Physics Teacher Education Coalition

Section on Teacher Preparation

Welcome to the New Teacher Preparation Section

Chance Hoellwarth-Editor

Welcome to a new section of the APS Forum on Education Newsletter, one devoted to teacher preparation. The purpose of this new section is to showcase and explore ways the physics community can help prepare K-12 science teachers.

Preparing science teachers may seem like a strange endeavor for the physics community, but it is important for our future. Teachers influence the science literacy of the general population, which influences the funding of science. Elementary teachers prepare and influence the students who enter (or don't enter) high school science classes. High school science teachers prepare and influence the students who enter (or don't enter) our university physics programs. University physics teachers help prepare and influence future teachers and physicists. Future teachers go back to influence students and the cycle is complete. Thus the future of science both in terms of future scientists and support depends on how well we prepare future science teachers.

Many of us already believe teacher preparation is important. Last year, 259 physics departments endorsed a statement saying they were committed to preparing better science teachers (http://www.aps.org/educ/joint.cfm). Maybe your department signed; maybe it didn't. Either way, you (as a member of the physics community) have an interest and a part to play in the preparation of science teachers.

Which brings us to the real issue: How does one better prepare science teachers? Preparing teachers is a daunting task. Luckily, you don't have to figure out how to do it alone. Members of the physics and education communities are already successfully preparing future science teachers. The purpose of this section of the newsletter is to tell their story so that you (and your institution) can take the ideas and the tools that they have developed and implement them at your institution in order to improve (or begin) your teacher preparation effort. Therefore, if you have stories to tell, let me know about them.

What if I told you there are people near you who are interested in preparing science teachers? Wouldn't that be great news? The fact is these people do exist. They are your local K-12 teachers. Many of them are passionate about teaching and they want to help you prepare teachers. It is possible to partner with local teachers and form what is called a Teacher Advisory Group (TAG). In this issue we will hear from three institutions that have done this: University of Arizona, University of Colorado, and Ball State University. They each have a different story to tell.

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An Advisory Group to Provide Input in the Preparation of Future Teachers

David Grosnick

With the advent of the Physics Teacher Education Coalition (PhysTEC) program [1] at Ball State University in 2001, a Teacher Advisory Group (TAG) was formed to provide ideas and guidance to the members of the PhysTEC team in the training of pre-service science teachers. In addition to university faculty, individuals were selected to be members of the TAG because they were external to the university, yet at the same time knowledgeable about the science teacher preparation curriculum and program at Ball State. The TAG has provided assistance in a variety of aspects related to the implementation of the PhysTEC goals, such as course revision, assessment techniques, and the induction and mentoring of new teachers.

A major problem that faces the science-education community is that a large fraction of science teachers leave the profession. Data show that as many as 40% of these teachers leave within the first 5 years [2]. The PhysTEC program was initiated in part to address this problem. The goal is to increase the number of well prepared pre-service teachers and to actively follow their progress in their first few years of teaching. Since it is a common belief that teachers "teach the way they were taught," a revision of the science content courses, as well as the science education courses, toward more active, student-centered learning methods was implemented.

One of the goals of the PhysTEC program is to bring together university faculty in the schools of education with those in the content courses (specifically in physics departments). All too often there is a lack of communication between the schools. This can hinder progress toward better educating prospective science teachers. Through discussion in the TAG, each group has an opportunity to view how the other operates and to make suggestions regarding the goal of improving science education.

Our TAG was originally formed in the spring of 2002 with the goal of planning implementation of the major components of the PhysTEC program, but its role has since evolved to addressing broader issues. It is modeled on the Department of Physics and Astronomy's Industrial Advisory Committee, a group that offers insight into local and state industrial concerns and gives advice on how the university's program might better prepare students for those markets. It is further based on the model of advisory groups that exist in large particle-physics

experiments, where regular technical reviews are common for overseeing the feasibility and readiness of complex detector components.

Another essential aspect of the PhysTEC program, which has greatly enhanced the TAG, is to bring a high-school or middle-school master science teacher into the university environment for one year as a Teacher-in-Residence (TIR). The tasks of the TIRs are many and diverse, but they include: identify and mentor the pre-service and recently-graduated science teachers; assist in the college classroom and in the course revision process; serve as a resource for classroom demonstrations; and together with students to provide outreach to the science teaching profession.

At Ball State University, each TIR has had his own emphasis and imprint on the PhysTEC program. Initially, the TIRs were active in course reform, designing more inquiry-based laboratory activities. A later TIR was actively engaged in the induction and mentoring of pre-service and new teachers (mostly at the high-school level). During his time as TIR, he rode a circuit throughout the state in support of this activity. This has fit in especially well with the new state program in mentoring new teachers. Another TIR at Ball State was interested in initiating research programs at the high-school level, such as analyzing seismic data, and involving high-school students in research at an early stage.

The TIRs have been an integral part of the TAG. Since they are a liaison between the university and high schools or middle schools, have extensive experience in the classroom, and have the necessary background in both education and science content courses, they serve as leaders of the TAG and often guide the discussion. They have set the programs for the TAG meetings, often linking these programs to their own interests and specialties. The TAG has also served as an opportunity for prospective TIRs to become familiar with the PhysTEC program and to meet current and past TIRs.

Members of the TAG have been selected from diverse backgrounds in order to provide a variety of opinions and advice. At the university level, members are selected from the physics department, science-education faculty, and Teachers College (the latter is where the education faculty and students reside, while the science-education faculty are part of the Department of Biology). Current and past TIRs are also members of the TAG, as are some of their in-service teacher mentees. Other important members are in-service teachers from the area who have extensive knowledge of the teacher education program. Some have been graduates of Ball State University's science-education program. Members of the Department of Education in the state of Indiana have also served on the TAG, including a member of the state Professional Standards Board and the state science consultant. Several guests have joined the TAG meetings from time to time. These have included the PhysTEC leadership team, the state consultant on induction and mentoring, and several of the pre-service teachers who were students in the PhysTEC-influenced classes. One of the most recent TAG members, now a high-school science teacher, served as the Teaching Assistant for the very first introductory physics class under the PhysTEC program. The number of members on the TAG is normally between twelve and fifteen.

The TAG meetings have consisted of discussions covering a wide range of topics. In the beginning, brainstorming sessions were held on how to implement the PhysTEC program and meet its goals. Plans were made not only for the university, but for a possible outreach to former students, who are now teaching in schools throughout the state. Questions such as developing an introductory physics course solely for pre-service teachers were debated, along with issues related to course reform. Another TAG meeting included several of the pre-service teachers in order to solicit their opinions and suggestions about the science content courses and the science education program in general. At yet another TAG session, the TIR, along with a guest consultant, presented information on the induction and mentoring of in-service teachers, the new state program in that area, and methods used to improve retention.

We have discussed ways to assess progress in the different areas of the PhysTEC program. An assessment template was developed and passed along to the national PhysTEC program. The most recent meeting featured presentations of possible research projects in which high schools may become involved with universities or national laboratories. Typically, the TAG meets once during the semester.

The Teacher Advisory Group has been a valuable resource for the science-teacher education program. Suggestions, opinions, and insights from this diverse group have greatly enhanced the quality of science teacher education at Ball State University.

References

[1] For more information on PhysTEC, please see the website, http://www.phystec.org, or http://www.ptec.org , and references therein.

[2] Richard M. Ingersoll, "Turnover Among Mathematics and Science Teachers in the U.S.," Report to the National Commission on Mathematics and Science Teaching for the 21st Century, Chaired by John Glenn, (February, 2000). (http://www.ed.gov/inits/Math/glenn/compapers.html)

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Partners in the Preparation of Secondary Science Teachers

Ingrid Novodvorsky

Overview of College of Science Teacher Preparation Program

The College of Science Teacher Preparation Program (TPP) was established at the University of Arizona in 1999, to provide preparation for prospective middle and high-school science teachers within the College of Science. Faculty members in the program are affiliated with various content departments, including physics, chemistry, molecular and cellular biology, astronomy, and biochemistry. They also function as members of an interdisciplinary team in managing the program, teaching its courses, and advising students. Students in the program have two different degree options that lead to eligibility for teacher certification. They may remain in their science-degree programs, and take an additional 30 credits of coursework in science teaching, or they may enroll in a B.S. degree in Science Education, with concentrations available in biology, chemistry, earth science, or physics. Each of the concentration options includes the 30 credits of science-teaching coursework, and at least 45 credits of science coursework.

The 30 credits of science teaching coursework are spread among seven courses, including a semester-long student teaching experience. Four of the courses that students take prior to student teaching include field experiences in area middle and high schools. These field experiences range from 20 hours of observations in the first two courses, to 8-week internships in the last two courses. Thus, students participate in approximately 140 hours of field experience before they begin their student teaching.

While the program faculty is responsible for teaching the on-campus courses in the program, it was clear from the very beginning that we needed the support and assistance of area secondary science teachers. During the planning stages of the program, the initial faculty members invited area teachers to a series of forums designed to gather their input on an ideal science teacher preparation program. These forums also served to begin building valuable partnerships with area science teachers, a partnership that continues to support the program on many levels.

We have hired three experienced science teachers, following their retirement from area schools, to work with the program as adjunct instructors. In addition, we have secured grant funding to hire Teachers-in-Residence, who leave their classrooms to work on campus for a year at a time. The presence of experienced teachers in key program roles has provided credibility in the eyes of science teachers in the community, which has strengthened their willingness to work with the program. In addition, area science teachers have a great deal of ownership in the program, further strengthening this important partnership. The following sections describe how these partnerships were established, how they are maintained, their impact on the program, and future directions.

Creation and Nurturing of Partner Group

During the summer of 2000, prior to the first semester of enrolling students in the TPP, we obtained funding to form a teacher advisory group, identified as Partners in the Preparation of Science Teachers (PEPST). The funding was provided by the Arizona Board of Regents through the Eisenhower Math and Science Education Act, and included stipends for participating in the summer workshop and attending monthly meetings during the school year. The goals for the first year of PEPST were

1) Formation of a professional learning community of teachers and science teacher educators,
2) Construction of a set of tasks for use when preservice teachers observed mentor teachers' science classrooms, and
3) Development of a written philosophy regarding the preparation of future science teachers.

To begin building that professional learning community, we spent much of the first summer workshop writing observation tasks for the introductory science-teaching course. Those tasks, which have been refined over the years, are still used today, and mentor teachers uniformly recognize their value in giving these classroom observations a purpose and directing our students' attention toward aspects of the classroom that they might not otherwise notice.

The summer workshops, which continued during three subsequent summers, each focused on pertinent needs of the program as it developed. The outcomes for the second year were:

1) Ongoing development of a partner "study group" focused on excellence in mentoring preservice science teachers,
2) Revision of a set of inquiry-centered teaching tasks developed and piloted in PEPST teachers' classrooms during the project's first year, and
3) Documentation of the preservice teachers' performance on the PEPST-designed teaching tasks.

In addition to the products that resulted from the workshop, we continued to increase our pool of PEPST partners, and thereby, the pool of classrooms in which we could place our students for their field experiences and student teaching. By the third summer workshop, we were ready to focus more on the professional development of our mentor teachers. The foci of the third year were:

1) College of Science TPP study to re-review the program
2) A professional study of the roles and responsibilities of successful mentor teachers,
3) A professional study of pedagogical content knowledge (PCK), and
4) A professional study of the mentoring and development of preservice teachers' PCK

In the final summer that these workshops were funded, we divided the workshop into two parts. First, we invited new PEPST partners to meet with us for three days to learn about the program and what we ask of our mentor teacher partners. Second, new and returning PEPST partners spent a week developing tasks based on videos that had been filmed in their classrooms. These tasks are used in all of the science-teaching

courses, and illustrate important aspects of communication, classroom management, and teaching strategies.
In addition to the summer workshops, we invite our PEPST partners to monthly meetings during the school year. At these two-hour meetings, we ask the partner teachers for feedback on the students they are currently mentoring and input on program decisions, as well as provide professional development. For example, we have provided them with samples of our students' work and asked them to analyze these samples for evidence that the students understood the rationale behind a teacher's instructional decisions.

Impact of PEPST

The impact of our PESPT partners on the TPP has been substantial. The partner teachers have provided valuable advice on all aspects of the program, much of which we have incorporated into the program. Because of this, the PEPST partners believe themselves to be equal partners in science teacher education, and they have become enthusiastic advocates of our program. As a testament to this, at our monthly meetings during the academic year held at 4:00 p.m. on a Friday typically 30-40 teachers attend. This feeling of being connected to the program is also conveyed in teachers' responses to post-workshop questionnaires.

As a direct result of PEPST partners' impact on the program, they are eager and willing to have our students in their classrooms. We utilize approximately 70 area science teachers each semester for our field experiences, and some 50 of those are PEPST partners. Our partners are free to choose the level of involvement that best fits with their needs each semester; i.e. observers, interns or student teachers. In addition, many PEPST partners report that they have declined to accept preservice teachers from other programs in favor of TPP students. (Mentor teachers also receive a stipend for working with our preservice teachers; these are paid with TPP operation funds.)

Another aspect of the impact of PEPST is our ability to recruit Teachers-in-Residence to work with the TPP. A Teacher-in-Residence (TIR) joins us for a year to co-teach classes, supervise field experiences, and participate in program management. We currently have funding through the Physics Teacher Education Coalition (PhysTEC) to support a physics TIR, and through the Howard Hughes Medical Institute to support a biology TIR. The teachers that apply for these positions have all been PEPST partners, and their work with the program in that capacity provides the encouragement they need to leave their classrooms for a year to work on the university campus.

Future Directions

We are committed to maintaining a strong community of mentor teacher partners to work with our preservice teachers and advise us on the TPP. Thus, one critical future direction is to recruit more science teachers into the PEPST partner group. While we recognize the increased value of placements in classrooms of teachers who know the program and what we expect, as our program has grown, we have had to place students in the classrooms of non-partner teachers. In addition, our mentor teachers need an occasional break from mentoring preservice teachers, so we need to expand the pool in order to accommodate that. We have learned that simply sending invitations to join the partner-teacher group is not very effective in recruiting busy professionals. Thus, we will be restructuring the work of our adjunct instructors to focus attention on going out to area schools to recruit additional mentor partners.

The summer workshops and monthly meetings have become a core aspect of the program for our teacher partners. Unfortunately, we did not have funding to continue them last year. Nonetheless, teachers requested opportunities to meet with TPP faculty members and other mentor teachers to continue their work with the program. Thus, securing funding to continue to support the PEPST activities is another critical future direction for our program.

Our partnership with area science teachers has reaped several benefits for the TPP. We have developed a cadre of mentor teachers eager to work with our students, and who are familiar with the program and feel a sense of ownership in it. We have greatly improved relationships between our TPP and area schools because we welcome and utilize teacher input. And, we have built a professional community of science teacher educators willing to work together to provide exemplary experiences for preservice science teachers.

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CU Physics Education: Recruiting and Preparing Future Physics Teachers

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Over the past several years, the University of Colorado at Boulder (CU-Boulder) has dramatically expanded its efforts to recruit and nurture the highest caliber future high school physics teachers. With the formation of the Physics Education Research Group at Colorado (PER@C)[1], the STEM-Colorado Teacher Preparation program[2] , and the newly initiated Physics Teacher Education Coalition (PhysTEC)[3], CU-Boulder has brought together faculty and students from the Department of Physics and School of Education to partner with local pre-college teachers, informal science educators, and K-12 students.[4] This collaboration has provided a rich venue for research, support for local communities and classrooms, and a coordinated recruitment, preparation and induction program for future K-12 teachers. One of the hallmarks of the CU-Boulder program is the notion that the preparation of future physics teachers begins in the physics department. Not only do undergraduate students have the opportunity to engage in teaching experiences early in their studies, but also this approach emphasizes the modeling of best teaching practices in

the undergraduate physics courses. Thus, we purposefully blend the mastery of physics content, pedagogy, and authentic practice.

Several CU-Boulder programs provide students the opportunity to engage in structured educational experiences to develop a comprehensive understanding of physics teaching and to engage in teaching opportunities. As part of an NSF-sponsored course reform effort[3], we have introduced *Tutorials in Introductory Physics*[5] into the physics-majors' sequence, and observed increased student mastery of content and improved attitudes and beliefs about the subject and educational process.[6] The success of the reforms has required additional staffing of the Tutorials which has been supplied in the form of undergraduate Learning Assistants (LAs). LAs come from two pools, the STEM-Colorado Program (described below) and a new upper-division/ graduate-level physics course, Teaching and Learning Physics. Thus, this increased demand for staff has provided an opportunity to introduce capable students to teaching. Two programs, STEM-Colorado, and Colorado PhysTEC support these efforts through strong partnerships with local high school teachers, a Teacher Advisory Group and a Teacher –in –Residence program.

The PhysTEC-Colorado Program has been able to build on STEM-Colorado's collaborative program involving several departments at the University of Colorado focused on Teacher Preparation. The goals of STEM-Colorado include reforming introductory undergraduate courses to include student and learning centered approaches, enhance the use of technology within the courses, and utilize trained undergraduates to assist the instructors in facilitating student learning. These Learning Assistants are undergraduate students with a strong content background who have an interest in teaching. During the semester, these LAs are awarded a stipend to work 10hrs / week` with the lead instructors in the courses (Astronomy, Physics, Applied Mathematics, Biology) and with faculty from the School of Education. As part of the STEM-Colorado and PhysTEC grants, a high school science teacher is supported part-time to work with the education faculty to help introduce the LAs to educational issues, learning theory, instructional techniques, and experiences working in K-12 schools. As part of an associated course LA's receive course credit in the School of Education.

The program has been quite successful in attracting candidates into the teacher licensure programs at the university. In three semesters of the program, 13 Learning Assistants from participating departments in mathematics and science have committed to becoming teachers and are enrolled in a certification program at CU-Boulder. Most of these students did not initially intend to become teachers. The School of Education typically recommends an average of approximately 20 mathematics and science students for certification each year. This program provides the LAs with a supportive environment to investigate, develop, and practice their teaching skills. Therefore, the Learning Assistants practice and develop skills in a learner-centered environment and are monitored by science and educational faculty. Our undergraduate LA's consistently report the experience as a strongly positive one, and the word has spread; applications for LA's outnumber positions 3:1 in physics and the program is attracting some of our best undergraduates who would not have otherwise considered a career in pre-college teaching.

The community has grown to include summer workshop experiences for local high school teachers. During our first Summer Workshop about 20 teachers participated in sessions that allowed the university faculty to showcase their reformed courses and share web-based resources that have been developed. The high school teachers described some of their experiences with state testing and the impact of content standards on their schools. More importantly though, the workshop provided a forum for high school and university teachers to share experiences and learn more about the challenges facing each group.

The PhysTEC-Colorado Program has capitalized on these experiences by incorporating some of the summer workshop teachers as well as other invitees to form a PhysTEC Teacher Advisory Group (TAG). The group meets quarterly in the late afternoon for about 3 hours. Discussion topics have included facility tours, curricula, implementation of novel computer simulations from the Physics Education Technology Project (PhET)[7], and employment options within the Teacher-in-Residence and PhysTEC Fellows program. The TAG provides regular communication with a cadre of high school faculty in several surrounding school districts, it enlightens the CU Physics faculty about "life in high schools," and it expands the network of concerned physics educators. A critical component of the TAG program is that it serves as a starting point for placing students in productive and engaging K-12 environments. Students get a positive and safe exposure to real pre-college classrooms, while teachers benefit from the added human resources and content expertise of the college students. These TAG teachers have formed the nucleus of school-based contacts for the semester projects for students enrolled in the Teaching and Learning Physics class.

In the first semester of the university-high school partnerships with the TAG, we have established placements for students in half a dozen schools (placing student for teaching experience), informal science environments (from science outreach workshops to the planetarium), and teacher in-service professional development opportunities. Finally, it is through the TAG that we will recruit teachers and increase teacher participation at CU-Boulder. Currently we are interviewing teachers for next year's Teacher-in-Residence Position (TIR) as well as a PhysTEC Fellows program. The TIR will continue to support campus-based efforts and liaisons with local schools, while the Fellows program will house two teachers for one month at CU-Boulder to work with the PER@C group and promote university– community collaboration.

More information may be found at in the reference to the PhysTEC [3], CU Physics Education Research Group [1], Colorado STEM [2], and the Department of Physics[8].

References

1) The Science Technology Engineering and Mathematics (STEM)- Colorado Program: http://cosmos.colorado.edu/stem; National Science Foundation Grant DUE-0302134
2) http://phystec.colorado.edu/
3) NSF, Course Curriculum and Laboratory Improvement Program, #0410744
4) These efforts build on longstanding commitments to education at CU, including the Wizards Program, the Saturday Physics Series, CU Science Discovery, and the pioneering work of many scholars including Frank Oppenheimer, Al Bartlett, John Taylor, and many others. [1] http://per.colorado.edu

5) McDermott, L.C. and Schaffer, P.S., (1998). Tutorials in Introductory Physics (Upper Saddle River, NJ: Prentice Hall).
6) Pollock, S.J. "No Single Cause: Learning Gains, Student Attitudes, and the Impacts of Multiple Effective Reforms" Physics Education Research Conference Proceedings 2004; Finkelstein, N.D. and Pollock S.J. , "Replicating and Understanding Successful Innovations: study of a secondary implementation of *Tutorials in Introductory Physics,"* in preparation.
7) http://phet.colorado.edu
8) http://colorado.edu/physics

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