute Physics Enhancement Program (MIPEP). MIPEP was graciously funded by the Mitchell Foundation.

In concert with the rest of the nation, Texas students lag far behind their international peers in science education. The Texas legislature has mandated that essentially all high school students take a physics course. This mandate obviously calls for adequate training for science instructors teaching in Texas class-rooms. The ranking of Texas schools in math and science is below average, the main reason being underprepared math and science teachers in the Texas classrooms. Many science teachers who are teaching physics in Texas schools have had 0 to 2 physics courses during their education. This problem was discussed with some leading Texas teachers and these discussions led to the realization that two full weeks of rigorous physics education training at the level of PHYS 201-202 could be of tremendous benefit in preparing the science teachers to teach in the high school classrooms across Texas. This acted as the motivation behind summer school MIPEP. MIPEP was held in Cook's Branch in Montgomery, Texas from June 6th to 23rd during 2012 summer.

The MIPEP summer school curriculum primarily focused on clarifying the fundamental physics concepts through easy introduction of necessary material, problem solving and hands-on demonstrations. A total of 14 physics faculty members from Texas A&M were involved in teaching the physics teachers who attended the summer school. As participants, 15 secondary school teachers who have only been previously exposed to 0 to 2 physics courses during their academic career were chosen from a large pool of applicants. The participants were also exposed to two days of laboratory-based work at Texas A&M.

Fourteen teacher participants of MIPEP completed both the pre and post assessments. The average of the teachers' scores on the pre-test was 2.12 and the post-test was 2.97, an increase of almost 1 point. Ten teachers scored below the group average on the pre-test while only 3 were below the average on the post-test. There was an overall 42% increase in the average self rating of the teachers. In every instance, the average of the teacher's self-assessment of mastery of the concepts after the program was higher. Six of the fourteen teachers increased their feeling of mastery by more than 50% of their initial rating.

The program was evaluated by Prof. Lynn Burlbaw, a professional evaluator from the Education Department at Texas A&M using pre and post-test instruments. The attendees were asked daily to provide their feedback on whether they have understood the physics concepts. Both the test scores and the feedback from the teachers clearly indicate that the program made great strides in meeting its objectives. Based on the evaluation findings, the organizing committee strongly recommends the continuation of the program with a multi-year model of instruction/participation, and scaling up the program to a larger number of participants.

INTRODUCTION

In summer 2012, from June 6th to 23rd, the Mitchell Institute of Fundamental Physics and Astronomy hosted the Mitchell Institute Physics Enhancement Program (MIPEP). In the next few pages, we describe the context and motivation behind this summer program, its key objectives, curriculum strategy and funding structure. Also discussed are the major findings from evaluating the program along with thoughts for next steps.

MIPEP CONTEXT & MOTIVATION

Our nation is currently challenged with two key educational goals: to generate a civil society that is more cognizant of the world of science and to stimulate young minds to enter the fields of science and engineering. The Texas legislature has already mandated that essentially all high school students take a physics course. This mandate obviously calls for additional training for science teachers. Further, the ranking of Texas schools in Math and Science is below average, a main reason being underprepared math and science teachers in the Texas classrooms. Many science teachers who are teaching physics in Texas schools have had 0 to 2 physics courses during their education. We had the opportunity to discuss this problem with some of the teachers (one of them, Paula Hiltibidal, a high school science specialist, a key force behind MIPEP) and found that two weeks of rigorous physics education at the level of PHYS 201-202 could be of tremendous benefit in preparing the science teachers to teach in high school classrooms.

MIPEP KEY OBJECTIVES

The primary objective of MIPEP has been to improve physics education in the state of Texas. Specifically, this summer school aimed at

1. positively impacting physics teaching and learning in Texas
2. increasing the participating teachers' understanding of physics concepts
3. assisting the participating teachers to develop and use researched-based strategies that engage and provide differentiated instruction for all of their physics students
4. providing authentic laboratory based learning experiences
5. facilitating collaboration of physics educators in Texas

MIPEP ORGANIZATION and PARTICIPANTS

Based on the idea of utilizing the "train the trainer" concept (Paula Hiltibidal, Alexey Belyanin, Tatiana Erukhimova and Bhaskar Dutta), the 2012 MIPEP summer school in was organized in a very short period. Valuable organizational help were available from two Master teachers, Mary Jane Head and Evelyn Restivo. The school program was evaluated by Prof. Lynn Burlbaw, a professional evaluator from the Education Department at Texas A&M following a social scientific program evaluation design.

But even in this limited time, extraordinary response was received from secondary school teachers throughout Texas. During this inaugural year, we could take only 15 of those who applied to participate in the summer school (Appendix 1). All of these participant physics teachers have had only 0 to 2 physics courses during their college education and were to be assigned to teach Physics in the next academic year. The Mitchell Institute's administrative assistant, Beverly Guster, helped with the organizational planning of MIPEP with her previous experience in working for a similar program and her contacts with the high school teachers from her previous job.

MIPEP FUNDING & VENUE

MIPEP was graciously funded by the Mitchell Foundation. Funds were utilized to provide travel assistance to Paula Hiltibidal, Mary Jane Head and Evelyn Restivo to travel to TAMU for initial planning of the workshop and for workshop related travel. Funds were also spent for travel and stipend for the high school teacher participants, fees for teaching faculties and Master teachers, supplies and van rental from Cook's Branch to TAMU. The expense report is attached in Appendix 3.

MIPEP was hosted at the Cook's Branch Conservancy in Montgomery, Texas. The conservancy is a Mitchell family property which won the Texas's highest award for private land conservation in 2012 and this venue was graciously provided by the Mitchell family for implementing the summer program.

MIPEP CURRICULUM

The summer school curriculum was focused on clarifying the fundamental physics concepts through easy introduction of necessary material, problem solving and hands-on demonstrations. The participants were also getting exposed to two days of laboratory-based work at TAMU. 14 TAMU physics faculty were involved in teaching these physics teachers (Appendix 2).

The curriculum was designed based on the following considerations:

1. The current Texas state assessment program, TAKS is being replaced by a more rigorous assessment program, STAAR, which introduces more rigorous standards in physics and mathematics, emphasizes college readiness, and adds test questions that require critical analysis and a more integrated knowledge of physics.

2. Physics instructors here at TAMU routinely observe that many incoming freshmen are not prepared for college-level introductory physics classes and have insufficient background in physics and math.

3. A large number of physics teachers in Texas have very little or no background in physics and/or are new to teaching physics.

The first MIPEP curriculum was targeting this group of teachers with a lower level of preparation. It was closely aligned with TEKS and built around the STAAR objectives of enhancing college preparedness of high school students. The curriculum was nearly comprehensive in terms of TEKS topics, as can be seen from the complete schedule in the appendix. At the same time, the emphasis was made on the topics that are particularly difficult for freshmen, according to our experience in teaching introductory physics classes at TAMU. Lectures were given by our best, most qualified instructors who have extensive experience in teaching introductory classes. Overall, 14 instructors participated.

Lectures were accompanied by discussion sessions and physics demonstrations of two different flavors. The first kind of demonstrations were those used in physics classes at TAMU. The second kind of demos were designed and built specially for high school teachers. They were relatively simple, inexpensive and easy to fabricate with limited school budget and capabilities. Some demonstrations were given away to the teacher participants. The curriculum also included a day of labs performed by teachers in the teaching labs of the department.

In addition to lectures and demonstrations on TEKS topics, there was an extensive enrichment activity on Fridays and weekends. It included lectures on hot topics in physics and advances in technology, the Physics Show, discussion with astronaut Rick Linnehan and other guest speakers, tours of Physics research labs, the Cyclotron, and the Mitchell Institute.

The MIPEP influence is felt long after the summer school ended. The lectures were collected on CDs and sent to all teacher participants. The teachers stay connected with each other and with the TAMU faculty through the MIPEP network. They send their questions and receive a prompt response from TAMU physics instructors.

MIPEP SCHEDULE

The full schedule of the summer school is available at the webpage http://mitchell.physics.tamu.edu/physics-enhancement-program.html (Appendix 4). The school was very intense and focused, with adequate pre and post assessments to track its effectiveness. At the very beginning, the teachers took an examination over some physics problems. At the end of the school, they took a similar test which would help find out whether the school has really helped the participants with their knowledge of physics. The school was evaluated by Prof. Lynn Burlbaw, a professional evaluator from the Education Department at Texas A&M following a social scientific program evaluation design. The attendees were asked daily to provide their feedback on whether they have understood the physics concepts. The teachers received a certificate and Continuing Professional Education credits for attending the summer school.

MIPEP KEY EVALUATION FINDINGS

The evaluation of the Mitchell Institute Physics Enhancement Program (MIPEP) was conducted using quantitative and qualitative measures. The quantitative measures used a pre-post model and consisted of a self assessment and a test of physics knowledge. The qualitative measures were daily reflections on learning and future use of the day's teaching (all items were open-ended responses) and a two open-ended questions included on the post self-assessment of mastery.

The evaluation process was designed to obtain information that would assess the program's success in meeting its objectives of

1. to positively impact physics teaching and learning in Texas

2. to increase participating teachers' understanding of physics concepts

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

4. to provide authentic laboratory experiences

5. to encourage and facilitate collaboration of physics educators in Texas

Based on the results of the quantitative and qualitative measures, there is evidence that the five objectives were met in varying degrees; the teachers improved their perception of their mastery of the physics content and skills necessary to teach high-quality physics at the high school level using high-quality instructional strategies and lessons, and learned new laboratory skills. The teachers appreciated being treated like professionals, enjoyed and valued their interaction with university faculty, and developed friendships that will provide a network of support (facilitated by the MIPEPTALK listserv) for their teaching in the coming school year.

The teachers recommended continuation of the program, the exploration of a multi-year model of instruction/participation, and expansion of the program to a larger number of teachers. The teachers also had suggestions for improvement in future years.

Quantitative Data Presentation and Analysis

The teachers were given a pre-assessment and a post-assessment where they rated themselves on a 4 point scale of their mastery of concepts and skills that were to be taught in the program See Appendix A for a copy of the Pre-Assessment. These topics were chosen from those teachers are required to teach in Texas classrooms by the Texas Essential Knowledge and Skills (TEKS) that constitute the curriculum for the public schools. The rating scale for the self-assessment was

4 = complete mastery - I can thoroughly and easily explain this concept to my students or use this skill in instruction without serious review prior to class or use of notes during class.

3 = mastery - I can explain the concept to my students or use this skill in instruction but need to review prior to class and prepare notes for use during class.

2 = Familiar with but do not claim mastery - I am unsure about the meaning; need thorough study prior to class or use and rely heavily on notes during the presentation or use.

1 = Not familiar with and cannot explain - I know little about this concept or skill and do not know how to use it with or teach in my class.

Fourteen teachers completed both the pre and post assessments[1]. Table 1, on page 2, is a listing of the scores of the teachers on the assessments showing the change in their self assessments. The average of the teachers' scores on the pre-test was 2.12 and the post-test was 2.97, an increase of almost 1 point. Ten teachers scored below the group average on the pre-test while only 3 were below the average on the post-test. There was an overall 42% increase in the average self rating of the teachers. In every instance, the average of the teacher's self-assessment of mastery of the concepts after the program was higher. Six of the 14 teachers increased their feeling of mastery by more than 50% of their initial rating.

From this table, one can conclude that, overall, teachers self-identified an increased mastery of concepts and skills taught in the program.

Table 1 - Individual Teacher Pre and Post Self-Assessment Values with Difference and Percent Change

Teacher Number	Pre-Average	Post-average	Difference	% change
Teacher 1	1.68	2.84	1.16	69%

[1] One teacher left the program before its completion due to a family emergency and did not complete the final days' evaluations or post-assessment.

Teacher 2	1.74	2.68	0.95	55%
Teacher 3	1.79	2.32	0.53	29%
Teacher 4	1.79	2.05	0.26	15%
Teacher 5	1.95	2.84	0.89	46%
Teacher 6	1.95	2.95	1.00	51%
Teacher 7	2.00	2.53	0.53	26%
Teacher 8	2.00	3.05	1.05	53%
Teacher 9	2.05	3.47	1.42	69%
Teacher 10	2.16	3.11	0.95	44%
Teacher 11	2.26	3.26	1.00	44%
Teacher 12	2.37	3.79	1.42	60%
Teacher 13	2.63	2.84	0.21	8%
Teacher 14	3.37	3.84	0.47	14%
Average	2.12	2.97	0.85	42%

The teacher assessment values for each of the topics were recorded and the pre and post average rating for each topic is displayed in Table 2 on page 3. On the pre-test, 9 topics were rated below the group mean for that test; on the post-test, only 7 averages were below the group mean.

On every topic, teachers showed an increased level of mastery ranging from less than one-half a point (Work, Power, and Energy (.46 - 18.73%); Conservation of Energy (.47 - 18.13%) and Electromagnetism (.50 - 24.42%)) to greater than 1 point (Dynamics, Free-Body Diagrams (1.29 - 62.44%); Laboratory Experience (1.20 - 66.67%); and Electrostatics (1.00 - 48.62%)).

Table 2: Teacher Ratings of Mastery by Topic in Program, Pre, Post, Difference and Percent Change

Topic Area	Pretest Group Average	Posttest Group Average	Difference, Pre to Post	Percent Change
	N=15	N=14		
Kinematics	2.47	3.21	0.75	30.31%
Graph	2.47	3.21	0.75	30.31%
Vector Addition	2.40	3.21	0.81	33.93%
Vector Components	2.27	3.21	0.95	41.81%
Projectiles	2.13	2.93	0.80	37.28%
Dynamics, Free-Body Diagrams	2.07	3.36	1.29	62.44%
Work, Power, Energy	2.47	2.93	0.46	18.73%
Conservation of Energy	2.60	3.07	0.47	18.13%
Momentum	2.53	3.07	0.54	21.24%
Conservation of Momentum	2.40	3.00	0.60	25.00%
Laboratory Experience	1.80	3.00	1.20	66.67%
Circular Motion	1.67	2.57	0.90	54.29%
Rotation	1.53	2.29	0.75	49.07%
Gravity & Gravitational Interact	2.33	3.21	0.88	37.76%
Electrostatics	2.07	3.07	1.00	48.62%
Electric Current and Circuits	2.27	3.21	0.95	41.81%
Magnetism	2.00	2.71	0.71	35.71%

Electromagnetism	2.07	2.57	0.50	24.42%
Nuclear and Modern Physics	1.67	2.57	0.90	54.29%
Mean Score/Difference	2.17	2.97	0.80	38.52%

The greatest percentage increase was in the topic of Laboratory Experience. This increase can likely be attributed to the fact that each topic taught was accompanied by a lab experience directed either by a university professor or experienced classroom teacher or both. This increase is of special interest since the State of Texas requires that students enrolled in science courses spend at least 40% of their class time in laboratory situations. The value of the instruction and labs to teachers was also reported in their daily reflection and end of program assessment (see details under qualitative analysis)

Quantitative Summary

The analysis of the quantitative data collected on the pre- post self-assessments shows that there was a positive effect on teachers' sense of mastery of content and skills in all areas. This conclusion is supported by the qualitative measures also used to evaluate the program.

Qualitative Data Presentation and Analysis

The qualitative data used for evaluation was collected using two instruments. The first was a web-based daily reflection form (See Appendix B) and two open ended questions appended to the post-assessment of mastery of knowledge and skills. The daily reflection form asked teachers to record what they had learned during that day, things from that day (specific content, strategies, demonstrations, etc.) that will help them in their classroom, areas where they needed additional help, things they would like the MIPEP facilitators to consider and an overall assessment of the day. The responses to the daily reflection were collated and shared with the program facilitators on a daily basis to provide on-going feedback for the program. At the end of the program, each teacher's daily reflections on what they had learned and what they could use in the classroom were collated, saved as a pdf file and emailed to the teacher.

The open-ended questions asked the teachers to list the best thing they had to say about the program and one improvement that they would recommend for next year. These comments were also shared with the program facilitators.

Results of What I Learned Today

Generally, the teachers reported learning both content and pedagogical knowledge during the program. Several came to understand parts of physics that, although they had taught the content in their classrooms, they did not understand the theory or reasoning for the content. Several also had their knowledge of physics deepened through the interaction with the university professors. Statements from two teachers' daily reflections illustrate this.

Numerous demonstrations extremely significant along with work concepts clarified like never before. The lights are starting to come on.

I had never understood impulse until today. I enjoyed the egg in the sheet. It is always good to see how something can go wrong. The two professors today were a little too fast for me. But I've also come to the conclusion (day 4 of 11) that it is OK for me to mentally shut down occasionally when there's adequate participation from others in the group and when the material is not likely to be necessary for me to teach this coming year. If I don't have an opportunity to practice a new skill soon, I'm aware that I'll lose it. So sometimes it isn't necessary to obtain the skill at this time in my life. But I'm still fascinated by the diversity in styles of the professors as well as the choices they make for variable symbols...letters. I'm embarrassed by my frustration the first and second day. I just expected that people of the same university would use similar techniques, letters, etc. I know more about conservation of energy and work and momentum and impulse, thanks.

The increased depth of knowledge was clearly stated by one teacher on the final reflection, as well as the social benefit of the program.

While I have developed a deeper understanding of the physics concepts, I would have to say the very best thing about this program, in my opinion is the relationships with people that I have made with my fellow teachers. I look forward to keeping in touch with everyone.

Results of Future Classroom Use

Teachers identified many valuable lessons learned that they would be able to use in their classrooms in the coming year. Many of them indicated that they would now teach topics in physics that they previously had not either because of lack of knowledge or confidence.

I will use it [vectors] in my classroom. Vectors are interesting, I may even dust off my old force table and use it now that I know how.

The toys again really help with ideas for ways to specifically apply concepts in labs. I struggled last year to use all the equipment we had for its intended purpose. I think it will go much better next year, not only because of the increase in expertise I'm getting from this, but also because I'll have 75 minutes per class period, and I think a portion of that being devoted to those mini labs every day will be pretty great.

Other reflections related to classroom instructional practices are stated below:

The inertia demonstrations that Paula showed us were great. I am excited to take them back to my classroom. (examples: potato on a skewer will move up the skewer as it is hit with a mallet, wire coat hanger with tennis balls will balance on your head but as you move your head quickly, the balls will remain in their original orientation, broom bowling, etc). Dr. Toback's teaching style using humor and problem solving strategies reflects the environment I would like my classroom to have. He also modeled how to help the students who were struggling with concepts while allowing the more "advanced" students to work on practice problems.

I am going to use the building up of working circuits and current just like the professors did in their lectures. They started small and simple and then became more complex but never leaving algebra based physics.

Results of Areas Needing Help

On every topic, at least one teacher indicated that he or she needed additional help. Some indicated a desire to have closer coordination between some of the lectures and the lab practice from those lectures. Generally, though, teachers indicated the need for time to process the content and practice. The most specific requests for information came in the area of pedagogy and school operations. I need help figuring out how long to spend on kinematics, I have great information to impart to the students and so little time. I love electricity, momentum, gravity, vectors....but how do I cover it all with every student (ESL, Special Ed, Regular Ed and gifted) all together. My formulas are printed on a STARR Chart. I teach with those formulas because the state mandated that my students need to pass that test to graduate from high school. This year I had success, I had students take it the past 2 years to see where my pedagogy is weak.

Creative and fun ways to connect this information to student's real lives.

One teacher expressed a desire to more closely connect the program activities to the state curriculum, saying, "It would help if I learned more about how to teach specific high school TEKS." Other teachers expressed a frustration in the mis-match between what the state requires and what university professors expect of students: "Is there any way that the State can collaborate with the schools and colleges where our curriculum helps both, instead of forcing me to teach to the State mandates and then send kids to college where it is all so different." The comments also expressed their frustration with the state of readiness of districts to support quality physics instruction, primarily in the area of finances. Full-fledged laboratory experiments to use. My previous district was tremendously cash poor and the science department's official policy was that we couldn't run any labs that our students didn't bring 100% of the materials for from home. I'd like to see some tried and true lab setups, even if it's just a set of instructions for running labs, or something of the sort. I could use some more help on strategies of obtaining classroom materials. Such as learning more about tax breaks. I would find it very useful on how to write grants and where I could find some grants for my physics class.

Teachers expressed the need, as learners do in general, to have time to reflect on what they had been taught and their overwhelming need for material support in the public schools to teach physics. All of the teachers see themselves as "becoming" competent physics instructors who need support as they go through the year and recognized the constraints inadequate instructional facilities and materials would have on them doing the maximum they could - all expressed the commitment to providing quality instruction, even in the face if less than optimal conditions.

Results of Final Reflection

Without a doubt, the program should be considered as being a success. The teacher comments, outlined below, clearly indicate that the program made great strides in meeting its objectives.

I am so much more confident now than I was; simply because I have heard "from the horse's mouth" that many of the methods I had taught myself and applied in the classroom are correct.

I gained a lot of content knowledge.

I learned that there are several different types of teachers and several different learning styles. I do have to commend the professors for trying their best to present the materials without going over our heads. There were several professors that even though the content may have been hard to follow, they knew when we needed time to break and digest information, while others did not. I got tips on how to and not to run a classroom on top of a better understanding of content. Plus the demos that the physics outreach program put on was by far amazing.

Although it was fast and furious, I feel like I learned at least some of everything that we're having to teach in Physics, instead of concentrating on just a few subjects. plus I feel like we all received an extremely well laid foundation that will allow us to move forward with much more confidence and zeal.

Most of the content I am more confident about now that I have learned the true concepts and math. I have also developed great relationships with many teachers across the state.

The absolute best thing about this program was learning from the professors and having them relate to us on a first name basis---it made me feel like an equal as an educator. They were obviously trying to help us rather than to show us how smart they were.

The teachers offered recommendations for future programs. Three areas were mentioned by several of the teachers: time allocation for various activities including down-time; facilities and their relation to instruction; and the relationship between program content/instruction and the state of physics instruction in public school classrooms.

Better usage of time. Maybe lecture for a few hours and then have an activity, and then lecture for a few more hours with another activity to follow. It was painful for me to sit for 8 hours every day and give my full attention.

More evening time to ourselves. I would have liked to have 3 hours in a row free instead of one hour then something one hour and then something and then one hour and then bed. We need time to detach in the evenings.

I believe that had the Master Teachers had an opportunity to give us lessons on the topic the afternoon before and then have the Profs. come in and teach us the next morning that I would have had an opportunity to look over the material, work problems, and be better prepared for what they had to offer. Coming from such a deficit, I have learned tremendous volumes of material that now I will be able to go home and process. It would be great to be able to return next year to enhance what was taught coupled with what I now have a foundation to build upon throughout the year.

I would have liked to see the program at the A&M campus instead of the Mitchell Conservancy. Not to say that where we stayed was not breathtaking and a once in a lifetime experience. I think that for the involved parties, having it at the campus would have solved many problems in the time management arena. Plus it would have given many participants the opportunity to use the physics facilities to the fulfillment and the campus as well. Such as, lecture in the morning, lab early afternoon over morning lecture, and then lecture in the afternoon with evenings off. Have problems worked that evening so they can be talked about the next morning before class. Then the next day start with lab then lecture then lab. Keep repeating the process for the two weeks. It helps to chunk, digest and process the information presented in lecture and tie it to the lab experiences.

If the professors had been more informed as to the state requirements of physics programs it would have been better. I don't regret the complex physics shown to us...but if they had been a little more knowledgeable of our day to day experiences with "on level students" it would have been more meaningful.

Maybe the best sentiment and guidance for the program is found in this teacher's statement:

It would be awesome if this program was actually a two year program, the material could be covered in better depth. For example, one summer, semester 1 is covered in depth over a two week period, and the next year semester 2 is covered in depth over a two week period. That might give the teachers a better opportunity to work through and build a deeper foundational understanding of the physics concepts without feeling overwhelmed by the sheer volume of concepts we covered.

Qualitative Summary

In reviewing the responses of the teachers, one sees that they were candid in their observations and interested in improving both their knowledge and instructional skills. They were also appreciative of the program and looked forward to the following school year where they could apply their new-found or improved physics knowledge and their ability to work with other teachers across the state and university faculty from Texas A&M University. There was ample evidence in the qualitative responses to justify the conclusion that the MIPEP had met the program objectives but that there was/is still room for improvement.

INSIGHTS & RECOMMENDATIONS

Based on the first year implementation findings, we think that this summer school based intervention for the high school science teachers in Texas has a significant impact on high school education in the state. The feedback from the teachers has provided tremendous input to plan the future outreach initiatives of the institute. The actual effectiveness of the program, however, can only be realized with the help of obtaining future data from the program participants on course knowledge retention. Following the completion of the summer school, the program attendees have been given the opportunity of being continuously connected with the Physics faculty members through a listserv which has been set up for their assistance with day to day teaching issues. They are effectively utilizing it for various types of teaching help.

Overall, since this pilot program has been unique at Texas A&M, its demonstrated success and evidence of effectiveness have the potential of making it an integral component of standard university curricula funded by the state where groups of physics teachers from various high schools in Texas can come to the university and get trained during summer to teach physics appropriately. Based on these findings, the organizing committee strongly recommends scaling up the program to a multi-year model of instruction and participation involving larger number of high school teachers.

As next steps, web-based surveys with the participants will be implemented to track if the summer program has better prepared them to handle the science classrooms, what worked and what could have worked better. This post-program evaluation component would help enhance the future summer school objectives and curricula by integrating the best practices and sustaining the program in future. For the next few years, the Mitchell Institute plans to continue this program. As an improvement, same set of teachers might be allowed to participate in the program for two consecutive years so that the learning material can be spread out over longer period of time thereby allowing better absorption and retention. To help more schools in a shorter time period, the future goal will be to increase the number of program participants from 15 to 25.

APPENDICES

Appendix 1

Participants

Name	School	Location
Pam Backlund	Central HS	San Angelo, TX 76903
Nolan Bentley	Cypress-Creek HS	Houston, TX 77070
David Brake	Clear View HS	Webster, TX 77598
Angela Case	Eldorado HS	Eldorado, TX 76936
Heather Ebner	Cypress-Creek HS	Houston, TX 77070
Zach Hawkins	Hereford HS	Hereford, TX 79045
Ester Johnson	Del Rio HS	Del Rio, TX 77840
J. Adam LeJeune	Louise HS	Louise, TX 77544
Crystal Randall	Clear Springs HS	League City, 77573
B. Nichole Roberts	Lubbock HS	Lubbock, TX 79401
Daniel Schalit	Uvalde HS	Uvalde, TX 78801
Karen Turner	Stockdale HS	Stockdale, TX 78160
Dan Van Pelt	Deweyville HS	Orange, TX 77632
Michael Whitfield	Goliad HS	Goliad, TX 77963
Zach Youngblood	Ozona HS	Ozona, TX 76943

Appendix 2

Texas A&M University Physics Faculty Lecturers

Glenn Agnolet

Bill Bassichis

Tatiana Erukhimova

Lewis Ford

Rainer Fries

Ed Fry

George Kattawar

Helmut Katzgraber

Lucas Macri

Joe Ross

Dave Toback

Vy Tran

Bob Webb

George Welch

Organizing Committee

Bhaskar Dutta	TAMU, Professor, Physics
Tatiana Erukhimova	TAMU, Senior Lecturer, Physics
Alexey Belyanin	TAMU, Professor, Physics
Paula Hiltibidal	Master Teacher, ESC Region 15

Appendix 3

Expenses

Pre-Workshop		$2,697.09
Workshop		
	Master Teacher Fees	$10,300.00
	Faculty lecturer Fees	$5,423.97
	Supplies	$2,900.99
	Rental Vans & Parking	$959.10
	Travel	$5,672.96
	Participant Stipend	$7,500.00
	Food (at TAMU)	$761.38
		$36,215.49

Comments on Expenses: Many of the expenses were waived since lodging and workshop facilities (except on Fridays) were held at the Mitchell Family Ranch-Cook's Branch Conservancy.

None of the faculty requested mileage to the ranch. Staff support was given by the MIFPA, Physics labs and the Physics department provided equipment for the demonstrations/training. In addition the assistance of, Technical Laboratory Coordinator, Tony Ramirez, was generously given for each Friday the participants were at the TAMU.

Appendix 4

	Monday 6/11	Tuesday 6/12	Wednesday 6/13	Thursday 6/14	Friday 6/15	Saturday 6/16
8:00 a.m.	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
9:10 – 10:00 a.m.	**8:30 – 9:30 a.m. - Physics Exam **9:30 – 9:40 a.m. – Break **9:40 – 11:00 - **Motion & Graph Analysis**	**Vectors & Projectiles (Continued)**	**Dynamics (Continued)**	**Conservation of Energy**	*10:00 – 12:00 noon **Labs @ TAMU Mitchell Institute**	**Waves**
10:00 – 10:10 a.m.	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK
10:10 – 11:00 a.m.	**Motion & Graph Analysis (Continued)**	**Vectors & Projectiles (Continued)**	**Dynamics (Continued)**	**Conservation of Energy (Continued)**	**Labs @ TAMU Mitchell Institute**	**Waves (Continued)**
11:00 a.m. – 12:00 noon	Demonstrations & Discussion	Demonstrations & Discussion	Demonstrations & Discussion	Demonstrations & Discussion	**Labs @ TAMU Mitchell Institute**	**Speaker – Current Events in Physics**
12:00 – 1:30 p.m.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:30 – 2:20 p.m.	**Vectors & Projectiles**	**Dynamics**	**Work-Energy**	**Momentum**	*1:00 – 3:00 **Labs @ TAMU Mitchell Institute**	Independent Study
2:20 – 2:30 p.m.	BREAK	BREAK	BREAK	BREAK	BREAK	
2:30 – 3:20 p.m.	**Vectors & Projectiles (Continued)**	**Dynamics (Continued)**	**Work-Energy (Continued)**	**Momentum (Continued)**	**Labs @ TAMU Mitchell Institute**	
3:20 – 4:20 p.m.	Demonstrations & Discussions	Demonstrations & Discussion	Demonstrations & Discussion	Demonstrations & Discussion	**Physics Show, Tours, Guest Speakers?**	
4:20 – 4:30 p.m.	Break	Break	Break	Break	Break	
4:30 – 5:30 p.m.	Problems & Tutorials	Problems & Tutorials	Problems & Tutorials	Problems & Tutorials	**Physics Show, Tours, Guest Speakers?**	
6:30 p.m.	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner
8:00 – 10:00 p.m.	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire

	Monday 6/18	Tuesday 6/19	Wednesday 6/20	Thursday 6/21	Friday 6/22	Saturday 6/23
8:00 a.m.	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
9:10 – 10:00 a.m.	**Circular Motion**	**Electrostatics**	**Circuits (Continued) & Magnetism**	*10:00 – 12:00 noon **Labs @ TAMU Mitchell Institute**	**Electromagnetism (Continued)**	**Optics**
10:00 – 10:10 a.m.	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK
10:10 – 11:00 a.m.	**Circular Motion (Continued)**	**Electrostatics (Continued)**	**Circuits & Magnetism (Continued)**	**Labs @ TAMU Mitchell Institute**	**Electromagnetism (Continued)**	**Optics**
11:00 a.m. – 12:00 noon	Demonstrations & Discussion	Demonstrations & Discussion	Demonstrations & Discussion	**Labs @ TAMU Mitchell Institute**	Demonstrations & Discussion	**Speaker – Current Events in Physics**
12:00 – 1:30 p.m.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:30 – 2:20 p.m.	**Rotation**	**Current & Circuits**	**Magnetism (Continued) & Electromagnetism**	**Labs @ TAMU Mitchell Institute**	**Atomic, Nuclear, Quantum**	Independent Study
2:20 – 2:30 p.m.	BREAK	BREAK	BREAK	BREAK	BREAK	
2:30 – 3:20 p.m.	**Rotation (Continued)**	**Current & Circuits (Continued)**	**Electromagnetism (Continued)**	**Labs @ TAMU Mitchell Institute**	**Atomic, Nuclear, Quantum**	
3:20 – 4:20 p.m.	Demonstrations & Discussions	Demonstrations & Discussion	Demonstrations & Discussion	**Physics Show, Tours, Guest Speakers?**	Demonstrations & Discussion	
4:20 – 4:30 p.m.	Break	Break	Break	Break	Break	
4:30 – 5:30 p.m.	Problems & Tutorials	Problems & Tutorials	Problems & Tutorials	**Physics Show, Tours, Guest Speakers?**	Problems & Tutorials	
6:30 p.m.	Dinner	Dinner	Dinner	Dinner	Dinner	**SAFE TRAVELS!!**
8:00 – 10:00 p.m.	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire	Physics Around the Fire	