

Chapter 10

Forming a Consortium on Physics Problem Solving

Discussion led by David Hestenes, *Arizona State University*

FIGURE 1

<p>Consortium on Problem Solving (COPS) in physics Recommendations by D. Hestenes and W. Zhang</p>	
Rationale:	Problem solving skill is the most widely accepted measure of physics understanding.
Purpose:	To promote consensus within the physics community on standards and measurements of problem solving skill (F. Reif, <i>AJP</i> 64 , 687 (1996))
Objectives:	<ul style="list-style-type: none"> • Coordinate research on problem solving from many perspectives • Provide a forum for discussion and debate of goals, standards, and measurements in the domain of physics problem solving • Maintain a Web-based Resource Center enabling instructors to access information and contribute data regarding problem solving, including: <ul style="list-style-type: none"> - banks of carefully designed and evaluated problems - assessment instruments and online evaluation - standardized grading criteria and interpretation of results - collect and analyze data - current results • Provide a mechanism for the physics teaching community to compare the efficacy of various instruction strategies • Organize workshops (e.g. at AAPT meetings) to disseminate results and new teaching methods.
Request NSF support for COPS	(due November 25, 1998)
	<ul style="list-style-type: none"> • Research support for 7 Postdocs (or equivalent) @ 75 K/y working with active PER groups—typically 1 per institution • Web base support @ 100 K/y • PER Oversight Committee

David Hestenes

Let me just say briefly how we came to make these recommendations for talking points (see Figure 1). Like other institutions where there's physics education research, we have a regular physics education research seminar with graduate students and post docs. One major topic of our discussions and our research is problem solving, as is the case with other groups. We spend a considerable time reviewing work on problem solving by other groups, and we have our own unique

way of doing it, which of course is based on the modeling approach to problem solving.

But we understand the need for arriving at some sort of consensus on these issues. All of the issues were raised this morning, particularly the issue about assessment. And let me remind you that there was an article in the *American Journal of Physics* a couple years ago by Fred Reif, a guest comment, addressing this fundamental problem of establishing standards and measurements for results of Physics Education. (see Figure 1 for reference)

If we want to convince the community at large of the efficacy of new instructional methods, a major way to do that is to develop the means for producing objective evidence for comparing results.

Fred Reif was talking in a more general context about developing standards and measurements, but I'm sure he would agree that one of the fundamental issues would be to address problem solving. Our colleagues recognize problem solving as possibly the best measure of physics understanding. If we want to make a case for our views that we can do better in physics teaching, then we need to have some standards of comparison for different methods.

The main objective here is to coordinate research on problem solving. There are a lot of different views, so we need to have a diversity of methods, but we want to develop a common system of assessment tools.

At the end of our list of recommendations is a request. Weijia Zhang has been doing quite a bit of work on problem solving and reviewing the literature, and one of my motivations has been finding support for him as a post doc, as well as for others. This consortium is in part a device for engaging post docs, and a way for our community to help support our post docs in a constructive way.

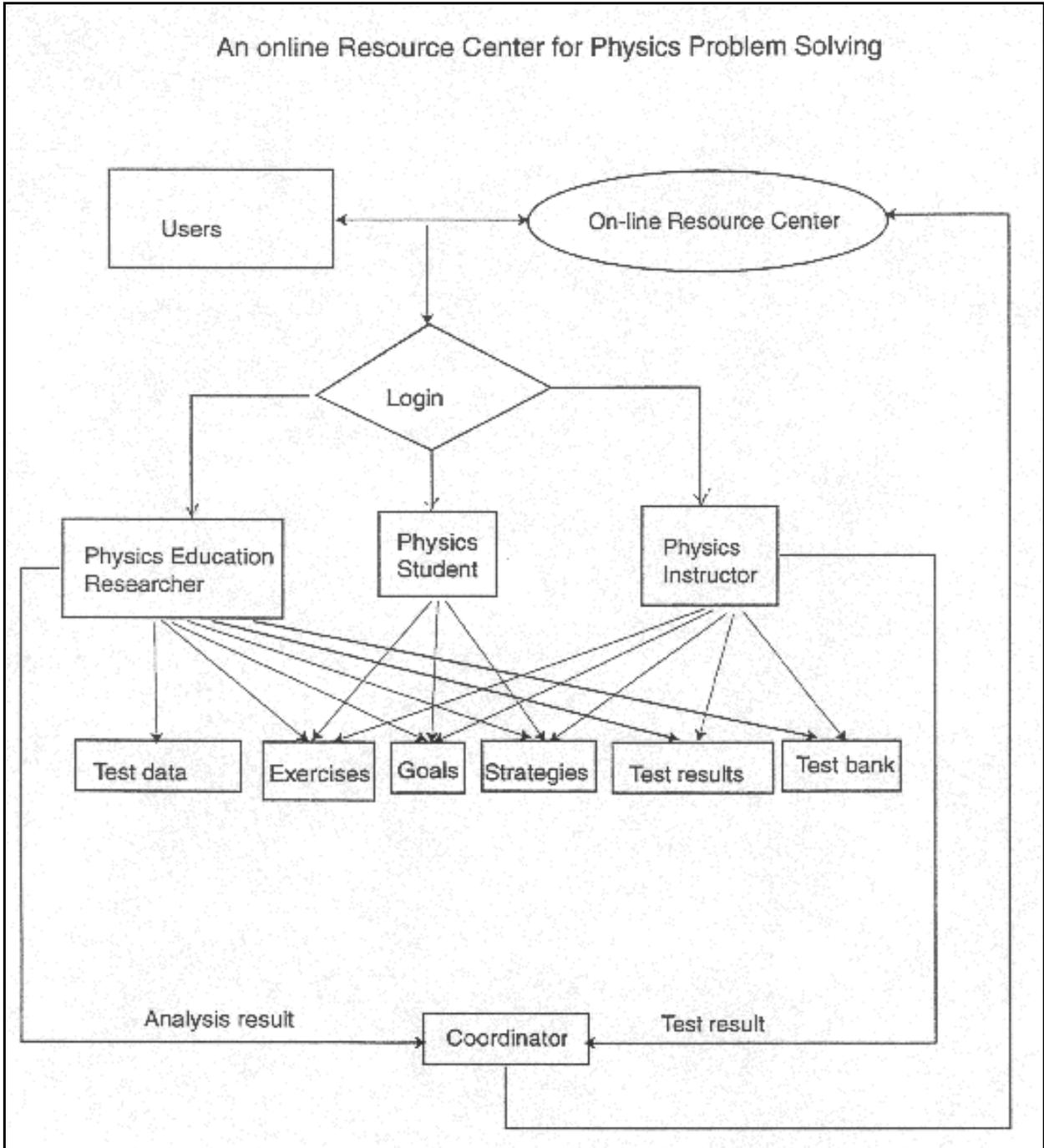
Our suggestion is that at least a limited number of institutions, if not the whole community of people in physics education, can join the consortium. The consortium as a group would submit a proposal to the NSF for support of educational research and development on problem solving.

The first point of the request is support for seven post docs, or the equivalent. It doesn't have to be post docs only, but that's a separate issue. These post docs would be at different institutions. Not seven post docs at one place but seven post docs at up to seven different institutions where programs of educational research are already established. These post docs would work on problem solving within that context, and coordinate the problem solving activities with post docs at other places. That is to say that these post docs would be responsible for developing this coordinated program of approaches to problem solving, the Consortium on Problem Solving (COPS).

This would involve constructing and maintaining a web-based resource center, (see Figure 2) which will have banks of carefully designed and evaluated problems and assessment instruments; on line evaluations; standardized grading criteria and guides for interpretation of results, collecting and analyzing data, as well as current

results. In other words, the post docs would be responsible for coordinating research in the various groups and for constructing this web-based resource center, which would be open to anybody in the physics community. If somebody wants to know how they are doing in their instruction we should have a set of problems that they can download and give to their students. Then they can get the results and compare them with a data bank of results from problem solving research.

FIGURE 2



I envision that this would be quite a large activity. There are many other details about having an oversight committee, and how we go about constructing this. One more point before I open it to discussion. It has been noted that the NSF is not prepared to entertain a proposal of this kind because it doesn't fit in any of their programs. If we want to have a consortium for cooperative work on problem solving, then we have to construct a white paper and make a presentation to the NSF to ask for some exceptional treatment in this regard. This is not a proposal that can go in right now on any program, as I understand it, with the NSF.

Q

Could you please point out to the graduate students in this audience that the fact that it costs the contract 75 K does not mean that that's what the salary is, so their expectations are not inappropriately raised?

David Hestenes

Yes, that's an estimate of what it costs the institution to support a post doc.

Q

I'm in high energy physics in another in another incarnation, so I really believe that the way to go is to make large collaborations to attack real and significant problems. I think this is a good direction. On the other hand and, and maybe you didn't mean it, or maybe you are just much further along than we are in problem solving, but this list of things—I mean, just valid problems, or carefully designed and evaluated problems, or assessment instruments and an online evaluation. These things, as I see it, are multi-year, incredibly difficult tasks, starting where we are now.

David Hestenes

Right. That's why we have to remember that this says "objectives". It doesn't say that we're doing them now.

Q

I just want to make sure that you weren't giving the impression that these are things that we can start to work on now and get them on line in a couple of years, and people would be using them.

David Hestenes

Exactly right. Exactly right. And that's why we have to have an army of people with a lot of time to work on this. This is incredibly time consuming, to work on problem solving. Although a post doc in your group would be able to draw on the resources that you have, as well as the resources of groups in other places.

Q

I think this is really a great idea, but I'm worried about two things. You mentioned interest in working with established groups. If I am trying to start up a group, for example, what I am seeing from the discussion yesterday with regard to the NSF, is that maybe this has exhausted all the money I can (inaudible).

David Hestenes

That was one of the comments. If this were funded by DUE, it would exhaust the entire budget. I think that's a very important issue. Seven post doc positions is just

a suggestion, of course. The point of attaching it to established groups is to be able to draw on the experience of the established groups in getting things going. One of the possibilities is somebody in another group working with an established group, but not there. Also, it is quite possible for a lot of other groups to be in the consortium, and there can be an oversight committee. One of the possibilities of having an oversight committee would be to look at the issues and proposals for different people who say, "I really need some of this money in my particular group and we have this idea." The money, I think, should be moveable so that it can move one place or another.

Q

Let me point out that in past years the Physics Division has supported small projects like this, about one quarter the size of this budget. They developed a database of problems and delivered it on the web without any of the thoughtfulness or the research base or the testing that you're putting in here. I would think that this, if phrased properly, could go to the Physics Division and not to DUE.

David Hestenes

Yes. I think that's right.

Q

Well I just had a question as to the comprehensiveness of the problem solving issue as you're presenting it. Certainly we talked this morning about problem solving skills being vital and how other departments see it—when we teach the engineers they want the problem solving skills taught—but it doesn't seem to show up as much in the Physics majors and in the Ph.D.s. Is this going to focus on all levels? It seems as if there's been a lot more research done in the lower levels.

David Hestenes

We were thinking specifically of concentrating on first and second year physics at the university level. I'm sure it would have implications both up and down.

Q

If you follow up on the idea of asking the Physics Division for funding, it might be a good idea to raise that level a little bit, maybe to first year and beyond. It might be more palatable to the Physics Division.

Q

Problem solving means something very different to some of my physics department colleagues than what it means to me, and probably what it means to you.

David Hestenes

I would envision that the web site can have a great variety of approaches to problem solving in including different sets of problems, and that a major part of the work by the post docs would be to establish criteria for evaluating what is a good problem and what is involved in solving different problems. Of course this should be backed up by statistics from our universities. There's a tremendous range, but I think there should be something for everyone on the web site.

Q

I guess I would disagree with your “something for everyone” philosophy. I think that the whole rationale for this is absolutely incorrect. That is, the problem solving skill is not the most widely accepted measure of physics understanding.

David Hestenes

Really?

Q

Most of our colleagues do not value problem solving skills that much and do not examine it in any of their evaluations of students.

David Hestenes

Well, they give lip service to it.

Q

That’s correct, but if this is about problem solving then it should be about real problem solving. I actually think real problem solving has been defined. We know what real problem solving is in the literature. I think it’s only in physics, maybe, that there’s any debate about what problem solving is. But come to the Context Rich Problems tutorial this afternoon where we’ll talk about it. I would hope that this thing would focus on what really is problem solving and not the many things that might pass for problem solving.

David Hestenes

Well, I think a diversity of approaches should be reflected.

Q

I’ll be more negative. I’m not sure this is a good idea, generally. For one thing, I think it constrains the field, whether you like it or not, to focus a lot more on problem solving than other things which may be equally important. I agree problem solving is important and there should be research on it, but this raises it to a level I don’t particularly like. It may also elevate problem solving, with our colleagues, to almost the only measure of success. I’m trying to convince my colleagues that there are other ways of measuring competence in physics than just problem solving. Finally, I think judgements will be made about the teaching quality and the quality of institutions by seeing how people perform on these things, which I don’t like at all.

David Hestenes

You don’t like the idea of comparing performance in different groups?

Q

(inaudible).

David Hestenes

Part of the point is that we are being called for justification for what we do and we have to have some measures and standards for being able to do that. So that’s part of the objective.

Q

I want to offer a comment about the magnitude of the project. I like the goal. One of the things that we should be looking at in our community is problem solving. At the University of Washington we have been looking at a specific kind of problem solving for a very long time, and we have been looking at quantitative problem solving in recent years. When I look around the community and I see who else has been looking at problem solving, I can identify several things that have a long tradition with problem solving. Requesting support at this level—I'm not sure that the community is ready to provide the intellectual input for something like this, even if you did have the money. Because it takes a very long time to propagate the information to the whole community, and as a community we are not at the point yet where we have common goals or common language about problem solving.

David Hestenes

A common language has to be negotiated. We need a mechanism for doing that, and that's the purpose of the consortium. This would include regular meetings, probably associated with the AAPT meetings, on discussing problem solving research, problem solving standards and so on, run by the post docs with advice from other members. There is a lot of good work on problem solving at the various different groups, but it tends to be isolated within the group. If you want your results and your insights in problem solving to have an effect, you need a mechanism for helping them to propagate to the other places. That is one of the purposes of this.

Q

I agree. One of the things that I think would be a wonderful step towards that is to start that discussion at the AAPT meetings, and to have special meetings where these things can be discussed. To request specific funding in order to increase the cooperation between the groups and the communication between the groups that we have right now.

David Hestenes

I think much more than discussion is needed. I think action is needed.

