

## Chapter 6

### But How Do We Pay for All of This?

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Chair: John Risley, *North Carolina State University*

#### John Risley

The situation in physics education is different from the more traditional fields in physics. If you are in high energy physics, you can only tap a couple of sources for funding, NSF or DOE, or you can go directly to the labs themselves. We, on the other hand, can take advantage of a number of different resources—not just the NSF or DOE. But you have to look hard. And there are non-federal sources. You often have to be creative in finding the support you need to do the research you want to accomplish.

It is important to have a clear vision of what you are trying to do and then to be persistent and keep asking for funding. And you have to think about the needs of the funding agency. For instance, take Jack Hehn. Last year, he had funds to distribute for the NSF. Well, you might think, he did not give any support to us. But he made awards. There were investigators who wrote excellent proposals and were funded. As long as NSF has funds, there will be funding, although there may not be sufficient resources to fund all excellent proposals. The lesson here is that we must submit excellent ideas and write excellent proposals.

#### Q

I just want to make one comment. Take high energy physics, which I know. The thing about high energy physics is that if you did decent work, which we did, you got new funds again and again. And we didn't have to come up with something entirely new, we just had to be doing very worthwhile physics, and we could continue doing some of what we were doing, if that makes sense. That doesn't appear to be the case with physics education research.

#### John Risley

Well, I can address that quickly. There is a difference when you have experimental groups with a large infrastructure. If you have a large accelerator, you cannot sustain the effort with funding on an annual basis. If you miss a year or two, the whole project fails. It is too expensive to restart a lab that has been closed down. Too many skilled people would leave and the knowledge necessary to run the accelerator is lost. It is an issue of continuity. The question that must be asked is, do you need the money for your research? Or do you need it for recognition? There is a big difference. Some research can be conducted with internal funding. For instance, all of us at this conference got here somehow. How did we pay for it? Some are paying out of our own pockets, others through salaries from our

universities, and a few from research grants. In many scholarly fields there is very little research support. The sciences are the exception. But science needs support because the research cannot be done without it. That's the critical issue. Reviewers of research proposals look at this issue very carefully. If this person does not get funding will the research get done or not?

Dean Zollman

Okay, actually Ron Thornton brought up one of my pet peeves that I'm always talking to my colleagues in atomic and high energy physics about, and it's even worse I think in that they'll get some sort of warning before their funding gets cut off, where we get it only sometimes. Let me start with a brief survey. How many people here have been a PI or co-PI on an NSF grant? A pretty large number. For those of you are new in the business—how many of those people have been rejected by NSF at some time. That's not quite as large. Some of you haven't had that experience—that's too bad. Karen Johnston will arrange that for the fall for anybody who wants to have it. What about other funding agents? How many people have received funding from FIPSE? I guess a little bit for me, too. How about the Howard Hughes Medical Institute? Two of us. Other funding agencies? Anybody ever get any money from the Department of Energy? For education? What other funding agencies have people gotten money from for education research? Exxon? Hewlett Packard? Apple? IBM? Sloan? NASA? A long time ago we got some money from that. Eisenhower Teacher Enhancement Grants? A few people. That's sort of to follow up on John Risley's point that indeed there are a lot of funding sources, but of course there are also many people trying to get that funding.

And, you know, there really are two issues here. One is how do we as individuals or as groups get funding or find sources to fund the research and development that we want to do? Then there's the other issue of how we make the pie big enough so that there's enough money for all of us, without hitting the powerball the next time it gets up to 200 million dollars or whatever. And the latter issue is a big one. If we continue just to look at NSF as a primary source, well, it's fairly safe to say that within NSF within the division of undergraduate education there's not likely to be a big jump in funding in the next few years.

What I'd like to talk about first is how do we get funding for individual projects, and probably leave the latter one for questions later on. One thing to look at is that education is different in another way from our other areas of physics research in that—and I understand Ron Thornton alluded to this, actually he more than alluded to it—we are in many ways product driven. Education is more out in front of the public. We can't say, as one of my colleagues just loves to say when people ask him what his research is good for, something like "Well, you know somebody a long time ago noticed that the nucleus had spin. Nobody knew what that would be good for. But look what it's used for in medicine these days." That's true, but you can't do that in education. You can't say, "Well, I don't really care what my research is good for, because fifty years from now somebody is going to come up with some idea that will use it." And that is in part because we're much more public and it's harder for us to say things like most physicists say, which is basically, "Well, you

can't understand us anyway so go away." My colleagues would probably never say that directly but they certainly mean it.

There is a part of product development that is always research. That has actually been talked about several times today. I don't need to spend a lot of time on it. But if you get a grant to develop a videodisc on the Tacoma Narrows Bridge Collapse, which Bob Fuller and I did a long time ago, that was something nobody had done before. They had never tried to figure out how to use this interactive video form. So there is research in just trying to figure out how to use it. There's research in evaluating it until you can start seeing what's going on in the minds of students, and you have to start seeing what's going on in the minds of students even though maybe you don't have a grant specifically for that type of research. And I think in any good education proposal these days that developing materials and doing research are going to be woven in together, in order to put the whole thing together in a sensible way. So we have to look at that aspect of the funding agency's needs in order to be able to try to pay for what we're going to be trying to do in the near future.

And then I'd also like to make a point to follow up on something that Rand Harrington said. I learned a long time ago to be careful about the questions you ask of the funding agencies. I'll illustrate this with a specific point. Back around 1980, NSF had a program that was joint with NATO, and they put out some proposals—these were for fellowships. In the opening statement of who's eligible, as they always have these things, there was a whole list of all the sciences that were eligible. And it said, "not including education or the social sciences." Well, I was in the same position that Rand is, I still am. Am I in education or am I in physics? So I called up the NSF program officer and he said, "No, you're not eligible." Well, the following year a similar program came out, for fellowships within the United States. And I read the same statement. And I said, "I'm not going to ask this time. I'll just send in a proposal and make them deal with it." Well, I got the funding. So there are some questions you want to be careful about asking, because we are in this strange combination. If it's not education, well then we're physicists. If it says it's just for education, then we're educators. And we take advantage of that as much as we can. I think there are some programs out there that we can look at in that way that are rather good. There's also been a lot said for collaborative proposals, which I think a lot of us have to do in the future.

One thing that I worry about in the same way Rand Harrington does is this move, particularly at NSF, toward these big systemic things which seem to be primarily to pay for a large administrative staff at the state level so that a little bit of research can get done. And I know NSF people don't agree with that, but it's one that I think is a problem for all of us. When we're trying to do research, we don't need sixteen people from the state board of education as part of our overhead on the whole thing. So those are just a few thoughts I've had. I really do want to spend most of our time discussing things.

David Hestenes

I think there are two major issues that we probably want to talk about. First is working the system. How do you get grants? Second is changing the system. Which I think is something that we really have to work actively for.

With respect to working the system, let me just tell you a little bit about my own experience. I have been pretty well funded, in fact continuously funded for the last ten years from NSF. But I really started about ten years before, in 1979, when I volunteered to be a panelist at NSF. That turned out to be a very valuable experience because if you are doing reviewing, you find out a lot about how other people do their reviewing. And you get a sense of the nuances that make a difference, such as the different kinds of responses that you get from different populations. For example, whether the reviewers are educators first and scientists second or whether they are scientists first and educators the other way. That experience helped me understand a good deal about the system. And another point that goes in with this: At our university, our grants office will send anybody to Washington D.C. at any time they want to talk to program managers about possible funding. That's also a recommended activity—get to know what the programs are and who the program managers are. Unfortunately there are not enough of them here at this time. Usually we have several of them at the AAPT meeting in the summer, but that has been curtailed a bit this summer for reasons of austerity so AAPT meetings are often good opportunities to meet the program managers, and if not, go to Washington and talk to them because you can learn a lot about how they operate and run their grant reviewing processes and so on. Also, you need to know the grant guidelines; there are nuances in the interpretation of the guidelines that make a huge difference sometimes. So that's the first thing. Then keep writing proposals and re-submitting them; keep re-working them and paying attention to the reviewers' remarks. Of course, the problem is that you get the reviewers' remarks one year and then the next year the panel is a whole different set of people, so you can't count on getting the same response the next year.

With respect to changing the system, and the operation of the system with respect to physics education research. This is where there has to be a change in NSF policy to get the kind of funding that we think is necessary for the research that we think is needed. About the total amount of money—I was talking with one of the program managers, whom I will not mention, about NSF funding over the last thirty years for training of physics teachers. If you take the money that has been put in for NSF programs and divide it by the number of physics teachers in the United States, which is something like sixteen to eighteen thousand high school physics teachers, it turns out that the NSF has already spent enough money to give extensive workshops for every single teacher. And yet, it appears that only about 5 percent of them have been affected. The distribution of the money leaves a lot to be desired. It's the same people over and over again who are getting the benefits of these programs. That's one of the points.

Now I have noticed a change with respect to the NSF policy, and the NSF policy is affected a good deal by the program managers who are already there. There used to be a program called "Research in Teaching and Learning" at NSF. That was

primarily the baby of Ray Hannepel who was a program manager for a long time and was well educated in cognitive science and physics education. Because he was more experienced than others, he was very good at nurturing quality grants through the system.

That brings up another point. After your proposal failed, don't just look at the reviews you get back from the reviewers but go and talk to the program manager if you can, and get the program manager's view about what happened and why there was a problem and what needs to be done. That's what I learned from Ray Hannepel at the very first review committee that I performed on back in 1979, because there were a few hints about an obscure high school teacher named Jim Minstrel who was one of the people that we were reviewing. Just a few hints to the committee from the program manager really changed the tenor of the discussion about this guy so he got funded and I think some of you may have heard about the results of that since then.

Since Hannepel left, research in Teaching and Learning has disappeared as an NSF program. I am afraid that indicates a trend. I think it was approximately 1993 when it was discontinued and turned into Research in Education Policy and Practice, which is supposed to include the NSF program for science education research. But I must say that since this program change has been made, I have been unable to identify within that program what kind of a solicitation they will be amenable to. The situation is absurd. That is my present view. And that comes from not just reading what they say but going and talking to the program managers. Unfortunately, I think that the present situation is that there is no well defined program for physics education research in NSF.

There are ways to smuggle in your physics education research, especially with respect to teaching enhancement projects and so on. The way I've continued my research in recent years is primarily as part of a teacher enhancement project. For a good project you need quality research associated with it. As far as I know it's still possible to get the necessary enhancement of funding over a mere delivery project to be able to support research. Anyway, we have been successful with respect to that, but I can't say whether that's standard NSF policy.

Overall, it appears that NSF is not mature with respect to funding science education research. The differences between supporting research in physics education and supporting research in physics show some real problems. One was already mentioned by Ron Thornton, about enabling continuity. Another problem is research freedom. We now have outcomes based evaluation with NSF, so you have to have sign up for what your outcomes are. Well, what's typical in real research is you don't know what your outcomes are, and you should be taking opportunities to change the direction of research as they arise. In my experience, there are unfortunate consequences if you try to change the direction when it's an education research proposal.

I think one of the points that has to be made here is that the physics education research community has to work together to prepare policy recommendations, by some mechanism, to the NSF for the changes that are needed.

John Risley

We will now hear another perspective, from an insider at NSF, but from one of our own. We shouldn't forget that most people at the NSF are practicing educators and scientists, and we should not think of them as the enemy. They are there to help us.

Jack Hehn

First, let me apologize to Beth Thacker for not bringing the "Show Me the Money" talk. This is more a talk among friends. Let me respond to John Risley that those decisions that NSF makes are based on peer review. And program officers do not have much latitude, in the sense that we ask for peer comments and we base most of our decisions directly on those peer comments. So the program officers really spend time organizing and soliciting comments from the community.

I would like to say three things. I would like to tell you a little bit about what I have seen as the history of funding physics education research and comparing it with teaching. I would like to talk to you about a few of things that I wish I could show you, but they're not quite ready for public consumption yet. And that will lead us to the idea that it is a very opportune time to make your voice heard at the Foundation.

I really enjoyed what Arnold Arons said about the thirty years of PER. I am incredibly encouraged by the number of people in this room, and by the fact that this is the third in a series of meetings. I think members of this community over time have become much better at self-identifying and starting a dialog. I think that has been a tremendous accomplishment in and of itself. I mean this meeting, the fact that you are here. And really the fact that you are collaborating, cooperating, and supporting each other. I think that is the strongest thing that you can possibly do. And I think building that sense of community gives you a voice.

You do have a voice at NSF. You have a voice in the physics community. And you have a voice in the private funding foundations. Because the people who are asked to provide reviews, who are asked for expertise, are you. It is a peer reviewing system.

What are the characteristics of PER that I see as encouraging reviewers and program officers? I think the most important thing is "It isn't about delivery, it isn't about the content, it's about the learner." And it is about looking at learning and the learner-mechanisms that can increase the effectiveness of teaching and the relationship between teaching and learning. And that is what makes this community different. I suggest that you capitalize on that every time you have a chance.

There is another important factor regarding the peer review process. It can be explained by what I said was the subtitle of this talk—paraphrasing Alan Bromley: "When you circle the wagons, make sure you shoot out." That is exceptionally important, especially in a developing community. You must support each other and help each other. It is not time for exclusion but for inclusion.

Regarding funding programs, I do not have a particular program that I can send you to at NSF, as young physics education researchers, and say to you: "Here is the program that is going to generate the best letter in response to your proposal." The NSF budget is about 3.6 billion dollars. About 625 million of that goes, across the board, to education. That is approaching 25 percent. Much of that goes to public school education. And some of it goes to informal education. And not much of it goes to undergraduate education. I think a growing part of the budget is likely to be set aside for teacher preparation. In fact, I think you will read over and over that teacher preparation is a very important upcoming theme. And I hope this community takes an active effort because I would really like for teachers to be prepared with a solid basis not only in good science content but also in good learning and teaching strategy and skills.

There are several funding sources available to you at NSF. The first thing I say to you is that you should seek out and develop as many different funding opportunities as you can. Always be on the lookout and always be telling your story and always be looking for the person who will resonate with your story and what you are passionate about doing. It is the idea, it is the concept, that should draw out the funder's interest. If you have a good idea and you are passionate about undertaking it, you are headed in the right direction to find someone who will support your idea.

I think there is nothing worse than chasing money based on something that somebody told you that you needed to do. Or they told you that you needed to file an application for some particular pot of money because it was sitting there. I don't think those applications work well anywhere.

This community has consistently put together a patchwork of funding. Inside the Division of Undergraduate Education (DUE) it has included the Course and Curriculum Development (CCD) and Undergraduate Faculty Enhancement (UFE) programs. And those programs are changing. The "new" DUE program has undergone some fundamental changes.

In the Division of Elementary, Secondary, and Informal Science (ESIE) you have had Teacher Enhancement (TE) and you have had Instructional Materials Development (IMD). Across the two, over the years, there has been Teacher Preparation, which is now centered in the Collaboratives for Excellence for Teacher Preparation (CETP).

In the Division of Research, Evaluation, Communication (REC) the old Research in Teaching and Learning (RTL) and RTL spin-offs are now the Research in Educational Policy and Practice (REPP) program.

There have been cross-cutting programs that do not operate from a single Division of NSF such as the Post-doctoral Fellowships in Science Mathematics Engineering Technology Education (PFSMETE). The CAREER awards provide a way of supporting outstanding faculty members. There are also recognition awards like the RARIE awards that Kansas State University and Dean Zollman received.

In the Division of Physics, in the Directorate for Mathematics and Physical Sciences, there have been some funding efforts supporting PER projects. There have also been some curricular funding efforts in upper division courses.

So there has been this patchwork. You have brought your good ideas to NSF and you have tried to find ways of matching ideas and concepts with programs because the solicitation directed at physics education research was not there.

Now, let me change to a second topic and talk to you about something called the Preliminary Report of the Working Group of Undergraduate Education. I will talk about it in bits and pieces. This is not on the street yet, not yet public. In November of 1997, the senior management integration group of NSF called together an internal working group and gave it two charges. One of the charges was to recommend an overarching integrative concept to guide future investments in foundation-wide undergraduate SMETE. And secondly to frame strategies for transforming the concept in operation. That means that the Foundation asked a group of people to look at all of the money that the foundation spends in undergraduate education and try to make sense out of it. That group came back and made five recommendations.

The first recommendation was high quality science and mathematics engineering technology for all undergraduate students. I won't address that. That's extremely difficult to do given the budget but a very admirable goal.

Second, to look at effectiveness in teaching and scholarship in all types of institutions. And I think you know that there is a broadening of support to different kinds of institutions.

Third, which I thought would be of most interest to you, is to develop a robust research base that strengthens education in SMETE disciplines.

Fourth, Undertake measures and studies that accurately assess the quality of undergraduate education. You've got something to do with that.

And fifth, look for outcomes from organizations that exert collective responsibility in leadership for improving undergraduate SMETE education. I think that means the Foundation wants more comment and advice from the community on how to accomplish these goals.

In every case, evaluation of all programs is essential and must be built into every new and existing program. I want to actually read you the format of recommendation three, which is about research. It is to support a revitalized knowledge base on teaching and learning within undergraduate SMETE disciplines, to strengthen research on the human learning applied to undergraduate SMETE disciplines and to support research on educational uses of technology. Now, you do two of those.

I suggest that you make it well understood that you, as a PER community, do some of those things, and that if that is a priority for how NSF spends its money, then it is probably a good idea for NSF to support some of the work that you talk about doing.

Now I am going to refine these ideas to the Division of Undergraduate Education. DUE is going to look at four entities that conduct research directed at undergraduate education. One is Research in Higher Education itself, typically done in schools of education with a fairly large number of Ph.D.s in any given year. Research in higher education tends to be institutional, infrastructural, organizational, curricular, administrative -- it looks at the whole institution.

The second is we would call Science Education, however, it is usually broadened to Science, Mathematics, Engineering, and Technology Education. Science education examines how science is taught and how science is learned. Much of it, again, is done in Ph.D. granting institutions. An emphasis of science education has been directed toward K-12 education. I think less so toward undergraduates and more so toward larger and larger programs such as statewide systems.

The third research community is the Evaluation community. There is a large and well-funded evaluation community, which is supposed to examine projects and make judgements about how judiciously the support funds were spent.

Fourth, NSF is defining something called Discipline Based Research in Learning and Teaching. We are trying to define this research emphasis as an area of work that we can describe, characterize and defend. I would say that the people in this room are doing DBRLT in physics. NSF is looking for the people who are undertaking such research in the science disciplines. You probably know some "math educators"; others who are doing research in "chemistry education"; and maybe a few who are doing work in "biology education."

I think that one important comment is that this group will be seen as a single entity- not physics, not biology, not chemistry, not mathematics—but as a group of people who do research in learning and teaching and do it within the context of a discipline. They also will undertake the work within a department, which is the most fundamental unit, in my way of thinking, of a university. The ideas generated by discipline-based research can provide a base for revitalization and change.

This research can best be done by starting at the bottom and working up. One of the best ways to establish credentials is to be a member of a department and to be able to talk back and forth between learning and teaching and a particular domain specific issue that you have in mind. This should give you a flavor of what NSF is talking about. I'll be happy to take questions later.

Now I want to talk about your providing advice to NSF. If I were you, and I were giving advice or writing a report to me (to NSF), here are some of the things I would include: One of the first things I would think about is being what I call cooperatively proactive, meaning not fifty papers but a few. I would talk about it among yourselves and try to establish some priorities. I would try to characterize as carefully as possible the kind of work that should be supported and the benefits of that work.

I really suggest that being inclusive is a very good idea. However, be inclusive with standards, by which I mean stress the quality of the work itself and the scholarship. One of the best ways to do that is to establish a good peer review, peer

critique, peer support system. But it is the quality of the work that turns out to be important, and the credentials of the experts undertaking review should come from the quality of the work they have done.

The second thing I would say, to me, is that you want to talk about the impact of the work. Emphasize the importance of your evaluation. Because we are talking about taxpayer dollars being spent on these programs. You have to expect a government agency to be quite concerned about the way those taxpayer dollars are spent. Plus, the agency does have to make decisions based on priorities. For example, take a situation in which we have four really good proposals and we cannot fund all four of them. We think about what will be the effect on the proposer—the person's career—what will be the effect on the institution, and many other issues. But ultimately, again, I hope that any work is organized around the learner. All of it should come down to: is this proposal going to affect the students and the way they learn? The output turns out to be student learning.

The third thing I would suggest is that you need some shared goals. You need to become a community, a research community. A community is a group of people who are trying to make something to happen. They are trying to go somewhere—in a common direction. You need to clarify that direction among yourselves. In order to do that I suggest that you need to explain who is doing this kind of research, which is to characterize yourselves. And then, what are you doing, which means characterize the difference between discipline-based research in learning and teaching and physics research and science education research and evaluation and the many other kinds of work that is being done.

Again, what makes you unique and what kinds of impact can you have? I expect much of this work to be classified as applied, as opposed to intellectual- or curiosity-based research. I think you are advantaged if you can support work that is informing teaching, learning, and the production of curriculum, which is how you traditionally have funded "this stuff."

I think one thing you need to debate strongly among yourselves is "what is your role with respect to the department?" I think you do something unique because you are in the business of looking at learning and teaching. You should be able to engender confidence and help your fellow faculty members in your department, both with your research and also with the teaching that they are doing. And yet, very easily you can become overwhelmed by supporting your department and not leave yourself time to do your own research. You have to walk along some balancing line between being of service in your department and to your institution and working with your graduate students and with your teaching assistants and getting your teaching done and getting your research done.

And you have this difficult question of crossing disciplines. If we're all talking to "foreigners," it means that the content is different, a different language. But the students that take biology courses and the students that take mathematics courses and the students that take chemistry courses -- they are the same students. The student is what does not change. The student -- how do you focus on the person?

That is probably more than enough, I would say. Do not bring a case, a proposal, that makes you look like a victim. Bring a case that stresses your strengths, your passions, and the things you believe and the things you want to do. That is a case that I think you can sell.

I would really hope to hear from you. I look forward to hearing from you. And Karen Johnston, my fellow physics program officer in DUE, looks forward to hearing from you.

### Questions / Discussion

Q

I have a comment on a specific proposal. I think what Jack has said is extremely important for our community and I think we have to respond to it immediately. I propose that at the AAPT Research in Physics Education committee meeting that we have a significant discussion about this issue and make some particular plans as to what we are going to do.

Q

I have two questions, but first let me start with a little history of the NCSU Conference of '94 or thereabouts, there was a group of people that put together a white paper. The purpose of that white paper was to go to the NSF physics division and try to get them to recognize physics education research as a viable research area and thereby fund these proposals. I'd like Jack's opinion on whether that's a waste of time. And second, should we do a similar thing, but through the DUE? I think you are proposing that we should. I think you're saying we need to write on what we're passionate about—so people will believe that kind of concept—maybe we should really gear maybe a <?> with a similar group of people together and send them a white paper.

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I think it's important to get the APS into this. I think that's extremely important if you want to be recognized by the physics community.

### Jack Hehn

One of my quandaries is that I can't tell you who to go talk to. I can't say go talk to this person\_or that person. I think you have to talk to as many NSF people as you can. The down side of that is that you may start to think that you broadcast this idea and nobody ever pays attention to it. But I think you can direct it to this working group in undergraduate education. And I do think you should send it to physics and I really do think that having APS's concurrence and approaching and talking to AIP about programs is an excellent idea. You can't predict they're likelihood, but nothing happens until you try, and you learn to shop, and you see where it goes. You've got to keep pestering the committee with your projects in a kind sort of way. You have to start a conversation and you have to keep the conversation moving.

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Is there a new head in the physics division?

Jack Hehn

No.

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The person that used to be responsible for the kinds of projects in the education division is retiring. So we're going to be replacing that person, maybe.

John Risley

I had a conversation with Rolf Sinclair, who handles our proposals in the physics division. He sent me a list of proposals he has funded in the last seven years. Each division at NSF has a mandate within the discipline areas to fund studies in education. I was appalled at the lack of funding. In 1996, it was at a level of \$240,000 per year. At the maximum it reached a high of slightly less than half a million dollars per year. This is not very much support. If you write a grant that includes summer salary support, a couple of graduate students, some supplies and travel and then overhead -- you can quickly reach \$100,000 per year. You really need a lot of money to support an active group that can really do something. With this in mind, I was astonished at just how low NSF's funding actually was. When you are considering writing a proposal, it helps to talk to the relevant program officers rather than trying to decide, "Which division should I go to?" Program officers talk to one another. And Rolf Sinclair is certainly good at that. As soon as he gets a proposal in education, he would try to get additional support from other programs that support education research. When you have a good idea, make a trip to Washington and let NSF know about it. While it is try we can write "white" papers on the need for more funding and sign them, it is much better if each one of us contacts NSF directly. If every one of us called at the NSF and congress twice a year, they would be astounded. They wouldn't know what was happening, and they could not ignore the community's interest! Shifts in funding at NSF are based on politics. If the community has good ideas, and we all say, "Why can't you fund this?" NSF will run out of answers. They can't always just say no. Eventually, they will say something like, "We have to do something because the education people just keep coming through the turnstile, and there are too many of them. We've got to take care of them." That's what the high energy physics community does. That's what the nuclear physicists do. That's what all the successful groups have done in the past. The problem is that they have been doing it since the NSF was created in the 1950s, and it's a well-oiled machine by now. We're the new kids on the block, and we have to go up there and make our case. We don't have to be vicious or vindictive. We just have to be persistent. Keep calling. Let them know you are out there and that you need help.

Q

I just have to make this comment because the comment made about high energy groups who don't get funding one year and the accelerator gets shut down or whatever doesn't really sit well with me, because it's the same way for physics education groups. You probably can't separate what's been a very cyclic nature of physics education from what's been very cyclic funding for physics education. Coherent groups will dissolve if funding is not there for them.

John Risley

This is a problem. We've all been through this. I've had to curtail projects and it's very painful. There's no doubt about it.

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When we have to get new people in then there's start up time, so I think it's the same.

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I agree with you. In high energy just like anything else it's the people. Machines are crap. If you lose the people, you're done for. It's exactly the same. We in this field need continuity absolutely as much as you need continuity in high energy. There really isn't any difference. You can't stop and start. You just can't do it and have any kind of meaningful research program. It can't be done and I think that's the problem here. High energy has been lucky enough to sell that. But it isn't the machines and it's not the machine shops. It's not any of those things; it's the people. If you lose your post-doc it will take you three years to get back to where you were.

Q

All my experience is in astronomy and solar physics but I know one of the things we <?> Their recent campaign <?> has that really been done at all <?> The impression I get listening to everyone and this has been my experience, too, is that we get a lot of individual projects and while there is a group of people who know each other, there are several people working on several different things. When I've worked as a student in solar physics, I hadn't worked on the satellite that was funded for another ten years of observing <?> different theories <?> the idea that you're going to run into technical problems, but somewhere along the line the idea of longevity was very stressed. And certainly we talked about the whole focus on teachers and if we're going to teach the teachers, as Arnold Arons was talking about we have to get the equipment to the schools and of course we won't see results until those kids make it to college. That seems like a huge amount of time. Have we just not managed to produce the people that we really need you know a dozen years of funding and a huge project that encompasses lots and lots of different grade levels to ultimately prove that the people who educate as teachers and the <?> breakthrough or something will ultimately lead to kids who will come in and improve the scores. It seems like it has to start at all levels to get the ball rolling at all.

John Risley

All those cases have to be made. You're right. It is a long process. It's just that we're the new kids on the block, and we've got to make our case. And it has to be convincing.

Q

On to the problem of lobbying these program directors at NSF. I have an additional and very significant problem, which is the reviewers. On the one hand we are communicating with the traditional physics community, asking for funding through that avenue, and on the other hand from the science education community. Neither of those communities speaks our language very directly or is that familiar with either what we're doing or why we're doing it. I think it's a very

serious problem. We might have program officers and program directors who are as sympathetic as they can possibly be but, as Jack Hehn pointed out, they depend on peer reviews and the competence of the reviewers. In order to get funded you have to have not just two or three on the panel liking your proposals; you've got to have pretty much the whole panel on your side. That means you have to appeal to a set of reviewers from these communities which are really not our community, and who really don't at this point understand very well what we're about and where our proposals are originating from conceptually. I don't know how to deal with that, it's a long term problem to solve, but it's important to recognize that's it's not simply a matter of convincing the program director. It's actually a lot harder than that.

Q

I think the problem is a little bit more deep than that. This is the new group programming and if the programs in which the physics is really the only active discipline. And it's a program that has not been known about nor understood by our colleagues in the other disciplines and therefore there's not much pressure on the people that make the decisions within the NSF as to how important this is. We need to get that kind of a message to the leadership of the NSF, that we're for real.

Q

In response to David's comment, I think you should not underplay the importance of the program officers. In physics for example I don't believe that they do panel reviews, at least they didn't used to, and I think they still don't do them. Rolf Sinclair, or whoever it is, is going to pick reviewers and mail the proposals out to the reviewers. In the choice of those reviewers you can control everything. Even in the panel reviews, very often you get a cluster of proposals near the top. And having the program officers on your side is extremely valuable. I've sat on those panels and the program officers made comments about the guidelines and so on. Getting the program officers on your side is really really important. That brings up another comment; we've been talking all about this last issue which is very important but from these other two there's one comment. I just recently sat in on a couple of these panels. One of the things that I see when I read some of these proposals is that often the proposers have not carefully read the announcement and the evaluation criteria that are in the project description. That can be absolutely fatal because somebody on the panel will pick on that and say, "This one doesn't fit this criterion," and just wipe it out. So read those things carefully. They really do make a difference, and the program officers push them on you when you're on the panel. You have to state explicitly somewhere in your proposal how those conditions are met. Don't assume the reviewers are going to fill in the gaps for you, because they won't. They've got to be explicitly in there.

Q

I'd like to make a comment along that same line, especially for those who are writing proposals for the first time. Always ask roughly how many proposals are coming in for a certain announcement so you can get a feel for the odds. Last year, Bob Beichner and I were very fortunate to get a FIPSE grant. Bob kept saying, "We should try; we should try." I said, "Yeah, right. You can write it, and you know I'll support it, but...." Well, it turns out that, within the program we went to, FIPSE only

funded 3% of the proposals. That means 97% went unfunded. That's very discouraging. I've been rejected by FIPSE in the past. I've submitted probably hundreds of proposals, and have had hundreds of rejections. The rejections are disheartening, but you have to realize that there simply isn't enough funding out there to give everyone support. If each of us were to submit a proposal, we would wipe out the NSF budget. We would surely increase it incrementally, but many of us would remain unfunded. It is like a game of chance, and in reality there just isn't a lot of money to go around. But good things come from writing proposals, even if it is unfunded. You can use the proposal as leverage within your own institution. You can say, "Look, I'm serious about this research. This is what I want to do. Can I have summer support?" At the local level, they may be able to help out in ways they wouldn't have been able to otherwise if you did not have a proposal. Simply going through the process of writing a grant is very healthy. It forces you to define your ideas, and very often you get support from an area that wasn't obvious in the beginning.

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I just wanted to comment about the difficulties. Something like FIPSE is really difficult because they fund across all the fields. So consequently, those people who come to review the proposals are from many disciplines. For example, you could have a librarian from Nebraska reviewing your proposal. They look for good people to do the reviews, and I think the project officers exert a little more control over some things, but you basically have to have very good reviews, at least from some of the reviewing panel. That's an even more difficult problem than we are dealing with in terms of peer review. I don't know exactly how they how they manage to handle it so well.

