

Promoting Instructional Change in New Faculty: An Evaluation of the Physics and Astronomy New Faculty Workshop

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Abstract. An important finding of Physics Education Research (PER) is that traditional, transmission-based instructional approaches are generally not effective in promoting meaningful student learning. Instead, PER advocates that physics be taught using more interactive instructional methods. Although the research base and corresponding pedagogies and strategies are well-documented and widely available to physics faculty, widespread change in physics teaching at the college level has yet to occur. Since 1996, the Workshop for New Physics and Astronomy Faculty has been working to address this problem. This workshop, jointly administered by the American Association of Physics Teachers, the American Astronomical Society, and the American Physical Society with funding from the National Science Foundation, has attracted approximately 25% of all new physics and astronomy faculty each year to an intensive 4-day workshop designed to introduce new faculty to PER-based instructional ideas and materials. This paper describes the impact of the New Faculty Workshop as measured by web-based surveys of 527 workshop participants and 206 physics and astronomy department chairs. Results indicate that the NFW is quite successful in meeting its goals and that it may be significantly contributing to the spread and acceptance of PER and PER-based instructional ideas and materials.

Keywords: Dissemination, Educational Change, Higher Education

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INTRODUCTION

There are approximately 9000 full-time equivalent physics faculty at 797 degree-granting physics and astronomy departments in the United States [1]. Roughly 300 new physics faculty are hired into tenure-track positions at the assistant professor level in a typical year [1-4]. These new faculty often have little preparation for their roles as teachers and frequently struggle with their teaching responsibilities. Thus, an appropriately developed program for new physics faculty has the potential to help support new faculty in their teaching while at the same time promoting the spread of instructional strategies and materials based on Physics Education Research (PER).

The Physics and Astronomy New Faculty Workshop (NFW) brings together physics and astronomy faculty in their first few years of a tenure-track faculty appointment at a four-year college or university to a 4-day workshop at the American Center for Physics in College Park, MD. During the workshop participants are introduced to some of the basic findings of PER as well as specific instructional strategies and materials based on these findings.

Presentations are made by leading curriculum developers and PER researchers.

The primary goals of the NFW are to:

1. reach a large fraction of the physics and astronomy faculty in tenure-track appointments prior to their receiving tenure;
2. help participants develop knowledge about recent developments in physics pedagogy and the assessment of changes in pedagogy; and
3. have participants integrate workshop ideas and materials into their classrooms in a way that has a positive impact on their students and their departments.

DESCRIPTION OF THE NFW

Attendees at the NFW are nominated by their department chair and the only cost to the department is transportation to College Park, MD. The workshop runs from approximately 4:00 pm on a Thursday to noon the following Sunday and contains roughly 12 hours of programming each full day. Presentations and discussions include a mix of large group sessions and small group sessions. It is important to note that the workshop presenters are leading and well-

respected curriculum developers since research suggests that the reputation of the reformer and/or their institution can have an important impact on how a reform message is received [5].

NFW Attendees

During its first 11 years in operation, 759 faculty have participated in the NFW. This represents roughly 25% of the assistant professor faculty hires during these years [1-4].

NFW participants represent 344 distinct colleges and universities. This is 43% of the 797 degree-granting physics and astronomy departments in the US [1]. In addition, 170 departments (21% of all departments in the US) have had more than one faculty member attend the NFW.

Cost

The NFW was funded with two grants from the National Science Foundation (NSF #0121384 and NSF #9554738). A total amount of \$742,000 was spent during the first 11 years reported on in this paper [6]. This works out to a cost per participant of \$978 (not including transportation cost to College Park, MD).

DATA COLLECTED

During spring 2007, a web survey was administered to the 690 NFW participants who could be located and who were still in academia. Of these, 527 (76%) completed the web survey before analysis began. Also, during spring 2007, a web survey was administered to all 794 US physics and astronomy department chairs using an email list provided by the American Institute of Physics. The survey was completed by 206 department chairs (26%). Approximately 53% of survey respondents reported having a faculty member from their department attend the NFW.

RESULTS

The NFW improves participants' knowledge of PER-based teaching techniques and interests participants in trying these techniques. Table 1 shows that most NFW participants indicate familiarity with the specific PER-based approaches discussed at the NFW after the workshop. In addition, nearly all (93.7%) of the NFW participants report being interested in incorporating some of the workshop ideas into their teaching right after the workshop. This suggests that they had formed a positive opinion of the instructional techniques presented at the workshop.

TABLE 1. Summary of participant responses to web survey question #17.

	I currently use it	I have used it in the past	I am familiar with it but have never used it	Little or no Knowledge
17. Please rate the following:				
Astronomy Tutorials	8.7%	5.0%	30.2%	56.1%
Collaborative Learning	39.2	17.2	23.0	20.6
Cooperative Group Problem Solving	47.2	21.9	22.9	8.0
Interactive Lecture Demonstrations	46.1	24.2	23.4	6.3
Just-In-Time Teaching	22.9	18.0	50.9	8.2
Peer Instruction	54.1	21.4	22.4	2.1
Realtime Physics	5.2	7.5	46.6	40.7
Personal Response Systems	32.6	15.0	43.7	8.7
Physlets	19.7	21.4	41.3	17.5
Tutorials in Introductory Physics	13.1	20.9	45.8	20.3

Participants report instructional changes to more alternative modes of instruction. Department chairs agree. Figure 1 shows participant responses to survey questions 12 (rating of teaching style prior to NFW) and 13 (rating of current teaching style). This shows that there was a large shift to more alternative teaching styles after the NFW. Only 1% of participants rate their post-NFW teaching style as highly traditional.

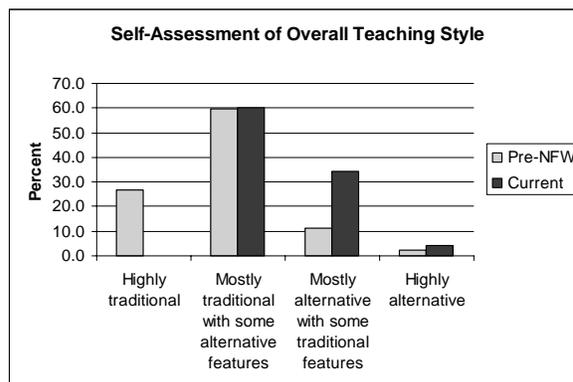


FIGURE 1. Participant self-assessment of their overall teaching style.

In addition, 70.7% of participants rate their teaching style as more alternative than other faculty in their department, and only 4.0% rate their teaching

style as more traditional than other faculty in their department. The department chair survey corroborates the participant self-report data -- 58.6% of department chairs rate NFW participants as having a more alternative teaching style than other faculty in the department and only 2.9% of department chairs rate NFW participants as having a more traditional teaching style than other faculty in the department.

Finally, 32.1% of participants report a “considerable” or “full” change in their teaching style since participating in the NFW. An additional 64.4% reported some change in their teaching style. Only 3.5% reported no change in their teaching style. Department chairs again corroborate the participant self-report data. Most department chairs (72.4%) report that NFW participants have made changes to their teaching as a result of the workshop. It is reasonable that this percentage is smaller than the percentage of faculty who reported making a change in their teaching since a department chair is unlikely to be aware of all changes made in the teaching practices of faculty in their department.

Participants report improved student learning. Department chairs agree. Most participants (64.7%) believe that the NFW has had a considerable or larger positive impact on their students and only 1.3% say that the NFW has not had a positive impact on their students. Similarly, most department chairs (72.6%) who have sent faculty to the NFW indicate that the workshop has led to improved student learning in classes taught by workshop participants.

Faculty report discussing NFW ideas with their colleagues and that some colleagues have made changes as a result of these discussions. Department chairs agree. If one of the ultimate goals of the NFW is to change the culture of physics teaching in the US, it is not enough for NFW participants to just learn about PER-based instructional materials and strategies and make changes to their own teaching. They must also bring these ideas into interactions with colleagues in their home departments. There is evidence that this has taken place. Most participants (86.8%) say that they have discussed NFW ideas with their colleagues. Based on their written descriptions, these discussions often occur as a result of pre-tenure teaching observations made by colleagues or during formal presentations at a department colloquium or faculty meeting.

Many NFW participants (39.8%) report that their colleagues have made changes in their teaching as a result of these discussions. Many department chairs (51.0%) also believe that NFW attendees have influenced other faculty in the department.

THE DANGER OF SELF-REPORTED DATA

Table 1 shows that participants report high levels of use of one or more PER-based instructional strategy. One danger of the use of such self-report data is that a respondent may say that they are using a particular instructional strategy when an outside observer would think otherwise. One way to estimate the degree of over-reported use is to compare the general statements of instructional style made on Table 1 with more detailed descriptions of instructional activities. In one part of the web survey, NFW participants were asked to select a particular class that they had taught frequently since the NFW and to identify the frequency with which they engaged in particular instructional activities. Table 2 shows the responses for the 192 participants (36.4%) who said that they used Peer Instruction on question #17 (Table 1) and also opted to report on the details of an introductory level class that they had taught. These instructors report instructional patterns quite different from traditional instruction, which would rarely, if ever, involve students working on quantitative or qualitative problems nor would students ever engage in pair or small group discussions. But, to what extent are the reported instructional styles indicative of Peer Instruction?

TABLE 2. Summary of self-described instructional activities of NFW participants who are teaching an introductory course and indicated that they currently use Peer Instruction.

	Never	Once or twice per semester	Several times per semester	Weekly	Nearly every class	Multiple times every class
Instructor solves/discusses quantitative problem	3%	5%	13%	33%	36%	10%
Instructor solves/discusses qualitative problem	4	2	10	25	37	24
Students solve/discuss quantitative problem	9	9	16	33	23	10
Students solve/discuss qualitative problem	3	1	12	25	33	27
Pair or small group discussion	4	2	15	24	25	30
Instructor questions answered simultaneously by entire class	8	2	8	15	26	40

Three of the instructional activities are particularly relevant for the non-traditional aspects of Peer Instruction: “Students solve/discuss qualitative problem”, “Pair or small group discussion”, and “Instructor questions answered simultaneously by entire class”. In Peer Instruction, each 1-hour class session involves three or four lecture-ConceptTest segments [7]. During each segment the instructor first lectures on a particular topic. Students then work individually on a multiple-choice ConceptTest (a qualitative problem) followed by a pair or small group discussion with nearby classmates. Finally, the students simultaneously report on their answers using a show of hands, flash cards, or a classroom response system (i.e., clickers). Thus, we would expect faculty engaging in the “pure” form of Peer Instruction to report each of the three relevant activities occurring multiple times each class. This was true for only 37 (19%) of the subsample of 192 participants. If the criteria is loosened a bit to include faculty who report each of these three activities “nearly every class”, the number increases to 73 (38%).

Thus, only 19%-38% of faculty who say they are using Peer Instruction report instructional activities that could be consistent with Peer Instruction. A possible explanation for this difference, consistent with other available evidence, is that many of these faculty have not used Peer Instruction “as is”, but rather have made significant changes based on some of the ideas of Peer Instruction [8]. Henderson and Dancy call this mode of operation reinvention and, in a small qualitative study, found that this was the most common way that faculty made use of developed curricula [9]. There is not enough evidence available in the survey data to judge whether the reinventions of Peer Instruction engaged in by NFW participants are likely to be productive or not.

CONCLUSIONS

Evidence presented suggests that the NFW has been effective in meeting its goals of introducing new faculty to PER-based ideas and materials and motivating faculty to try these ideas and materials. There is some evidence that NFW participants have also had an influence on other faculty in their departments. Thus, the NFW appears to be contributing significantly to the spread of PER ideas.

The apparent success of the NFW appears to be its ability to give faculty an introduction to PER-based instructional strategies and materials and to motivate many of them to continue to work on instructional improvement after the NFW. Thus, this study suggests that, at least under certain conditions, a relatively short, one-time, transmission-based

professional development program can successfully spread research-based ideas and curriculum into higher education. Keys to the success of the program may be that: 1) it is sponsored and run by three major disciplinary organizations; 2) it introduces participants to a wide variety of PER-based instructional strategies and materials; and 3) presentations are made by the leading curriculum developers in PER. Other disciplines may find it useful to implement similar disciplinary-based programs for new faculty. Such disciplinary-based models may also be appropriate for experienced faculty.

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