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EASY COME, EASY GO?

With September and the beginning of the school year I can't help but think about my "family" of students – physics teacher education majors. During the past few weeks I have met new members of the family – incoming freshman and transfer students. During the past few months I have had to say good-bye to five PTE majors who have been with me for the past four years. Each of these latter students has taken six courses with me during their junior and senior years. I have served as their academic advisor over the whole of four years, and I have supervised their student teaching during spring semester. We have all labored long and hard together, and now they have departed to take charge of their own families of students.

The first thing I notice about new PTE majors isn't that they are so young or "nontraditional" – of which we usually have both – but that they are so few in number. Granted, Illinois State University does have one of the largest PTE programs in the nation with 20-25 majors. Still, with 20 other teacher education universities in Illinois we collectively will graduate only about 10-12 physics teaching majors during a typical year. When I realize that this is probably less than half of the qualified high school physics teachers who will retire or otherwise depart the teaching profession, I can't help but wonder what's happening in our high school physics classrooms. It is likely that over time more and more of our physics classrooms will be staffed by less than completely qualified physics teachers. The same is true in the other secondary-level science disciplines.

In addition to reflecting on the small number of incoming PTE majors, I can't help pondering about my five spring graduates. They are now in the first days of teaching in new settings, with new faces, and under new conditions. While I believe that my teachers are well qualified to teach, as a "parent" I can't help but worry. Will they have all the resources they need? Will they respond appropriately to any situation that might arise? Will they loose interest in teaching because of sometimes trying conditions? Will they have someone to turn to in need? Will they hang in there during the tough times, or will they become disgusted and leave the career they have long prepared for?

As a teacher educator, I've come to realize that as far as high school physics teachers are concerned, it is not easy come, easy go. The number entering this profession is too small, and those leaving is too large. As high school, community college, and university physics teachers and teacher educators we all must work to recruit new teacher candidates, and support those in preparation and teaching in our schools for the first time. It's not too late now to consider lending a helping hand to transitional physics teachers. As a high school teaching colleague, reach out to a novice teacher. Offer that helping hand, ask questions, and lend support. As a teacher educator, reach out to your recent graduates and support them during this difficult transition time. A "care package from home" in the form of useful computer files or e-mail messages providing reminders or a word of support, will be greatly needed and warmly received. Offering to answer questions and provide advice will be helpful even to the most qualified. All of us also need to think about and become proactive in the search for and recruitment of new physics teachers. A properly timed suggestion, a kind word, might make the difference in a physics student's career plans. With recent improvements in teacher preparation following new standards, we have much to offer. Let's both individually and in concert build up and work to support our family of physics teachers at every level.

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The following individuals have graciously agreed to serve as editors and reviewers for this publication. This publication would not be possible without their assistance.

Physics teachers' concepts of statistical significance.

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This study used a multi-participant case study research design to investigate prospective and practicing secondary school physics teachers' conceptions of statistical significance. Specifically, the researchers examined how each of three participants evaluated the statistical significance of differences in scientific data that were presented in hypothetical scenarios that described students' data and conclusions. In this study, the participants tended to integrate understandings of physics subject matter with conceptions of variance, experimental design, and instrumentation in their critical evaluation of the significance of differences in data. This tendency suggests that teacher education curricula should encourage prospective and practicing physics teachers to further develop these types of complex, integrated understandings of scientific data. The authors recommend that prospective and practicing physics teachers engage in both original scientific research as well as the transformation of their research procedures and findings into an evidence-based scientific argument suitable for publication in a refereed journal.

Introduction

Some researchers in the science education community have suggested that concepts involved in data interpretation (such as those related to variance) have been grossly underrepresented in K-16 science instruction (Driver, Newton, & Osborne, 2000; Duschl, 1990). McDermott (1990) attributed such underrepresentation in part to the prevalence of confirmatory laboratory courses in many secondary and post-secondary science programs, leaving little time for more conceptual studies. This apparent disregard for the development of data interpretation concepts has been linked to many students' inability to critically evaluate scientific claims (Solomon, 1991).

In response to research findings such as these, the *National Science Education Standards* (NRC, 1996) formulated a vision of science learning where students engage in "weighing the evidence, and examining the logic so as to decide which explanations and models are best" (p. 175). This vision is consistent with the views of scholars such as Latour and Woolgar (1986), who described an accurate picture of the nature of scientific activity as including the weighing of evidence/data and the critical assessment of explanations and knowledge claims.

To this end, *Science for All Americans* (AAAS, 1989) suggested that students need guidance in "collecting, sorting, and analyzing evidence, and in building arguments based on it" (p.201). Engaging students in these ways raises an important question for science teacher educators: what types of understandings should science teachers have in order to provide such guidance?

Teacher education scholars and researchers have suggested that teaching for understanding requires rich and flexible subject matter knowledge (e.g., Borko & Putnam, 1996; Grossman, 1990; Shulman, 1986; Smith & Neale, 1989). Similarly, helping students think critically about scientific evidence likely requires that teachers possess appropriate conceptions related to scientific evidence. Specifically, Gott and Duggan (1996) suggested that one's ability to critically evaluate scientific evidence might be supported in part, by a distinct set of conceptions pertaining to the reliability and validity of scientific evidence. The research described in this paper was influenced by this viewpoint.

Science teachers' conceptions of the reliability and validity of scientific evidence has received little attention in the research literature; only a small number of studies have examined science teachers' evaluations of scientific evidence and knowledge claims (e.g., Jungwirth, 1985, 1987, 1990; Jungwirth & Dreyfus, 1992; Nott & Wellington, 1995).

Nevertheless, these studies have been important to the field: in them, prospective and practicing (primarily life science) teachers responded to hypothetical scenarios that described experiments, data, and in some cases, conclusions based upon the data. Some of the scenarios contained conclusions that were based upon a single observation while others contained conclusions that were based upon insignificant differences in data. These scenarios were grounded in biological as well as "everyday" (non-curricular) contexts.

In his study, Jungwirth (1985, 1987) asked science teachers to respond to these scenarios in two different ways. He used a multiple-choice protocol, which required the teachers to select among several different "opinions" of the students' experiment (see sample items in figure 1) and, in a 1990 study, he employed a more open-ended protocol in which science teachers provided extended responses to the hypothetical scenarios.

Table 1 illustrates how a sample of 39 South African science teachers (29 in-service and 10 student teachers) responded to the items above. Jungwirth discovered that a very small percentage of the science teachers were concerned that only one bean plant

1. 150 members of a sports club prepared for a marathon. Group A (50 members) took part in 20 training sessions. Group B (50 members) took part in 15 training sessions. Group C (50 members) took part in 10 training sessions. 48 members of group A successfully completed the marathon. 46 members of group B successfully completed the marathon. 44 members of group C successfully completed the marathon. What is your opinion?

(a) The results were to be expected, since it is well known that in sports those who train more succeed better.
(b) The difference between the three groups is too small to allow conclusions.
(c) In this case the results show clearly that an increase in training results in an increase in achievement.
(d) I don't agree with any of these choices.

2. A grade 8 class performed the following experiment: They grew one bean plant at 10 degrees Celsius and another at 30 degrees Celsius. All other conditions (soil, water, light, etc.) were the same. After several weeks, the plant grown at 30 degrees Celsius was almost twice as tall as the other one and much better developed. What is your opinion?

(a) The experiment shows that a temperature of 30 degrees Celsius is much better for beans than one of 10 degrees Celsius.
(b) It is well known that warmth is needed for plant development, so the results could be expected.
(c) There are many different kinds of beans, some like higher and some like lower temperatures, and this explains the results.
(d) I don't agree with any of these choices.

Figure 1. Sample multiple-choice items: Adapted from Jungwirth, 1985, 1987.

was tested at each temperature. In addition, he found that only a slightly larger percentage of the teachers recognized that the differences across groups in the number of sports club members finishing the marathon were quite small and could have resulted from random variation as well as any number of factors besides training time. The small number of teachers recognizing experimental issues becomes especially troublesome when one considers the recommendations of influential reform documents such as *Benchmarks for Scientific Literacy* (AAAS, 1993). This document suggested that students' understanding of the nature of science include the notion that "when similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant" (p. 7). Clearly, the judgment process is complicated.

Respondent Science Teachers	% Selecting Option B in Item 1	% Selecting Option D in Item 2
(n=39)	27%	6%

Table 1. Science teachers' responses to Items 1 and 2 in Figure 1. Source: Adapted from Jungwirth (1985)

Regarding this process, Jungwirth (1985) described "a lack of knowledge of certain sets of *simple* rules relating to the acceptability or admissibility of evidence and the permissibility of extrapolation in general, and in scientific methodology in particular" (p. 59). Jungwirth's conclusion regarding a limited knowledge about scientific evidence strongly suggests potential foci for research and development issues in science teacher education.

The work of Jungwirth and others has begun to inform science teacher educators as to the nature of science teachers' conceptions of both appropriate sampling techniques as well as statistical significance. However, these studies were conducted primarily with life science teachers and did not examine these conceptions within other disciplines such as physics. The research project on which this paper is based, helped fill a void in the literature by examining conceptions of statistical significance held by physics teachers in physics-specific contexts.

Purpose of the Paper

The principal aim of this paper is to describe the collective conceptions of sampling and statistical significance held by a group of three secondary school physics teachers. The focus on sampling and statistical significance is a sub-study in a larger research project (see Taylor, 2001; Taylor & Dana, 2001) that attempts to explain the nature of physics teachers' conceptions of scientific evidence. Specifically, the sub-study described here was designed to address the following research question:

- When presented with hypothetical scenarios that describe unsound experimental procedures or poorly supported conclusions (or both), what concerns related to the sampling of data or the significance of differences in data will the prospective and practicing physics teachers raise?

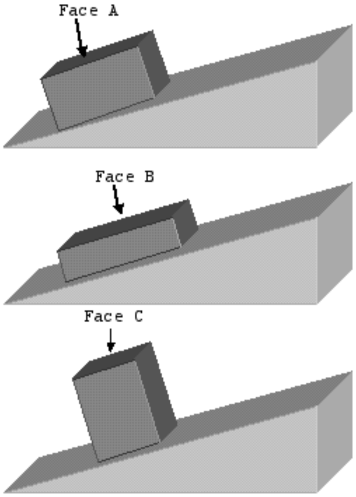
Research Methods

Since the principal purpose of this study was to describe secondary school physics teachers' conceptions of sampling and the significance of differences in data, descriptive case study research methods were deemed most appropriate (Creswell, 1998; Merriam, 1988). Since this case was informed by data from multiple participants, it can be thought of as a *collective* case study (see Stake, 1995). In this study, participants were selected because they possessed varying amounts of physics teaching experience. One participant was recruited from each of the following points in their careers: early in the teacher education program (Betty), during the first year of teaching (Kurt), and after 11 years of teaching (Nina). Differences were expected among these participants because it was assumed that experience with student-generated data and conclusions based on data might promote the development of certain conceptions of scientific evidence. The authors intended to highlight these differences in an effort to thoroughly describe the case.

The protocol used in this research required the participants to respond to two hypothetical classroom scenarios that were developed especially for this study (see figures 2 and 3). These scenarios, which were grounded in electricity and inclined plane contexts, described student-designed experiments, and when appropriate, corresponding student-generated conclusions.

The authors analyzed the participants' written responses as well as audio taped discussions held with the participants as they constructed their responses. The rationale for this protocol was based in part on previous research that suggested responses to hypothetical scenarios or passages were potentially reliable measures of selected critical thinking skills (e.g., Jungwirth, 1987; Kitchener & King, 1981).

10. One of the student groups suspected that the minimum applied force necessary to overcome friction depended on how the block was placed on the incline. That is, the minimum applied force needed to initiate motion up the incline would vary when the block was placed on each of its three, different sized faces (see figure below).



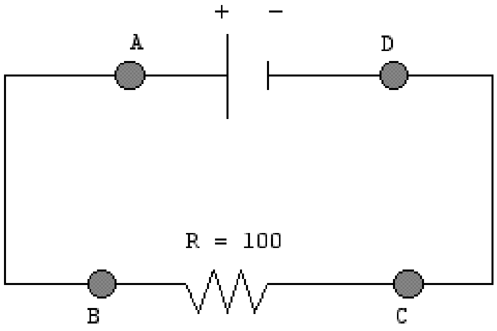
Using the spring scale provided, the students pulled just hard enough on the block to initiate motion. This was done: once on Face A, once on Face B, and once on Face C. The students concluded that the minimum applied force necessary to initiate motion depended on the size (area) of the face that the block was dragged upon. The students supported this conclusion with the data provided in the table below.

Face	Required Applied Force
A	9.70 N
B	9.65 N
C	9.75 N

How would you respond to this group's evidence? Explain.

Figure 2. Item 10 from the *Analysis of Classroom Passages Surveys* (Inclined Plane)

10. One of the student groups suspected that the amount of current in a series circuit depended upon the location in the circuit at which the current was measured. The students investigated this hypothesis by constructing the circuit diagram shown below and varying the placement of the ammeter each time. The ammeter was placed at locations: A, B, C, and D. The circuit was not changed in any other way. A current measurement was taken when the ammeter was placed at each of the locations.



The students supported this conclusion with the data provided in the table below.

Location	Current
A	1.25 A
B	1.24 A
C	1.23 A
D	1.23A

How would you respond to this group's evidence? Explain.

Figure 3. Item 10 from the *Analysis of Classroom Passages Surveys* (The Resistance of a Wire)

Findings and Discussion

The overarching theme in the findings of this study was that the participants were rarely critical of conclusions drawn upon statistically insignificant differences in data. Specifically, the participants did not always recognize flaws in experimental design or statistical insignificance. This pattern was especially evident in the inclined-plane based scenarios. The following illustrative excerpts were taken from the participants' written and oral responses to the items in figures 2 and 3. In the hypothetical scenarios described in figures 2 and 3, the students based conclusions upon differences in data that might be thought of as insignificant or fortuitous. Specifically, the differences in the data could be attributed to limitations in the sensitivity of the instruments or simply to random variation.

Consistent with the findings of Jungwirth (1985, 1990) the interview excerpts suggested that the participants did not always

Betty (inclined plane):

I: How would you respond to that?
B: Umm...I would agree with it. But umm...you would think that if they're sliding it along this, this face, there's gonna be a lot more friction acting on it as it moves along.
I: Just to be clear, they were measuring the force that it took to initiate motion, not to keep it moving.
B: Right.
I: So, they took the reading just before it started to move,
B: Right.
B: Okay. I think I would still stick with that answer.

Kurt (inclined plane):

I: How would you respond to this group's evidence?
K: I would discuss with them and ask them if they thought that one trial for each was sufficient. I would say that those trials by themselves are not enough to umm...garner, you know, enough information to make that kind of a relationship.

K: Also, I would ask them to look at the average for all three trials and look at the distance from the average that each trial was.

K: I would discuss the relative errors that are in this lab. Are the distances from the average enough to give us relationships or are they most probably resulting from the error in this lab? How accurate are our spring scales, Is it plus or minus, you know, a half? Is it plus or minus point one newtons. To see what kind of a range surrounds that value.

Nina (inclined plane):

I: So they concluded that the applied force required to initiate motion up the plane depends on the face that it's on. What would you...how would you respond to that?
N: Well, I would agree somewhat, Umm...I would say it does vary somewhat.

Betty (electricity):

I: So, what do you think about that conclusion?
B: Well, I don't think that conclusion is correct because I think the current in a series is the same everywhere.
I: So, if they continued to see this difference, what would you...
B: I don't know. I really... But to my knowledge, I would think the current would be the same everywhere in the series circuit. So...
I: So, if the student says, well, what about this difference (in data)?
B: I'm not sure.

recognize experimental design flaws or the insignificance of differences in data. Further, the participants' responses indicated that their evaluation of the significance of differences in data was influenced by their knowledge of physics subject matter. That is, the participants' recognition of the statistical insignificance of the differences in data reported in these scenarios was, at times, inhibited by limitations in their understanding of physics concepts. For example, in the inclined plane context, Betty did not express concern with the students' conclusion. This observation seemed to follow logically from the remainder of her response, which indicated that she expected the amount of force necessary to initiate motion to vary predictably with the area of the surfaces in contact. Similar limitations in subject matter knowledge of mechanics have been documented in research with students *and* teachers of physics (e.g., Finegold & Gorsky, 1991; Palmer, 1997; Trumper, 1996).

It should be noted, however, that Betty's response in the electricity context suggested that a critical evaluation of the significance of differences in data does not depend solely on knowledge of physics subject matter. She correctly expected that measurements of electric current in a series circuit should be similar, and this alerted her to a problem with the students' conclusion. However, she was unsure of how she would help the students evaluate the significance of the differences in current measurements.

Nina's responses also demonstrated the influence of her knowledge of physics subject matter. She did not express concern with the differences in applied force measurements reported in the scenario nor did she express an expectation that these values should be similar. In contrast, her expectation of constant current values in the electricity experiment seemed to focus her attention on the significance (magnitude) of the discrepancy in the current measurements. Along with her concern regarding the magnitude of the difference between electric current measurements, Nina also expressed a concern with the number of trials conducted in the experiment:

> N: Additional trials would be needed to support their evidence. One trial just isn't enough to really conclude that statement.

Nina's concern about limited trials clearly focused on the number of trials taken at each ammeter location. Her apparent focus on repeated trials in this research prompt was consistent with a previous statement in which she mentioned that the need for repeated trials had been "drilled into" her in her undergraduate physics courses.

Kurt also expressed concern with the single trial experimental design. The solution he proposed included not only the incorporation of additional trials but also an examination of the variance within those trials. Kurt's concern with the conclusions drawn by the students was also based upon issues related to instrument precision. He mentioned the amount of estimation that occurs when the needle of an instrument falls between two

<u>Kurt (electricity)</u>:

I: How would you respond to this group's evidence?
K: I would discuss with them the error that we have in taking our data and show them that this discrepancy is most likely coming from this error and not from a change in current. If necessary, I would take the students through an error analysis to see just how accurate our data is. This would include how much of our reading was estimated by the students and other variables that could introduce error to our lab.

K: I Would probably talk them through errors in our...in our ammeters.
I: So, would this ammeter allow a student to make the conclusion (Each participant was shown an ammeter with a range of 0-500mA and scale demarcations every 10mA)?
K: Umm... Generally on that order, if that (the difference in data shown in the table) was the discrepancy that we were having, I would say no.
I: Why?
K: We can get somewhat accurate on these, but we're still looking at one division being that, you know, that hundredth of an amp. And being off one division is not... You know, it's not a significant enough...
I: It's not significant enough?
K: Plus or minus one division on any kind of a scale is certainly within reasonable error unless we've got a truly accurate and precise...
I: So, in general, you would have a problem with them drawing a conclusion based upon those differences?
K: Yeah. Yeah.

<u>Nina (electricity)</u>:

I: How would you respond to this group's evidence?
N: I would think the values (current) should be the same. That's what I would think because of the series circuit. I would need to do the experiment to agree with my students' findings. I think that the students need a greater difference to prove the hypothesis.

subdivisions on a scale and how this estimation influences the precision of the measurements. In addition, Kurt's reference to a measurement being "plus or minus" a certain value suggests that he associates a certain amount of unreliability (tolerance) with each measurement. His response indicates that his evaluation of the significance of a difference in data involves knowledge of the reliability of the instrument being used.

In sum, the collective responses of the participants suggested that several different types of understandings were integrated to evaluate the significance of differences in data. Collectively, the participants accessed their understandings of physics subject matter (e.g., friction), instrumentation (e.g., precision), experimental design (e.g., sampling), and variance (e.g., confidence intervals) while making this type of judgment.

Implications for Future Research

Currently, the literature base lacks adequate breadth to properly inform physics teacher education as to practicing and prospective teachers' conceptions of experimental design and statistical significance. In this study, the authors grounded their examination of the participants' conceptions in the contexts of the inclined plane and electrical circuits. These contexts, though important, constitute only two of many possible physics contexts that could have been used in this research. Future research might augment the findings of this study and those of Jungwirth and his colleagues by investigating science teachers' evaluation of experimental design and statistical significance in other physics contexts or in other secondary school science domains (e.g., chemistry, earth science).

Future research might also examine some other intriguing issues that emerged in this study. For example, Betty described her undergraduate physics experience as one where the need for repeated trials had not always been "emphasized" as much as it had with Nina. The difference in Nina and Betty's teaching experience raises important questions about the differences in their respective rationale for repeating trials. It seems possible that in the time since Nina's teacher preparation program, advances in science-specific educational technology such as the development of sensitive probes and computer-based data collection techniques may have inspired a change in how undergraduate physics investigations are designed. Further, these same technological advances may have initiated a change in how scientific inquiry and the nature of science are represented in undergraduate physics courses.

If such a change has indeed occurred, it is possible that Betty's conceptions of the need for repeated trials reflect the implicit messages being sent by contemporary practices in undergraduate physics education. Future research might investigate whether or not the discrepancy in rationales (for repeating trials) observed across Betty and Nina's responses is in fact widespread across novice and veteran science teachers. Further, future research might investigate the influence of prospective science teachers' perceptions of the reliability of computer-based data collection techniques on their rationale for repeating trials.

Implications for Physics Teacher Education

Critically evaluating the significance of differences in data required the participants in this study (collectively) to use physics subject matter knowledge in conjunction with understandings of instrumentation, experimental design, and statistics. This finding is closely aligned with the notions of Schwab (1964, 1978) who was one of the first to suggest that two different types of understandings constitute well-developed subject matter knowledge. These understandings included knowledge of the essential concepts, principles, and theories of the discipline, as well as knowledge of the canons of evidence that guide inquiry in a discipline. Schwab referred to these as *substantive* and *syntactic* knowledge respectively.

The researchers suggest that physics teacher educators nurture the effective partnership between substantive and syntactic knowledge that was demonstrated in this study. This would require both substantive and syntactic knowledge be emphasized to a greater degree in physics teaching methods courses. This suggestion is consistent with those of numerous scholars and researchers who have recommended a renewed emphasis on subject matter knowledge in physics teacher education courses (e.g., Abd-El-Khalick & Boulaoude, 1997; Lederman & Latz, 1995).

Some in the science teacher education community have described what subject matter (substantive and syntactic) knowledge-infused instruction might look like. Friedler and Tamir (1986) developed an instructional module for use with high school biology students called *Basic Concepts of Scientific Research*. In this module, students discussed selected issues that relate to knowledge construction in science. The module culminated with the students conducting original (at least to them) scientific research. The final phase of the module was intended to help the students integrate science content knowledge with the key epistemological concepts of the module. Tamir (1989) described the positive results of the module and suggested that similar instruction be designed for prospective science teachers. Based upon their study of undergraduate physics students' conceptions of measurement errors and statistics, Sere, Journeaux, and Larcher (1993) also supported an integrated approach suggesting that instructional interventions concurrently address issues of subject-specific science and data evaluation.

The involvement of prospective science teachers in original scientific research has been recommended by a growing number of scholars and researchers (e.g., Grossman, Wilson, & Shulman, 1989; van Tilburg, Verloop, & Vermunt, 1999). Specifically, Grossman, Wilson, and Shulman (1989) suggested that: "In learning to conduct their own inquiries - scientific, historical, mathematical, literary, or otherwise - students learn the difference between evidence that is acceptable and unacceptable, sufficient and insufficient" (p. 30). Similarly, Gess-Newsome (1999) described original research as an activity that can help prospective teachers become familiar with the nature of knowledge construction and validation in a respective field.

The practice of encouraging students to conduct original research is quite common in colleges of science but usually does not occur until graduate school or at the advanced stages of a baccalaureate program. Often advanced level baccalaureate courses are not required in undergraduate physics teacher education programs. Since physics teacher education programs can require only a limited number of physics content courses, many prospective physics teachers complete their programs without ever engaging in original scientific research. These trends emphasize the importance of incorporating original research into physics teaching methods courses.

It is unlikely that the act of conducting original research, in and of itself, will fully support the development of substantive and syntactic understandings. The researchers suggest that prospective physics teachers augment their research experiences with activities that simulate other aspects of the scholarly work of scientists. This might include the adaptation of research methods and findings such that they are suitable for publication in a refereed journal. Such an activity would encourage prospective physics teachers to develop content understandings that would allow them to situate their research in the findings of others. In addition, preparation of a scholarly manuscript would help prospective physics teachers become familiar with established norms for describing procedures and instrumentation, reporting measurements, as well as, choosing and representing statistical tests.

The physics teacher who understands these norms is more likely to be capable of critically evaluating experimental data that is reported in his or her scientific field. These types of understandings may support teachers in their goal of staying abreast of new developments in the field. Therefore, teacher education programs should include instruction aimed at the development of both substantive and syntactic knowledge in their efforts to prepare prospective physics teachers as lifelong learners.

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JPTEO

A new model of physics teacher preparation.

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The University of Arizona has established a new science teacher preparation program within the College of Science. We describe the structure of the program and some initial results, and profile two of the preservice physics teachers in the program.

In 1999, the American Physical Society, the American Association of Physics Teachers, and the American Institute of Physics approved a joint statement regarding the preparation of K-12 teachers (American Institute of Physics, 1999). That statement read, in part "APS, AAPT and AIP urge the physics community, specifically physical science and engineering departments and their faculty members, to take an active role in improving the preservice training of K-12 physics/science teachers. Strengthening the science education of future teachers addresses the pressing national need for improving K-12 physics education and recognizes that these teachers play a critical education role as the first and often-times last physics teacher for most students."

In addition, several national commissions, including the National Commission on Teaching and America's Future (NCTAF, 1996) and The National Commission on Mathematics and Science Teaching for the 21st Century (NCMST, 2000), have urged higher education institutions to reevaluate their traditional practices in teacher education and transform or develop new teacher preparation programs to remedy major problems identified in these reports:

- Lack of coherence within the teacher preparation programs, fostered by the paucity of communication among subject-matter faculty, education faculty, and experienced teachers in the secondary school setting.
- Lack of connection and congruence between what is advocated (teaching for understanding) and what is practiced in the subject matter and pedagogy courses, and field experiences in the secondary school classroom.
- Inadequate subject matter preparation.
- Inadequate and unsupervised nature of school-based experiences of the student teachers.

In response to this call for improvements in initial teacher preparation, the University of Arizona has established a new science teacher preparation program within the College of Science. In this paper, we describe the history and structure of the new program, and results from the first two years of working with students. In addition, we profile two of the preservice physics teachers in the program, to characterize the range of backgrounds of our students as well as the dilemmas with which they struggle as they progress toward teacher certification.

History and Program Structure

The College of Science at the University of Arizona has had a long history of involvement in teacher preparation. Several departments within the college have offered subject specific methods courses. The Mathematics Department sponsors a teacher-exchange program in which high-school teachers serve as clinical faculty in the department and work with preservice teachers. Faculty members in the Department of Physics have taught special courses for preservice teachers and have served as university supervisors for student teachers. In addition, over the last ten years, subject area colleges at the University of Arizona have assumed a more active role in the preparation of secondary school teachers, while the College of Education has gradually refocused its teacher preparation efforts at the elementary school level.

In 1999, the College of Science embarked on a new program in teacher preparation. The underlying theme of this new program is to closely couple science content and science pedagogy by preparing future teachers within the College of Science (CoS). The Provost authorized four new faculty positions within the college to focus on secondary teacher preparation. In order for departments in the college to provide a home for a new faculty member, each interested department had to make a commitment to this new expanded role in science teacher preparation. As a result of the search process, three new faculty members were hired, one each in the departments of Physics, Chemistry, and Molecular & Cellular Biology. In 2001, we added a fourth faculty member, whose home department is Astronomy.

During the 1999-00 year, the new faculty members designed the program, in collaboration with other faculty in the Colleges of Science and Education, as well as local science teachers. The new program is aligned with research on teacher preparation

(Anderson and Mitchener, 1994; Howey, 1996), and recent calls for reform of science education (AAAS, 1993; NRC, 1996, 1997, 2000). This program is housed entirely within the CoS, with all pedagogy courses designed for undergraduate science majors and taught by science education faculty members. The first classes were offered in fall 2000.

The new program includes 30 credit hours of science education courses, most of which include a field component:

- Teaching Science (3 credits; 20 hours field experience)
- Adolescent Development & Learning Science (3 credits; 20 hours field experience)
- Science Instruction in Secondary Schools (4 credits; 45 hours field experience)
- Curriculum Decisions & Assessment in Science (4 credits; 45 hours field experience)
- Subject Methods Courses in Physical Science, Biology, or Earth Science (3-4 credits)
- Science Teaching Practicum (12 cr; 18 wks student teaching)
- Science Teaching Seminar (1 credit)

In addition to developing a suite of science education courses, we have developed a set of Core Understandings to guide our work with preservice teachers. These form the underpinnings of all of the science education courses and guide assessment of both students and the program (see Appendix).

Students can remain in their science degree programs and complete the 30 credits of science education courses in order to be eligible to apply for teacher certification. Alternatively, students can enroll in a new degree program, B.S. in Science Education, with concentrations available in Biology, Chemistry, Earth Science, and Physics. Currently, most of the students in the program have opted to remain in their science degree programs and complete the additional 30 credit hours of science education. This is perhaps one of the most attractive features of the program from the students' perspective.

After students complete the program and receive their teacher certification, we continue to support them. The model that we have adopted for our Beginning Teacher Support Program is that of educative mentoring (Feiman-Nemser, 2001), which is based on a vision of good teaching embodied by our Core Understandings and works to guide new teachers in improving their implementation of those understandings. Our teachers-in-residence, whose role is more fully described in the next section, observe the new teachers frequently, and then discuss their observations, guided by the Core Understandings. In addition, new teachers meet quarterly as a group to share experiences and learn from each other. We also provide funds for the new teachers to travel to professional conferences and take graduate courses. Although the CoS Teacher Preparation Program (CoS TPP) has just finished its second year of operation, there are early indicators of success. During the first academic year of the program, 27 science majors completed at least one of the science education courses and, in the second year, the enrollment in our introductory course has almost doubled. We currently have five program graduates teaching and anticipate that an additional six students will complete their student teaching during the 2002-03 academic year. In addition to our on-campus courses, beginning in the fall of 2002, we will offer the first course in our program at the local community college, to recruit prospective science teachers who will then transfer to the UA to complete their degree programs.

Key Partnerships

The early success of our program has been heavily influenced by the partnerships we have formed with area science teachers (Talanquer, Tomanek, Novodvorsky, Slater, in press). Utilizing funds from the Howard Hughes Medical Institute, we have been able to invite teachers to spend a year working on campus with the TPP, providing a critical "real classroom" perspective. In spite of the fact that all of the core faculty members in the program have secondary classroom experience, the preservice teachers perceive the experiences of the teachers-in-residence as more relevant. The teachers-in-residence help to teach the science education courses, coordinate the field experiences, and do field supervision of student teachers and beginning science teachers in our induction program. In the first two years of the TPP, six middle and high-school life-science teachers have served as teachers-in-residence. Beginning in fall 2002, we will also support a physics teacher-in-residence through funding provided by the National Science Foundation to the Physics Teacher Education Coalition (PhysTEC.) With funding from a private donor, a chemistry teacher-in-residence will join our program in fall 2003.

Another key partnership is with the mentor teachers from throughout the community who serve as hosts for the preservice science teachers. These teachers are program partners, and as such, they have assisted in the development of the tasks that preservice teachers complete in their classroom and contribute to the assessment of the preservice teachers. In addition, these teachers meet with us monthly to advise us on aspects of the program, provide feedback on the field experiences, and discuss issues regarding teacher knowledge and retention. Their participation is currently funded by the Arizona Board of Regents through the Eisenhower Mathematics and Science Education Act. About 30 middle and high school science teachers serve as program mentors.

Focus on Physics Teacher Preparation

In order to illustrate the impact of the program, we present profiles of two of our preservice physics teachers. Each of these students has completed 17 credit hours of our science education courses and will student teach during the fall 2002 semester. However, they bring quite distinct backgrounds and strengths to their work as CoS TPP students.

Paul

Paul is a physics major with an astronomy minor who has completed 48 credits of physics, and 16 credits of astronomy. He first became involved in our program in fall 2000; he had been planning to do graduate work in astronomy, but he was finding that astronomy research didn't appeal to him anymore. However, he enjoys amateur astronomy and geology, and working with people, so he wanted to explore the possibility of teaching.

Paul has been successful in his course work, maintaining an overall GPA of 3.5 (on a 4.0-point scale), and a science-course GPA of 3.4.

Paul has been enrolled in our program since fall 2000, and has delayed his graduation by one semester in order to complete his student teaching in fall 2002. As he finished his physics course work, Paul was able to articulate a coherent view of physics guided by big ideas. In this sense, Paul is atypical of many undergraduate science majors, who tend to view their major field as a sequence of topics defined by the courses they have taken (Hauslein, Good, & Cummins, 1992; NRC, 1999). However, as do many preservice teachers (Anderson, et al., 1995), Paul has struggled with convincing himself not to teach as he was taught in science courses for so many years. As noted by Carter and Doyle (1995), many preservice teachers conclude that lecturing can produce active student thinking because they were active thinkers during lectures, especially in courses in their teaching major.

Early in the course, Science Instruction in Secondary Schools, which includes a seven-week field experience, Paul was able to distinguish between different approaches to teaching students. He wrote in his weekly journal,

> *For instance, in [the field experience] classroom this week, I was surprised by the significant lack of "lecturing", instead having short explanations followed by the students working on problems amongst themselves. On the surface, in the conscious part of my mind, this was a wildly different way of teaching, compared to what I saw as the standard paradigm of science instruction. But deep in my mind, I knew that this was the "right" way to teach; let the students learn by doing. As I sat writing this paragraph, I put it all together and realized why. Because in research science, the paradigm is working through the problems, struggling with the concepts, but when it all comes together, it's like daylight. The standard teaching paradigm I'm so used to from many years as a student is the teacher lectures, and then we do simple homework, and confirmatory labs. I was finally seeing science teaching being done like science, and that's why I knew deep down that it was "right".*

Later in that semester, Paul was able to clearly articulate what he perceived as a conflict between how he had learned science and how he was being prepared to teach science:

> *It seems there is a conflict between the ideas of "learn now, understand later" and "develop a functional understanding now, and then add the concepts." Is one really better than the other? I learned science (fairly well, I would say) from the former model, while the [science teaching] classes are primarily focused on the latter model. Is one better for more advanced classes who are able to build internal conceptual maps "on the fly," while the other to be used for introductory-level students who need to be able to "see & feel" something to really get it? I guess I'm torn myself, because I'm used to learning with the first model, but I see that, from a teaching perspective, it may be better to use the second model even though it takes more time and effort on the parts of both the students and teacher. Is the "most efficient" teaching style really the best way to learn?*

By the end of the semester, as he was preparing to finish all his on-campus courses and student teach, Paul expressed his realization that the process of changing his model of teaching will be a long-term and continuous one.

> *I guess one of my stumbling blocks is that I can cognitively think about the best ways of teaching physics, but when I plan or actually teach, I'm back in the compartmentalized picture I grew up with pedagogically. I need to learn how to apply these ideas about teaching that I know are better at promoting overall long-term student understanding to my actual teaching. At times I almost feel like a smoker who knows those things will kill him, but continues to light up anyway. I know that my own teaching will eventually come in line with what I believe to be the better way to teach, but it seems like a long process.*

In addition, Paul has struggled with the purpose and goals of teaching physics, and whether he should focus on a small subset of physics topics or try to expose students to a wide range of physics topics. This became especially clear near the end of his third semester, as he worked on creating a rationale for teaching physics and a yearlong syllabus in his Physics Teaching Methods course.

> *So, what do I do with my own classroom next year? My inclination is to teach all I know about physics, because it is neat, and because I learn that way best. It is frustrating to have to pare down the content to help the students "understand" it better, but will they really learn anything that they will take with them? I mean, REALLY learn anything useful to them? I would think probably not. And the ones who are interested in physics will benefit from the wide coverage because it will show them all the wonderful ideas physics has to offer. So why bother with all the in-depth inquiry? Just give them a straight answer and go on. They may be more grateful in the end.*

After several discussions with the instructors, both in class and via e-mail, Paul came to the following conclusions to guide himself toward student teaching:

> *It has been a challenging semester in terms of defining what it is I believe about physics teaching. I have wondered why should we even bother teaching the stuff, but I have also seen a lot of neat connections between physics taught in the classroom and students' everyday experiences. I think I end the semester and embark on my student teaching on a positive note, seeing how fun physics can be, and using it as a springboard to help my students get a little closer to becoming critically thinking, scientifically literate members of*

> *society. I think some of my questioning and apprehension has come from the false impression that my classroom has to carry the burden of teaching the students all of physics, and ensuring they are excellent critical thinkers, and making them aware of everything that is scientific literacy, and . . .*

Through his involvement in the CoS TPP, Paul has been guided to confront his own ideas about teaching, gained from his long "apprenticeship of observation" (Lortie, 1975). At this stage in his professional development, he has come to the conclusion that he should not, in fact, teach as he was taught. The message he has received in all of the science education courses and field experiences is that he needs to create opportunities for his students to struggle with concepts and come to their own understanding, albeit with his guidance. In addition, his journal entries suggest that the TPP experiences influenced his thinking as he struggled with the classic "breadth vs. depth" dilemma. In guiding him to identify and articulate his goals for teaching physics, we were able to help Paul recognize and appreciate the multiple goals of effective secondary teaching. Paul's comments clearly show he is looking forward to his student teaching experience, and we are optimistic that he will continue to focus on student understanding as his ultimate goal for teaching physics.

Dennis

The second preservice physics teacher we wish to profile is Dennis, who entered our program after having completed a B.A. with a philosophy major and physics minor, and has completed 34 units of physics courses. His overall GPA is relatively weak, 2.7 overall with a 2.5 in his physics courses. By his own admission, Dennis has struggled with some physics concepts, and in using mathematical techniques in problem solving. To address his weaker content background, we arranged for Dennis to serve as a special tutor for two introductory physics courses, and earn independent-study credit in physics. He provided two to three hours of tutoring each week over two semesters, which required him to do all of the assigned homework problems and prepare to answer students' questions. The content focus for those two semesters was mechanics, thermodynamics, and relativity. In addition to the tutoring sessions, Dennis also assisted with the lab sessions in these courses, which are being reformed to be more inquiry focused. Dennis attended at least two sessions of lab every week, modeling questioning strategies for the supervising Graduate Teaching Assistants and answering students' questions.

To determine whether this tutoring experience resulted in improved content understanding, Dennis was given conceptual instruments in a pretest/posttest format. His pretest scores were higher than we expected given his lack of confidence and his low grades in the related physics courses. On the Force Concept Inventory (Hestenes, Wells & Swackhamer, 1992), his pretest score was 87% and his posttest score was 90%. On the Heat and Temperature Conceptual Exam (Thornton & Sokoloff, 2001), his pretest and posttest scores were 64% and 75%, respectively. Although these test results are inconclusive regarding the benefits of the tutoring experience, Dennis' own impression was, "As time progressed this semester, tutoring was the primary source of my increased confidence in physics."

As a corollary to his struggles with content knowledge, Dennis struggled with being comfortable "performing" in front of a class and being fluent with the material (NRC, 1999). After a week of teaching a high-school physics class, Dennis commented,

> *The weird part is, I don't generally think of myself as unsure of myself. But what I do know about myself is that I get "stage fright" (except when I'm really on stage!!!) [Dennis is also a member of a musical group that performs regularly in the community.] It's almost as if the buffers in my brain need a little boost to get the knowledge queued up, but once it's there, I know I've got it. So, compared to someone like [my mentor teacher], or you, or [another physics professor], where it seems like you can access random knowledge at the drop of a hat, I have to dig through mental scraps of paper before I find it. When that happens I feel embarrassed for myself and when it happens in front of someone it's even worse. I've got to get to a place inside my head where not knowing something doesn't make me feel self-conscious.*

The other issue that Dennis has confronted during the course of the last three semesters is the belief that he is a prototype of his students (Holt-Reynolds, 1992). Since Dennis is very comfortable learning on his own by tinkering with things, he believed that his students would be able to learn in that way as well. "I came into this program with the idea that you could just set a student in front of something and say 'go' and they will learn." As he progressed in the program, his journal entries show that, he was beginning to recognize that not all students learned in this way, and that he needed to provide direction for their exploration. However, he still struggles with how to balance students' interests and his learning goals:

> *If they develop questions that they want to pursue on their own, I don't want to squelch that! But how can we move along in a class if the students actually get interested in something we've surveyed and they want to study it in more depth? Do you say, "Sorry, we have to move along?" But if you did let students take on their individual projects, how could you possibly manage it?*

Related to this is the issue of just how much guidance to provide students in a given activity, and how that relates to his approach to classroom management.

> *One of the difficulties that I've faced is that I find my experiences sometimes contradict each other. I might decide to steer away from learned helplessness and enforce a classroom that will demand that students really think on their own. Then the lesson flops because students don't know what to do. On the other hand, I model. I show students exactly what to do and they don't learn a thing but everything appears to go smoothly.*

Dennis will need to continue to improve both his knowledge of physics content and his self-confidence with fluent retrieval of that knowledge. His mentor teacher for his last field experience, who herself holds a Ph.D. in Astronomy, reported that she focused on helping Dennis to better comprehend the physics that they were teaching. His student teaching mentor is a teacher who has extensive experience using the "modeling method" of physics instruction (Wells, Hestenes & Swackhamer, 1995). We expect his work in this classroom to help him gain greater mastery of physics content and increase his confidence. As Dennis prepares to begin his student-teaching experience, he commented, "I am excited to begin trying my ideas and engage in a scientific inquiry of my own and start testing hypotheses on what would work better in the classroom."

Dennis' participation in the CoS TPP has had an impact on his content knowledge of physics, and his fluency with that knowledge. We have provided targeted experiences (both in physics and in actual classrooms) for him to grapple with his own understanding of physics content and to practice guiding students' understanding of that content. In addition, we were able to challenge his thinking about his students sharing his learning style, and provide him with the knowledge and tools to create multiple learning opportunities for his students. As with Paul, we are optimistic that Dennis will retain a focus on student understanding as his goal for teaching physics.

Concluding Remarks

While it is not uncommon for Colleges of Science to have science educators among their faculty, and for those faculty members to be involved in teacher preparation, it is important to note that the CoS TPP has several unique aspects:

- The science education faculty in the College of Science are completely responsible for all aspects of the program, including course development, student and program evaluation, and field placements, with the help of the teachers in residence and mentor teachers.
- Although the program is completely housed within the College of Science, it does not belong to any one department.
- All courses are designed specifically for prospective science teachers, focus on science teaching or learning, and are taught by science education faculty,
- Students are able to remain in their science degree programs while completing the science education courses necessary for certification.
- Entry to the program is open to all interested students, while "exit" to student teaching and program completion is regulated by a series of performance assessments guided by the Core Understandings.

As an illustration of the benefits of a College-of-Science based program, we presented the cases of two preservice physics teachers in our program. One, Paul, is a strong physics student with traditional teaching baggage that he is struggling to reconcile with our focus on student understanding. Our program has provided him with opportunities to practice student-centered teaching and to reflect on the effectiveness of that approach, while also refining his rationale for teaching physics. The other, Dennis, is already convinced of the effectiveness of student-centered instruction but struggles with weak content knowledge. Our program has helped him to improve his content knowledge, not by having him retake physics courses, but by immersing him in a teaching situation in which he felt it necessary to know the content well enough to help other students. In addition, we have helped to refine his ideas about student learning styles. This close personal attention to the different needs of two preservice physics teachers is an example of the benefits of a comprehensive program whose faculty members are involved in all aspects of teacher preparation.

The College of Science Teacher Preparation Program, while in its infancy, has already sparked a strong interest among science majors to pursue a career in secondary science teaching. We currently have students who are preparing to teach in all the secondary certification areas of biology, chemistry, earth science, and physics. By providing courses that are built around Core Understandings and by linking the content of science to science teaching, we are guiding preservice teachers in the development of pedagogical content knowledge (Shulman, 1986) and are helping to prepare the next generation of science teachers.

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Appendix—CoS TPP Core Understandings

Prospective teachers will:

1. Demonstrate understanding of their science disciplines and the nature of science. They understand science deeply enough to build alternative representations of the scientific knowledge that are pedagogically sound and meaningful for diverse learners.
   a) Articulate and connect the central ideas in their scientific discipline.
   b) Demonstrate solid and coherent conceptual understanding of the central ideas and tools of inquiry of school-based scientific disciplines, particularly in their area of expertise.
   c) Critically reflect on the philosophical and social facets of the scientific work.
   d) Build multiple meaningful and appropriate pedagogical representations of the science content to be taught.
2. Demonstrate understanding of how adolescents learn and develop. They display a philosophy of teaching that focuses on students' understanding.
   a) Analyze and evaluate the central tenets of relevant theories of learning and adolescent development.
   b) Demonstrate knowledge and understanding of students' common alternative conceptual frameworks in science and the role that they play in learning.
   c) Use their scientific and pedagogical knowledge to conceive meaningful learning opportunities that recognize learners' diversity and focus on students' understanding.
3. Make coherent curriculum decisions that promote students' engagement in learning and understanding of science. They plan, implement, and assess lessons with the learning goals guiding their choices and actions.
   a) Identify and describe the curriculum/teaching decisions that influence learning outcomes.
   b) Identify and select coherent sets of long-term and short-term learning goals.
   c) Select and create meaningful activities that build upon students' interests and prior knowledge and promote understanding.
   d) Implement and evaluate diverse teaching strategies and materials to achieve the instructional goals and meet student needs.
   e) Select and implement assessment strategies that support understanding.
   f) Analyze assessment data to guide teaching.
   g) Assess the coherence of curriculum/teaching decisions that influence learning outcomes.
4. Create and manage a productive learning environment that fosters the development of student understanding.
   a) Demonstrate and use knowledge about human development, motivation and behavior to create an engaging, safe and supportive learning environment.
   b) Recognize, describe, and implement effective classroom management practices that are fair to students and support individual and group work.
   c) Recognize, describe and analyze the connection between effective classroom management and opportunities for student learning.
5. Establish clear communications and positive interactions with learners, colleagues, administrators, and parents. They are comfortable interacting with members of these groups and actively work to become a part of the school culture.
   a) Present ideas and information, outline expectations and desired behaviors, ask questions and facilitate discussions in clear and unambiguous ways.
   b) Interact with individual learners and groups of learners in ways that develop a climate of respect and rapport in the classroom.
   c) Collaborate with colleagues, administrators, parents and other members of the community to support student learning.
6. Acknowledge the complex and often unpredictable contexts in which teachers work. They manage the complexity in ways that support and sustain student learning.
   a) Identify the professional demands that compete for a teacher's attention.
   b) Identify and evaluate teaching and curriculum dilemmas and suggest possible actions.
   c) Assess teaching decisions in light of the competing demands and dilemmas that teachers face.
7. Reflect on classroom teaching to identify evidence of student understanding; thoughtful consideration of this evidence results in well-grounded decisions to improve practice. They are comfortable in continually questioning their own practice and beliefs, are open to constructive criticism, and actively seek out opportunities to grow professionally.
   a) Pose reflective questions about the teaching/learning process related to their own teaching and the teaching of others.
   b) Gather evidence to answer their own questions about the teaching/learning process.
   c) Use their knowledge of practical evidence to plan and implement changes in the classroom.
   d) Evaluate the learning outcomes of their actions and be open to the constructive criticism and suggestions of supervisors and colleagues.
   e) Reflect critically on their personal beliefs about science, and science teaching and learning.
   f) Self-assess their weaknesses and strengths and utilize human and institutional resources to develop professionally.

A service learning project for prospective high school physics teachers candidates.

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As part of the orientation, induction, and quality-control process for Physics Teacher Education at Illinois State University, physics education majors are required to participate in and successfully complete a semester-long Service Learning Project (SLP) while enrolled in a one-semester-hour course-- Physics 209–*Introduction to Teaching High School Physics.*

This course and the SLP normally are encountered during a student's junior year in the program. All physics teacher education majors are required to successfully complete the SLP prior to being granted admitted to the University's teacher education program. The purpose of the SLP is to determine on the basis of evidence whether or not the student has adequate content knowledge, intellectual and social skills, and appropriate dispositions required of all Illinois State University teacher candidates. Dispositions assessed are those explicated in the University conceptual framework for teacher education, Realizing the Democratic Ideal. All prospective teachers are expected to demonstrate a sense of responsibility, reliability, commitment, and interest in teaching all students prior to being admitted into the University-wide teacher education program.

Students receive twenty-five (25) clinical experience hours for full and successful participation. Additional hours are credited if they are appropriately documented. Teacher candidates "work collaboratively with other candidates and clinical faculty to critique and reflect on each others' practice and their effects on student learning with the goal of'improving practice. Field experiences and clinical practice facilitate candidates' exploration of their knowledge, skills, and dispositions related to all students. Candidates develop and demonstrate proficiencies that support learning by all students as shown in their work with students with exceptionalities and those from diverse ethnic, racial, gender, and socioeconomic groups in classrooms and schools" (NCATE Standards, Chapter 2, page 27). Experiences of the Service Learning Project include but are not restricted to structured activities taken from the ISU Clinical Experiences Handbook for Science Teacher Candidates and the Illinois Professional Teaching Standards.

- Interviewing and observing teacher practice
- Tutoring students
- Constructing grading rubrics
- Grading of homework, labs, quizzes, exams, etc.
- Setting up or taking down of demonstrations/labs
- Assisting with demonstrations/labs
- Researching new demonstrations/laboratory activities
- Learning/teaching new computer software/hardware
- Teaching minor components of class and/or laboratory activities.
- Working with students with exceptionalities and from diverse ethnic, racial, gender, and socioeconomic groups.
- Assessing the efforts of student peers
- Assisting with extracurricular duties
- Self-assessment of personal practice on student learning.
- Demonstrate required teaching competencies (knowledge, skills, dispositions) outlined in national, state, and professional standards.

Daily records of service are required for each student in the form of a service log, one per hour of SLP work. Teacher candidates critique and reflect upon their own and each others' practice and their effects on student learning with the goal of improving practice. Personal reflections are required in the form of a daily journal, bi-weekly reports (see page 22), and two essays, one relating to the teacher education unit' conceptual framework and the other explaining why the student wants to become a teacher. While participating in the SLP, students meet for class once weekly to discuss and'reflect upon experiences. At the middle and end of the SLP experience, student practice is assessed using a 21-point instrument (see pages 18-21). Using this instrument, all of the main character traits (knowledge, skills, dispositions) are evaluated by the cooperating high school teacher on the basis of experience with the prospective teacher candidate. Both at midterm and a the concluding evaluation the cooperating teacher makes initial and final recommendations about whether or not the student should be admitted to candidacy in the University's teacher education program. recommendation, students are temporarily barred from admission to teacher education. Following remediation and a successful follow-up SPL with another cooperating teacher, the student normally can be admitted to candidacy without any delay in the original anticipated graduation date.

The SLP was created with the assistance of Mr. Jim Kinsella, University High School, Normal, IL; Dr. Lawrence McBride, Department of History, Illinois State University; and Mr. Chuck Lormis, Regional Alternative School, Regional Office of Education, Normal, IL.

INSTRUCTIONS:

In each of the following areas please indicate your response to the prospective teacher candidate’s work by circling one point on the scale. Please do not skip any of the 21 indicators or mark them “not applicable.””All items represent demonstrations of <u>required</u> competencies for prospective teacher candidates. The scoring rubric is as follows:

1–Unacceptable: Prospective teacher exhibits no regard for expected behavior.
2–Weak: Prospective teacher attempts to exhibit expected behavior, but fails.

3–Acceptable: Prospective teacher implements expected behavior to a limited degree.
4–Strong: Prospective teacher regularly exhibits expected behavior.

- **TEACHER CANDIDATE’S KNOWLEDGE**

Please assess the teacher candidate’s content knowledge using the characterizations below. Please note that it is not the purpose of this section to judge intellectual ability. Rather, the purpose of this section is to help determine whether or not the teacher candidate possesses and illustrates holistically the basic content knowledge required of a teaching professional.

The teacher candidate:	**Midterm**	**Final**
1. exhibits an understanding of the central concepts of the subject matter to be taught.	1 2 3 4	1 2 3 4
2. explains subject matter in a manner appropriate to the level of student learners, including the use of analogies, relevant real-world experiences and examples, etc.	1 2 3 4	1 2 3 4
3. facilitates learning experiences that connect to other subject areas, students’’lives and career experiences.	1 2 3 4	1 2 3 4
4. uses a variety of explanations to help students understand key concepts.	1 2 3 4	1 2 3 4
5. demonstrates an understanding of scientific problem-solving processes.	1 2 3 4	1 2 3 4
6. elicits a variety of clear and accurate explanations to assist students gain understanding.	1 2 3 4	1 2 3 4

Comments: (mid-term review)

Comments: (final review)

• TEACHER CANDIDATE’S SKILLS

Please assess the teacher candidate’s intellectual and social skills using the characterizations below. Please note that it is not the purpose of this section to judge personality. Rather, the purpose of this section is to help determine whether or not the teacher candidate possesses and illustrates holistically the fundamental skill required of a teaching professional.

The teacher candidate:	**Midterm**	**Final**
7. interacts well with peers and superiors, takes direction well, responds well to recommendations.	1 2 3 4	1 2 3 4
8. demonstrates an innate ability to teach, appears to truly enjoy teaching and interacting with students, peers, and superiors.	1 2 3 4	1 2 3 4
9. demonstrates a good ability to communicate expectations, and has a classroom management style that is conducive to good learning atmosphere.	1 2 3 4	1 2 3 4
10. can command student attention by appearing self-directed, showing drive and initiative, acting independently in thought and action, coming up with creative ideas, setting lofty goals and high standards for self and students, respecting authority and enforcing school regulations.	1 2 3 4	1 2 3 4
11. can interest students in the subject matter being taught, has an ability to motivate the unmotivated and interest the uninterested through exciting and sometimes entertaining, but always engaging practices, uses appropriate pacing and relevant lessons to eliminate and prevent student management problems.	1 2 3 4	1 2 3 4
12. can solve problems of a varied nature.	1 2 3 4	1 2 3 4
13. is well liked by students, peers, and superiors.	1 2 3 4	1 2 3 4

Comments: (mid-term review)

Comments: (final review)

- **TEACHER CANDIDATE’S DISPOSITIONS**

Please assess the teacher candidate’s dispositions using the characterizations below. Please note that it is not the purpose of this section to judge attitudes. Rather, the purpose of this’section is to help determine whether or not the teacher candidate possesses and illustrates holistically the appropriate dispositions required of a teaching professional.

The teacher candidate demonstrates:	**Midterm**	**Final**
14. ability to work with others, especially in a joint intellectual effort.	1 2 3 4	1 2 3 4
15. truthfulness to oneself and to others, exhibiting moral excellence and earning the trust of others.	1 2 3 4	1 2 3 4
16. ability to honor, value, and demonstrate consideration and regard for oneself and others, regardless of exceptionality (race, ethnicity, gender, origin, socioeconomic status, religion, etc.).	1 2 3 4	1 2 3 4
17. a reverence toward learning and a seriousness of personal, professional, and public service.	1 2 3 4	1 2 3 4
18. ability to adjust one’s emotional state to suitable level of intensity in order to remain engaged with one’s surroundings.	1 2 3 4	1 2 3 4
19. ability to review, analyze, and evaluate the success of past decisions in an effort to make better decisions in the future.	1 2 3 4	1 2 3 4
20. willingness and ability to adapt to change.	1 2 3 4	1 2 3 4
21. ability to act independently, demonstrating accountability, reliability, and sound judgment.	1 2 3 4	1 2 3 4

Comments: (mid-term review)

Comments: (final review)

RECOMMENDATIONS

Please indicate whether or not you recommend this teacher candidate for admission to the teacher education program at Illinois State University. Please note that a negative recommendation will result in the teacher candidate being barred from admission. If you do choose to provide a negative recommendation, please provide in writing supporting evidence for your decision.

Please circle the appropriate recommendation below. *Note that a positive FINAL recommendation requires a 75% or above approval rating in all three sections of the indicators.*

Midterm Recommendation:

I am fairly sure I will be able to provide a positive recommendation for the teacher candidate.

I am unsure if I will be able to provide a positive recommendation for the teacher candidate.

Final Recommendation:

I recommend that the candidate be admitted to the Teacher Education Program.

I cannot recommend that the candidate be admitted to the Teacher Education Program.

Explanations: (if you cannot recommend the teacher candidate at this time)

	Midterm	Final
Signatures of Cooperating Teacher:		
Signatures of Teacher Candidate:		

PHY 209 BI-WEEKLY PROGRESS REPORT

Name:____

Name of School Site:______________________________ Report Number:____________

Grade Level(s)/Subject(s):____

1. *Summarize your experiences during the past two weeks. Include particularly significant activities and highlights.*

2. *Describe two significant observations derived from your interactions with the students.*

3. *Describe two significant observations you have made in relation to the cooperating teacher.*

4. *What did you see, do, hear, feel, etc. that will help you become a great teacher?*

Prospective Teacher's Signature:______________________________ Date:____________

Hours completed during past 2 weeks:________ Cumulative hours completed:________