Workshops for New Faculty in Physics and Astronomy

Discipline: Physics and Astronomy

Workshop Leaders (PIs): *Robert Hilborn,* American Association of Physics Teachers, co-PIs: *Ted Hodapp,* American Physical Society, *Kevin Marvel*, American Astronomical Society.

Funding Source(s): National Science Foundation, Research Corporation for Science Advancement.

Cost per participant: $900

Costs/Fees paid by the participants (or their home institutions): Transportation to workshop site (College Park, MD).

Target Audience: Newly hired physics and astronomy faculty at four-year colleges and universities in first one-three years of initial tenure-track appointment.

Typical Attendance: 80

Workshop Duration: Three and one-half days.

When Offered: Originally once per year; since 2008 twice per year.

Workshop website: http://www.aapt.org/Conferences/newfaculty/nfw.cfm.

Program Description

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The problem

The New Faculty Workshop in Physics and Astronomy (NFW) was developed in the mid-1990s during the appearance of a disturbing trend: from 1990 to 1996 the number of baccalaureate physics degrees awarded in the U.S. declined by about 25% (American Institute of Physics, 2008), while the number of baccalaureate degrees in the other STEM disciplines was increasing by 10%. During this period, physics fell from awarding one out of 200 U.S. baccalaureate degrees to one out of 300.

The NFW was created under the assumption that poor physics teaching at colleges and universities was at least partly responsible for the decline in the number of majors. This view was reinforced by the research of Seymour and Hewitt (Seymour and Hewitt, 1997), who interviewed hundreds of students at seven colleges and universities to try to elicit common trends among the reasons that students switched out of STEM majors. Their research revealed that poor teaching, especially in introductory SME (science, mathematics, engineering) courses, was among the most commonly cited reasons for switching majors: "Students were very clear about what was wrong with the teaching they had experienced and had many suggestions about how to improve it. They strongly believed that the source of these problems was that SME faculty do not like to teach, do not value teaching as a profession, and lack, therefore, any incentive to learn to teach effectively....Students also made very specific criticisms of the pedagogical techniques of their SME professors. The most common of these were that lessons lacked preparation, logical sequencing or coherence, and that little attempt was made to check that students were following the arguments or ideas. Students interpreted poor preparation as reflecting faculty disinterest in how well their students were learning."

Participants at the 2006 Physics and Astronomy New Faculty Workshop.

Further evidence of the problems with undergraduate teaching was revealed in the study of U.S. research universities sponsored in 1995 by the Carnegie Commission, whose findings and recommendations were presented in a document commonly known as the "Boyer Report" (Boyer Commission, 1998). Among their conclusions were: "The research universities have too often failed, and continue to fail, their undergraduate populations….Some of their instructors are likely to be badly trained or untrained teaching assistants who are groping their way toward a teaching technique; some others may be tenured drones who deliver set lectures from yellowed notes, making no effort to engage the bored minds of the students in front of them….Advanced research and undergraduate teaching have existed on two quite different planes, the first a source of pleasure, recognition, and reward, and the latter a burden shouldered more or less reluctantly to maintain the viability of the institution." Although the commission did not deal specifically with science classes, the overlap with the Seymour and Hewitt results is persuasive.

The proposal

In the late 1980s and early 1990s, physics education research produced a number of successful models for effective physics teaching. A common theme of many of these projects was the need for an increase in student involvement during class time, as a contrast to the traditional and passive lecture mode of teaching. Over the years these pedagogic techniques, which were classified under such rubrics as *cooperative learning* or *active engagement,* proved to be extremely robust and to enhance student learning in introductory physics classes at a wide range of institutions, from community colleges to research universities. Indeed, a common outcome reported by users of these techniques was a doubling of learning gains relative to more traditional teaching methods (Hake, 1998).

Unfortunately, graduate students in physics PhD programs are often unaware of these pedagogic developments, and so newly hired faculty often rely on traditional (and less effective) teaching methods. It was clear that this problem was sufficiently widespread and common that it called for a national program to mentor newly hired physics faculty.

In 1995 a steering committee was established under the auspices of the American Association of Physics Teachers (AAPT), and a proposal was submitted to the National Science Foundation (NSF) for a national workshop for new physics faculty that would focus on a small number of well-tested pedagogic developments that could be implemented by the participants at their home institutions with minimal additional time commitment and risk. It was decided to limit the workshop to the research universities (defined, somewhat more broadly than the traditional Carnegie classification, as those offering either a MS or a PhD in physics), which account for 70% of tenured physics faculty, provide 70% of introductory physics instruction, and produce a majority of majors. The NSF funded the project initially for three years to hold an annual workshop for 50 attendees, and the first program was held in the fall of 1996.

NFW logistics

The target audience for the original NFW series was faculty at research universities in the first one to three years of their initial tenure-track appointment. Letters were sent to department heads inviting them to nominate their newly hired faculty to attend. The workshops were scheduled for late October or early November, a time that avoided conflict with most major physics research conferences in the U.S. Because each workshop presents more-or-less the same program, repeat attendance is not permitted.

The NSF grant pays all expenses for the workshop, except for transportation of the participants to the workshop site, which is the responsibility of each participant's home institution. No registration fee is charged. Participants all stay at the same hotel, which adds to the bonding effect in forming a cohort group.

The workshops are held at the American Center for Physics (ACP) in College Park, MD. The ACP building is ideally suited for a small conference of fewer than 100 participants. Because the ACP is the national headquarters of the AAPT and other physics professional societies, support staff are available onsite to assist with logistics, and personnel from the other societies can observe the workshops. Moreover, the participants gain a sense of "ownership" by attending the workshop in a facility that they support with their professional society dues, and there are fewer distractions as compared with a workshop held in a hotel.

The NSF grant included a budget for follow-up activities, which were planned to be of two types: (1) reunion meetings held in conjunction with selected national meetings of the various physics and astronomy professional societies, and (2) sessions directed at concerns of new faculty at the annual national meetings of the AAPT.

By year four of the grant we had decided that any future program under renewed NSF support should also include full participation by the four-year colleges (those that do not award graduate degrees in physics), so we opened up the program and attendance swelled to 73. In year five there were only limited funds remaining in the original budget, so we held a small workshop for only 40 participants.

In 2002 the NSF renewed funding for the program for an additional five years, expanding the capacity to 70 participants from any institution offering a baccalaureate in physics or astronomy or any related field. By this time the American Physical Society (APS) and the American Astronomical Society (AAS) had joined as co-sponsors of the program. In 2008 we expanded the program by holding two workshops per year, one in June and one in November, and we were awarded another five-year renewal of the NSF grant. In 2007 we held the first reunion workshop, in which we brought former participants back to ACP for discussions of teaching practices at a more advanced level; the third reunion workshop was held in November 2012. Other smaller reunions have been held in conjunction with national meetings of AAPT, APS, and AAS, with participants' travel partly funded by the NSF grant.

Table I shows a summary of the attendance since the inception of the program. Astronomers and astrophysicists (including those employed by departments of physics) originally constituted about 10% of the participants but their numbers have grown to almost 20% in recent years when invitations have also been issued to departments of astronomy. Women have constituted a nearly constant 24% of the participants, which exceeds their 18% representation among U.S. physics PhD recipients and perhaps reflects the larger fraction of women who are awarded PhD degrees in astronomy (40%).

YEAR	Highest physics degree of participant's institution				Total	% Astro	% Women
	None	BS/BA	MS	PhD			
1996	0	7	1	42	50	16.0%	22.0%
1997	0	9	1	47	57	10.5	22.8
1998	3	10	2	43	58	8.6	12.1
1999	1	30	3	39	73	13.7	24.7
2000	0	9	2	29	40	12.5	22.5
2001	3	32	5	25	65	24.6	30.8
2002	1	35	3	39	78	7.7	23.1
2003	6	40	5	40	91	19.8	20.9
2004	3	40	7	42	92	21.7	17.4
2005	1	39	6	40	86	18.6	26.7
2006	1	35	6	37	79	13.9	27.8
2007	2	29	4	47	82	19.5	20.7
2008 June	4	33	9	43	89	19.1	19.1
2008 Nov	5	44	4	42	95	16.8	25.3
2009 June	1	38	7	34	80	17.5	28.8
2009 Nov	2	25	8	37	72	15.3	27.8
2010	1	42	9	27	79	21.5	27.8
2011 June	3	29	9	36	77	16.9	33.8
2011 Nov	0	27	2	29	58	25.9	25.9
TOTAL	**36**	**553**	**93**	**716**	**1398**	**17.7**	**24.2**

The NFW Program

The NFW has three formal goals: (1) to involve a significant fraction of the newly hired physics and astronomy faculty; (2) to acquaint and familiarize the participants with recent and successful pedagogic developments; and (3) to effect an improvement in physics and astronomy teaching when the participants implement new pedagogies at their home institutions.

Although the main focus of the program is on issues related to effective teaching, we also involve the participants in discussions of other issues of concern to new faculty, such as tenure, time management, effective mentoring of research students, and extramural funding. Because delivery of information is a significant goal of the NFW, much of the program is lecture-oriented in plenary sessions. (However, even the plenary sessions model good teaching practices by having the participants often break up into small discussion groups.) The "workshop" nature of the program is achieved through frequent small "breakout" groups of 20 to 30 participants, which enable interactions of participants with one another and with the discussion leaders. Here they obtain practical experience with the techniques introduced at the plenary sessions or discuss other topics of interest, including digital libraries, tenure, time management, and teaching specific courses such as introductory physics, upper-level physics, or astronomy. Prior to the opening of the Workshop, participants have the opportunity to meet with program officers of NSF and Research Corporation to discuss grant writing and funding opportunities. A sample NFW program is shown below.

Day 1:

1:30 - 3:00 pm	Optional Workshop on Grant Opportunities with Research Corporation
3:00 - 4:30 pm	Optional Workshop on Grant Opportunities with NSF Program Directors
4:30 - 5:00 pm	Break
5:00 - 5:15 pm	Welcome and Introductions
5:15 - 6:15 pm	Eric Mazur: Introduction to Peer Instruction (Plenary)
6:15 - 7:30 pm	Dinner
7:30 - 8:30 pm	Peer Instruction Workshop

Day 2:

8:30 - 10:00 am	Lillian McDermott: Research in Physics Education as a Guide to Student Learning (Plenary)
10:00 - 10:15 am	Break
10:15 - 11:15 am	Ed Prather: Learner-Centered Teaching in Physics and Astronomy (Plenary)
11:15 - 12:00 pm	Breakouts: PhET, Digital Libraries, Lecture Tutorials
12:00 - 1:00 pm	Lunch
1:00 - 1:45 pm	Breakouts: PhET, Digital Libraries, Lecture Tutorials

1:45 - 2:30 pm	Breakouts: PhET, Digital Libraries, Lecture Tutorials
2:30 - 3:00 pm	Break
3:00 - 4:00 pm	Andy Gavrin: How to Get Your Students to Prepare for Every Class (Plenary)
4:00 - 5:00 pm	Small Group Discussions - Various Topics
5:00 - 6:00 pm	Noah Finkelstein: Evaluation and Assessment (Plenary)
6:00 - 7:00 pm	Dinner
7:00 - 8:00 pm	Dick Berg: The Physics IQ Test

Day 3:

8:15 - 9:15 am	David Sokoloff and Ron Thornton: Interactive Lecture Demonstrations (Plenary)
9:15 - 10:00 am	Breakouts: Intro Physics, RTP/ILD, Upper-level Physics
10:00 - 10:30 am	Break
10:30 - 11:15 am	Breakouts: Intro Physics, RTP/ILD, Upper-level Physics
11:15 - noon	Breakouts: Intro Physics, RTP/ILD, Upper-level Physics
noon - 1:00 pm	Lunch
1:00 - 2:00 pm	Breakouts: PUI, Ph.D. and Research Master's
2:00 - 3:00 pm	Ken Heller: Help Your Students Develop Expertise in Problem Solving (Plenary)
2:45 - 3:30 pm	Breakouts: Physlets/OSP/Ejs, Tenure Matters, Problem Solving
3:30 - 4:00 pm	Break
4:00 - 4:45 pm	Breakouts: Physlets/OSP/Ejs, Tenure Matters, Problem Solving
4:45 - 5:30 pm	Breakouts: Physlets/OSP/Ejs, Tenure Matters, Problem Solving
5:30 - 6:15 pm	Reception
6:15 - 7:30 pm	Dinner

Day 4:

8:15 - 9:00 am	Tim Slater: Case Studies Discussion of Student Behavior (Plenary)
9:00 - 10:00 am	Diola Bagayoko: Mentoring for Retention (Plenary)
10:00 - 10:15 am	Break
10:15 - 11:00 am	Tim Slater: Time Management (Plenary)
11:00 - 11:30 am	Final Words, Evaluation Procedures and Adjourn

Assessment of NFW program

How well are we meeting our goals? The first goal was to involve a significant fraction of the newly hired faculty. Table 2 shows that nearly 1/4 of the (approximately 350 yearly) new U.S. physics hires have attended the workshop, with more than half attending in 2008. More than 75% of the Ph.D.-granting institutions have sent at least one faculty member. Sixteen Ph.D.-granting institutions have sent 10 or more faculty. Participation by the 510 baccalaureate departments is more difficult to assess, for these institutions average only 4 physics faculty and thus have new hires only rarely. Nevertheless the data show that we have typically attracted 1/3 of the hires at baccalaureate institutions, with nearly 2/3 attending in 2008. We feel that we are succeeding admirably at our goal of attracting a broad representation of the new hires in physics and astronomy.

Table II. NFW participants as a fraction of new U.S. physics hires.

YEAR	Highest physics degree of participant's institution			Total
	BS/BA	MS	PhD	
1998	9.6%	8.7%	31.4%	22.0%
2000	7.8%	7.1%	15.2%	11.9%
2002	28.2%	9.4%	19.8%	22.1%
2004	35.7%	20.0%	19.6%	25.5%
2006	29.7%	18.2%	18.0%	22.2%
2008	64.2%	43.3%	42.5%	52.6%

The extent to which the NFW program meets its second and third goals (acquainting the participants with new pedagogies and effecting improvements in teaching) can be assessed only through surveys of participants and their department chairs. For a detailed report on this evaluation, see the article by Charles Henderson in these proceedings. In summary, surveys of NFW participants reveal that 70% rate their teaching as somewhat or significantly more innovative compared with that of others in their departments. That evaluation is reinforced by the views of the department chairs, 73% of whom believe that students are better learners in classes taught by NFW participants.

Anecdotal evidence of the success of the program comes from statements by participants and their department chairs.

A Research I participant (now tenured) reports:

"Following the workshop I tried using several of the new … tools that were presented.… The results of these innovations have been so positive that other faculty who have subsequently taught the same courses have kept many of the same tools in place. In this sense, the New Faculty Workshop has benefited not only my own classroom performance but my entire department. The workshop also helped me formulate goals for the educational activities associated with my NSF CAREER award. For young faculty thinking about writing a CAREER proposal, the workshop is an incredibly valuable opportunity to find out what's going on in physics education."

A faculty member from a highly selective four-year liberal arts college states:

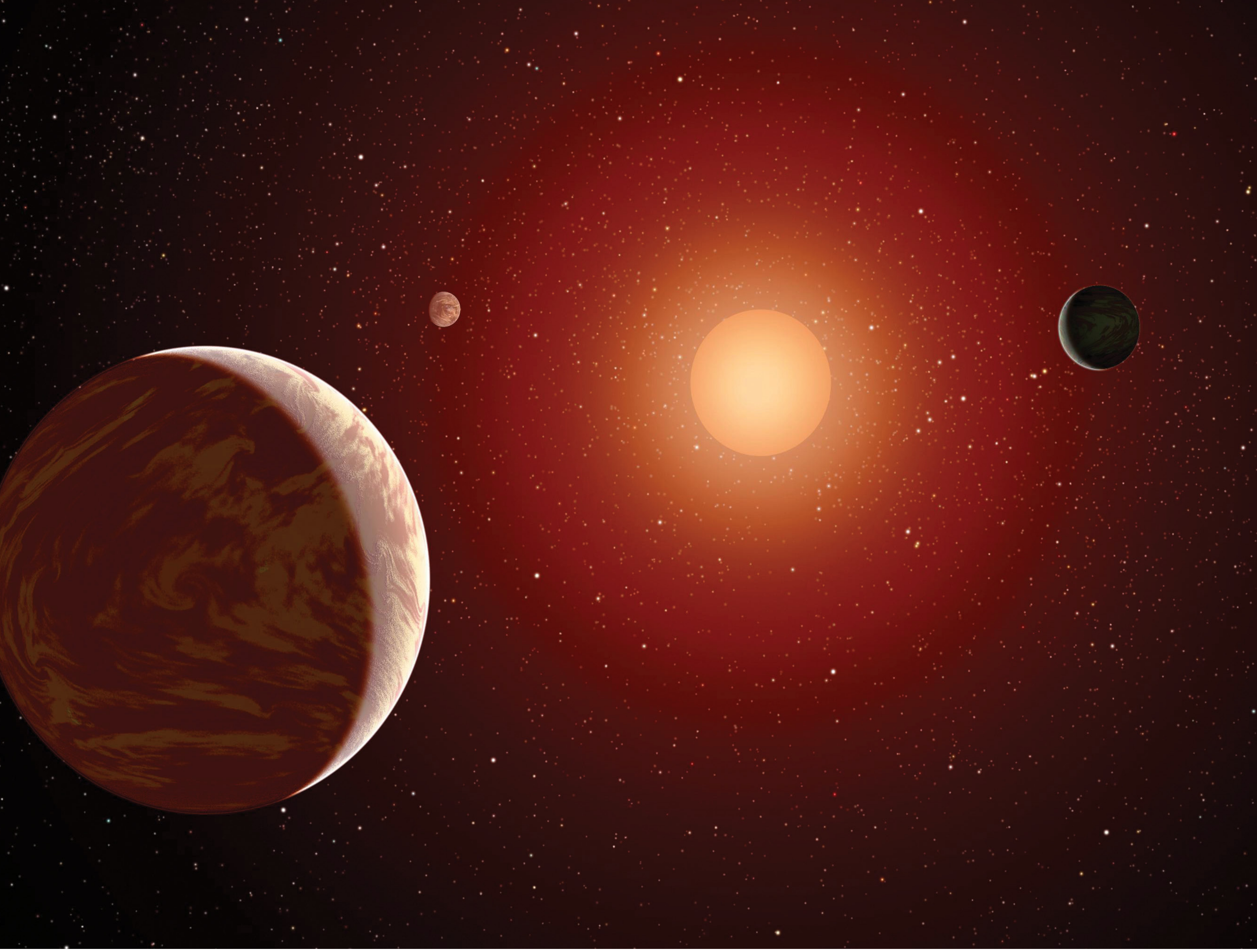
"I consider this workshop to have been an invaluable contribution to my development as an effective physics educator. The workshop introduced me to a variety of cutting-edge techniques in physics pedagogy, enabled me to develop a nationwide network of connections among new faculty members in physics, and introduced me to the community of physics education researchers. I have adopted several of the teaching techniques discussed at the workshop in my own teaching…. I am delighted with the changes in classroom dynamics resulting from better-prepared students and my own new insights into the particular difficulties with which my students are struggling…"

And from a Research I department chair (more than ¼ of whose faculty have attended the NFW):

"As a department chair, I believe that these workshops are more effective than I could ever be at convincing new professors that both the teaching and research they do will be recognized by their profession…. I believe the workshops have helped change the culture at (my) university to place greater value on excellent physics teaching. Our younger faculty have come to believe this with an enthusiasm with which they are gradually infecting the entire faculty of my department. I offer, as an indication of the progress which a dedicated cadre of faculty can achieve, the statistic that the number of physics majors graduated last spring was the largest in at least two decades. The improvement is not a statistical fluctuation, and represents a thorough reversal of the depressing decline in the number of majors through the 80's and 90's."

What are the characteristics of the physics-astronomy community that contribute to the success of the NFW?

1. Physics education research is a mature field with a large community of researchers. There is widespread agreement within this community about what constitutes "best practices" for teaching introductory physics, a course that is taken by virtually all majors in basic and applied science and engineering and that is offered with nearly identical content at institutions throughout the U.S. Within the physics academic ranks, there is thus a commonality of instructional challenges and remedies that transcends institutional types.
2. The small size of the physics community (compared with many other STEM disciplines) allows our program to have a major impact on the field while keeping the number of participants small. We have found this size to be essential in fostering discussion and interactions among the participants and between the participants and the presenters. There are often lively discussions during the plenary sessions (where many of our speakers model good teaching practices by encouraging active engagement of the participants in small groups), and the plenary speakers can easily circulate among the breakout groups to continue the conversations. These kinds of interactions would not be possible if the audience were significantly larger.
3. The program has enjoyed the strong support of major professional societies, whose emphases range from primarily teaching (AAPT) to primarily research (APS and AAS). In particular, the enthusiastic support by APS and AAS may in part be responsible for the active participation by the PhD-granting institutions, many of which do not normally participate to a significant extent in AAPT programs.



Acknowledgments

These workshops have been made possible through National Science Foundation grants DUE-9554738, 0121384, and 0813481 and grants from Research Corporation for Science Advancement.

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