

Chapter 11

Lone Rangers Getting Lonely: Getting Your Research in Physics Education Team Larger than One Professor

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Robert G. Fuller

One of the issues we ought to discuss in this community is the fact that nearly all of us are working in departments by ourselves. That's not typical of most research physicists: you leave a place, you're hired by the condensed matter group and you always join some other group. The idea that you would be like Randy Harrington, go and start a condensed matter group somewhere, that's very very rare in the lives of most other research teams in physics. It's not, however, unusual in this group and so the steering committee put together a list of issues that need to be addressed by this community: survivability—what's the critical mass; growth issues—we talked the very first day about funding issues, and I sort of made fun of the fact that in 1994 there were 25 of us, in 1996 there were 60 and now in 1998 there are 90, so you can predict when all the people in the AAPT will be coming to this meeting, and what does that say about support? How does one build continuity in a group? What does it mean to have a tenuous group? What about the tenure and promotion culture? How do we establish a norm for tenure and promotion in this area? And then there are other issues. In fact one of the people pointed out that if you look at the American Institute of Physics list of graduate departments you'll discover many people in these departments listed as doing education. You then look or you write to that department to say you want to come to do a Ph.D. in physics education research, and it turns out that all the people who have no grant money are listed as doing education—so there is a sense in which the larger physics community tends to list the people who are not doing scholarly activities as doing education because they feel that in the AIP survey of their department everybody should be listed, apparently. Arnold Arons and Bob Karplus successively were probably the pioneers in Physics Education Research in the early '70s—think about that, only about 25 years ago, there were only probably two places in the United States. You sort of had a degree at Kansas State but the physics department would have probably belched if you'd come in with a Ph.D. candidacy in the early '70s. So from that time we now have something that looks like this. There are at least five programs where we think there are at least two tenured faculty members, there are two other programs where there is a tenured person in physics and another person in a tenure track and then there are nine other places, so there are altogether 16

places now in the United States where you could get a Ph.D. in the physics department doing PER. North Carolina State, the University of Massachusetts-Amherst, University of Maryland, University of Minnesota, and Carnegie Mellon University we think have two tenure track people who can direct Ph.D. theses in this area. Montana State has one person with a tenure track person and Washington has a person and a tenure track person. The other places, as far as we know, have only one person and we're not even sure about Iowa State. I mean, they just started a research in physics education program this fall and we're not sure whether, if he wanted to have a Ph.D. student, they would really let it be. Arizona State, Iowa State, Kansas State and in some ways some of the state universities have a highly different history. Those form a community with a really interesting history because they had a long tradition, and maybe North Carolina State too, of teacher education, so they had Ph.D.s in education which some of those schools managed to get carried over into the physics department. Anyway, that's kind of the list and the thing that I think we can celebrate as a community is the fact that we started with one or two in the '70s and we now have like 15 or 16 or maybe 18 or 20 depending upon how you count them. So the question this panel is going to try to address, from their four different perspectives, is this. How do you get to be a group with more than one person? What are some of the issues that you need to deal with as you think about going out as a new young physicist in research in physics in education? How do you find a place that is viable and how do you continue to survive?

John Risley

It might be interesting to review how we got to where we are at this particular moment. Of course, everybody's recollection is a little bit different. I think it stemmed from our department head, Dick Patty, who had particularly strong interest in how well we teach physics and his willingness to try different approaches as well as a commitment to having a strong research-based program. We do not have a long tradition in research in physics education. Funding for research in the field just started about 20 years ago. But now it's a regular research field, with everybody fighting for funds, those who can get funding end up getting recognition at their institution. Unfortunately, that's how faculty look at it--all the way up to the deans -- if you have strong research support, then you can get what you need, and if you don't, you really have to fight for it.

But you have to ask, "Well, what does happen when you get funding? What are the differences?" I would say that it's absolutely critical to have a department head that can withstand the barrage of claims that another person is needed in astrophysics; another person is needed in nuclear physics; another person is needed in solid state physics. There are certainly some key starting points. I did go through a transition from atomic collisions into physics education research, and it was a long transitional stage. I tried to keep my feet on both sides, but eventually I learned that you can't do that forever. You simply wear out.

Throughout my years at NCSU, there are certain milestones that I recall. An important one is when Karen Johnston came in to our department. She made a big impact. She was hired to help out with our labs. This was an idea that could be sold to the rest of the faculty, but that was certainly not Karen's main goal. She quickly

started setting up a research program with master's degree students, and those were the first ones who started to come out. About that time Dave Haase got involved, and things started to nucleate. Karen made a strong pitch to the faculty to get somebody involved who would set up a Ph.D. graduate program in physics education research, and that's when Bob Beichner was hired. The expectation was a strong research program with graduate students. There were no ifs, ands, or buts about it. He took that role seriously, and fortunately he had the background to do it well.

Now what has happened? Well, as a lot of you know, we have found that our field is very attractive to graduate students, so much so, in fact, that the graduate program in physics education research is the most popular in our department. Fortunately, the rest of the department does not resent us. We attract strong students, and some of them decide to move into other areas of physics—just like students who want to be involved in particle theory or astrophysics but then later move within the department to do something else after they have been exposed to more opportunities. The same thing can happen in other physics departments. We can attract lot of students. This in turn garners the support of the faculty. They think it is great because we are recruiting graduate students and giving a few to them, even though we keep the best. That's just a little snapshot, and to get more details you should talk to Karen and Bob.

A few years ago, we changed department heads. He is younger than Dick Patty but was not as convinced of the importance and advantages of a physics education research program. The first year or two was a bit of a struggle. But now he is so much on the other side that it is almost embarrassing! He says the future of the physics department is through physics education research, and he frequently points out all the great things that our group is doing at faculty meetings. So in some sense we've gone from another low point to a high point where we may be walking on thin ice. But physics education research is popular, at least with our department heads.

What about the rest of the faculty? What do they think? This is difficult to assess. It is often hard to say if physics education research is accepted by researchers in traditional fields. One thing is for sure. If you are a graduate student looking for a job in physics education research, make certain that you have a strong mentor. You need someone to sell your case. Someone who can say things like, "Look! This is what physics education research is all about. These are the kind of journals you publish in. This research is OK. It is accepted by the community. This paper is just like an article in Phys. Rev. Letters." You know, few people actual read Phys. Rev. Letters, but they know if you get your work published there it has to be important. It is a constant battle. You have got to have a champion who's helping you. It is not absolutely necessary, but it sure helps.

Jose Mestre

Well, in our group there are two tenured faculty and two research faculty. How we got there is a long involved process involving lots of politics and so on. I was hired on a tenure track position in 1987 so that tells you when the department

figured this was worthwhile. I would say around 1985 or before there was no way they would have spent a position on this kind of thing, so things changed quite a bit. My approach will be to list some questions about those issues that you put up here: survivability, critical mass and so on, and to try to answer how my department views it and ask how your department might view those things, and that will help put things in perspective.

At the departmental level, under the politics of the situation, (and politics is big in our field if you're in a physics department whether you like it or not) is physics education research accepted as a viable research area or simply tolerated—are you an equal citizen or not?

It turns out that in our department, even though there was a group in 1985 doing this kind of work there was only one tenured professor, and I who got grants, and when the grant was awarded I hired myself, and that's the way it worked. We were tolerated in those days but now we're more accepted and valued, I think, in our department.

Is PER viewed as taking research positions away from the other groups which are doing "real" physics?

That's a big political issue. In our department there's always a fight for positions but we're holding our own and doing all right.

Does the department appreciate that the quality of the PER group will help shelter their best researchers to concentrate on research, thereby relieving the pressure from their often poor teaching performance?

That's something that you have to realize. Not every place has the best researchers be also the best course instructors with a PER group. The fact that there's somebody worrying about the quality of education at the institution liberates other people to do what they want to do.

Does the department appreciate that the presence of a PER group often results in marked improvement in introductory and undergraduate courses?

That's something that seems to happen in a lot of places, including my own, and I think the department, the provost and the dean like it and tout that as being important.

At the college level (I'm now going one level up) how do the other departments in your college view educational research being conducted out of a science department?

Maybe even though the physics department might accept this, the biologists or the mathematicians might think, "Oh, not us," so that may create a certain kind of friction.

Does the college personnel committee support or obstruct educational research being conducted out of a science department?

That's a toughie. I have long stories about my tenure battle, and usually the biggest battles occurred at that level and not at the department level. The department by then had accepted things but it was the college personnel

committee saying, “Why is this here and why isn’t this in the school of education or some other place?”

Is the dean proactive and supportive of the efforts of PER or simply tolerant or indifferent towards educational research?

In our case we have a very supportive dean. The last two deans, the current one and the previous one, have been very supportive to the extent that our two research professors are getting 30% of their salaries from the dean, in state support, so this is real money support. She’s very proactive—the dean goes around talking about her science departments and the efforts in outreach and education that happen in the college of natural sciences and mathematics—so that’s very good.

At the university level, is there a stated policy that quality education for undergraduates is a priority?

I think this is happening more and more in public institutions. We are being held more accountable for making instruction high quality for students.

Do the provost, chancellor and all those high-level people support educational research and outreach?

In our university, there is a lot of outreach and research in science education in general and every time these folks go around talking to the legislature or to parents or whatever they’re always touting all these things that we’re doing, and to them that’s important. It’s good public relations.

In terms of support at the departmental level, does the department support PER with adequate space and resources?

There’s one that’s easy to tell. Do you get the little closets here and there for your labs or do you get good space like everybody else? That’s easy to judge. In our case, we’re doing quite well.

Is the money brought by PER from external funding viewed as being “not as green” as the money brought in by “real” physics groups?

Sometimes even if you are bringing in a million dollars and another research group in condensed matter or something is bringing in \$150,000, they are getting more resources than you because, “It’s just education money and who cares about that?” That used to happen a lot more for us. It doesn’t happen as much now especially since our funding is going up and the funding for many other research groups is going down. The department has to figure, “Hey, if we’re going to maintain some overhead at least we better pay attention to these guys.”

Is the merit structure treated the same way for PER folks as other research folks?

In our case it is, we are being treated more than fairly.

Is the PER group allowed to grow commensurate with their success in terms of publishing and funding and productivity and so on?

In our case, what we’ve gotten is a statement in the long range plan of the department to have one hire in the next five years so that there will be a transition period between the time that Bill Gerace might retire in ten years. So

we'll have three people, hopefully, for the last five years of Gerace's tenure at U. Mass, so it's something that seems to have been won over at my institution.

Bruce Sherwood

We've tried to explain several times that we're here under false pretenses because we don't have two tenured people. The situation is vastly more complex than that, so I'll give you as quickly as I can a good news / bad news story. You may draw whatever lessons you can from it.

There are three senior people doing physics education research, Fred Reif, Ruth Chabay and myself. I have tenure but it's a peculiar circumstance that led to it. Fred Reif does not. He's a special university professor with appointments in the Center for Innovation in Learning, the Department of Physics and the Department of Psychology. It's a prestigious appointment but it's actually not a regular tenured appointment. Ruth Chabay is a senior research scientist in the Center for Innovation in Learning, and also in the physics department. I'll say a word about that too and it's not a tenured position. We're a group—there are a bunch of us to talk to and do things with—but we don't satisfy the characteristics of the situations elsewhere. That said, let me say a little bit more about the peculiar situation because many of you will have to look for odd niches as they occur, as we did, and you seize whatever opportunities you can find—so here's the quick history.

In the mid '80s Carnegie Mellon University and IBM were going to go into a glorious future together, whether it be a chicken in every pot or a UNIX workstation in every garage. Those machines would have a megabyte of memory and a megapixel of screen display and a mega-instructions per second. At that time I had been at the PLATO Project at the University of Illinois for about 15 years. In 1984 Jill Larkin recruited David Trowbridge who had been a post-doc—he had come from the Washington group; many of you know of his fine work as a graduate student there—he was a post doc with Alfred Bork at UC-Irvine, and one of the leading young lights in the use of computers in education. The University had the foresight to say that if it was going to put all these efforts into building up the technical infrastructure of these workstations, maybe it would be a good idea to have a group thinking about what you would do with that education, and Jill Larkin prevailed upon, at some cost to her career, to be the director of something called The Center for Design of Educational Computing (CDEC). She started recruiting people who already had experience in the use of computers in education. One of her first hires was David Trowbridge and I think maybe I was her second major hire—I came in January of 1985. I already had tenure at Illinois in the physics department. I had a joint appointment in the CERL (Computer-based Education Research Laboratory), the department of linguistics and the department of physics. I already had tenure as a full professor so I could argue that if I were going to come to CMU I would have to have tenure in the physics department, in order to be able to do the work that they thought they wanted me to do. If I was going to make a difference I could only do it with real tenure.

The physics department, in principle, was willing to do that as long as they didn't have to give up any slots, and as long as they didn't have to pay for it. So the head of

the department, played a very astute political game in which he had various bargaining chips and he got the best deal he could. I think it is entirely appropriate that he did that. The way it worked out was he said, “Yes, absolutely, we’ll be delighted to have this person in our department, we know about his work, it will be just fine and the University will pay his salary.” It doesn’t get charged to the physics budget so it’s a very unusual appointment. It’s real tenure and if everything collapsed and those centers that I’m in closed down I would fall back in the physics department, but I think they still wouldn’t actually have it charged against their lines, so it’s an unusual situation. However, despite all that, I have to say that the department has consistently treated me as though I were a regular first class citizen, and I have been careful to act at all times as though I were a first class citizen, and that has made an enormous difference and has made it possible to do things that otherwise I could not have done. So that’s my basic history.

Ruth Chabay came in 1987. She had a very distinguished career in applying computers to education; in her case chemistry education—she’s a physical chemist. Ruth was recruited, again by Jill Larkin, into the Center for Design of Educational Computing. She came as a senior research scientist, which is what she still is. Along the way, as she and I developed new and innovative and unusual ways of teaching physics, the physics department, without any involvement from me, took it upon itself to make her a member of the physics department. It’s an adjunct position but they didn’t have to do that, so there are various kinds of good news in these bad news stories.

Fred Reif came in 1989 with his very special university appointment. Sometime in the early 90’s CDEC, which had been increasingly doing things that didn’t necessarily involve computers, changed its name and its mission and it got broader and it became the Center for Innovation in Learning and got a little bit larger, and for historical reasons there are the three of us with strong interests and backgrounds in physics, but there are other kinds of people in this center, and we now have half a dozen principal people and we have several post docs, two of whom are here, Leon Hsu, who has an NSF traveling fellowship as a post doc, and Tom Foster who is working with us. There’s work on writing, there’s work on history, there’s work on statistics, there are all kinds of things. It’s a wonderful place to be. It’s one of the very few places where many different disciplines are being worked on in collaboration and it’s really quite wonderful.

At the same time our departmental connection is extremely precious to us. The fact that Ruth and I are accepted and valued in the physics department is terrific. Are we always valued at the same level by everybody? No, and in fact one of the more interesting aspects of the politics is that the physics department, which is struggling to become have a higher ranking than it now has, has done all kinds of long range planning. In every stage of this planning the discussion has been in terms of this group or that group, and there is not in that plan something called an education group or an education research group. Despite the fact of the presence of us people who have joint appointments, and despite the presence of Hugh Young who is highly valued as a member of the department and a well known textbook writer, we have not (I certainly have not) played all the political games of trying to get this as a

recognized thing. It does not figure in the future and my guess is that when we go, it goes, and that Carnegie Mellon won't have a permanent thrust in physics education research. It's all sort of a historical accident, but while it's lasting, it's a great ride.

There is a graduate program at CIL. In fact, Ruth and I are both sort of expected to supervise graduate students. We have them because CIL has just started a graduate program and we have three graduate students who will be getting a Ph.D. in instructional science (with connections with departments) but it's sort of a CIL degree. So, are we Ph.D. granting people? Yes, despite the fact that we're in an organization that isn't really a regular department. (Note added in proof: In Spring 1999 we acquired a strong graduate student who has chosen to do a thesis in physics education, and with a Ph.D. in physics, not CIL; he was too far along in his physics career for it to make sense to start the full CIL program, and the physics department is supportive.)

Now, CMU is a very funny place. I did want to comment on the issue of private universities not having to pay so much attention to this. The reason that the Center for Innovation in Learning exists is that when President Mehrabian came in around 1990 the fund raisers told him about their experiences in calling CMU alumni. They call them up and ask, "Would you give money to CMU?" and there would be this blast coming through the phone, "I had such a terrible time there! I wouldn't give money to Carnegie Mellon University—it was just awful, I felt harassed, it was stressful, it was terrible!" The president thought that a private university couldn't actually afford those attitudes and Herb Simon, who is our only Nobel prize-winning faculty member, had the president's ear and said, "Look, we have a special situation here that we should exploit. We have strength in cognitive psychology. We have strength in computing, and we have strength in curriculum development. You should take that CDEC thing and make it bigger and make it more general and let's go into a glorious future improving undergraduate education."

We are starting to make a mark on the campus. There are courses that we have been involved in in one way or another. We have a fellows program that brings in faculty for one or two semesters to live with us while they're working on educational programs and its working and there's university hard money in our salaries. We go out and try to get grants, of course, but there's actual real university support. So is the glass half empty or half full? It certainly is.

Ken Heller

I'll say a little bit about Minnesota because we're weird, too—maybe that's a hallmark of this field. It is very fashionably a multi-disciplinary field. Just use that with your deans. That's really in. We are multi-disciplinary. Neither one of us are officially physics educators within our university. I'm in the Physics Department and I'm a card bearing high energy physicist and proud of it, and Pat is in the School of Education's Department of Curriculum and Instruction and she is a card carrying science educator. But we have both a tradition and program in physics education, and there is some connection that is built into Minnesota.

The Department of Curriculum and Instruction is a discipline-based department. Pat was hired because she's a physics educator. They have a math educator or two.

They have a chemistry educator. They're looking for a biology educator now, and so they're discipline based and in principal they work closely with the other departments—some do and some don't. It depends on how receptive the other departments in the university are.

On the physics side, the Minnesota Physics Department, in the 1960s I believe, was involved in a program called MINNEMAST which had something to do with Minnesota and teaching math and science in public schools and actually hired a faculty member in physics education early on and it was a disaster. Well, it wasn't a disaster. He's a good guy. He's a good teacher, but he doesn't do any research. He was hired with tenure, and that was a problem. Of course you know that in your department, if you get one person like that, then everybody is like that and for the foreseeable future it will probably be impossible for the physics department to hire anyone called a physics educator because they know what that's like—it was the last point on Bob Fuller's list of issues. Somebody who basically just does teaching, and just doing teaching in a research oriented university is not enough. There's no value added—I wouldn't hire anybody who just did that either, because that's not our mission. We generate research and that's our main mission. We do teach undergraduates, and undergraduate instruction is very important. Many members of our physics are good teachers and they're dedicated. We have people who go tour the world doing physics demonstrations and we have lots of people who do things that are not education research, but which are interesting, and which are respected within the department—our department thinks highly of it but it's not part of our long range plan either.

Nevertheless, we do have a physics education group, because we have a group of graduate students and they live in the physics department. In principal we can grant the physics Ph.D. in physics education, but no graduate student has ever opted for it. They have all opted to take degrees in education, and probably, at least up until this time, that has been the really practical thing because your job expectations are just lots better if you have a strong background in physics and an education degree. I think all but one have faculty jobs in physics departments—all but two; one has a faculty job in an astronomy department, and they all have Ed degrees. The reason is that if you have an education degree with a strong physics background, that is, you grew up in the physics department and you did your research there, you can talk to the educators and you have a broad background as well. Talk to Tom Foster, who just graduated and now works with them. They have a broader background in research techniques and in the lingo and in other things. Lots of experiences. I think that it works very well for us and it works well in many places; those colleges whose physics departments are primarily supported by elementary school teachers taking physics. That's their student credit hours and what they need for that is somebody who speaks both languages, so for us that works very well, and we would really be happy to continue that—like another person like me in the physics department and another person like Pat in education. The cooperation is great. In fact, Pat was on the physics graduate faculty before she was on the education graduate faculty. We have another step in our university. You have to be there for some time and pass through a bunch of hurdles before you get on the graduate faculty. In fact education

is a lot more selective in Minnesota than physics, they're also a lot more highly graded. Our education school is really very good and our psychology people are really very good and that all helps, but it's been rocky because everybody doesn't understand everything.

Pat Heller

Again, we're weird. Our College of Education is now called the College of Education and Human Development, and our task is lifelong learning, sort of from birth to death, partly because of the work of science educators—Fred Findlay works with geologists and got enough money to do an undergraduate course—and so we've all worked sort of kindergarten through college. So what I do with the undergraduate physics education is considered to be quite natural and normal for a college that wants to span lifelong learning, so I think that there are more colleges of education moving in that direction and that might be a way of bridging the gap. The second thing I want to do is just reinforce the kinds of institutions that will hire people with our background, they do a lot of teacher education so they are housed in physics departments but they are also occasionally teaching methods courses or something like that and are expected to do physics education research, so there is a market out there for people like that as well.