

Modeling Success: Building Community for Reform

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Abstract. Dissemination of the Modeling Method of physics instruction to high school teachers has been considerably more successful than typical dissemination efforts in science education. In order to learn from this success, we interviewed five leaders of the Modeling Project. Based on these interviews, along with other information about the project, our preliminary findings suggest that the Modeling Project differed from standard dissemination efforts in several key ways that are likely related to its success. Specifically, the Modeling Project placed primary importance on the building of community. This emphasis on building community manifested itself in nonstandard community-based curriculum development and dissemination activities.

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INTRODUCTION

The education research community has produced a substantial body of research demonstrating the weaknesses of traditional instructional approaches and has developed a large number of proven alternative methodologies and curricular packages which are widely available [1]. In addition, considerable time, effort, and money have gone into disseminating both the research findings as well as curricula. Despite all these efforts, available evidence indicates that these products are at best only weakly integrated into mainstream physics teaching [2]. Although there is still work to be done, the research base is strong and alternative curricula are widely available. Therefore, for those interested in large-scale reform, attention needs to be given to issues of dissemination. Why does dissemination so often fail and how can we improve the outcomes of our dissemination efforts?

One way to approach this problem is to look at dissemination efforts that have achieved some measure of success. Within physics education, one approach that has impacted large numbers of physics classrooms is Arizona State University's Modeling Instruction in High School Physics Project [3]. Why has the Modeling project been more successful than many other reform projects? What can we learn from the dissemination of Modeling Instruction that will help improve the impact of other reforms? In an effort to answer these questions we conducted open-ended

telephone interviews with five leaders of the Modeling Project. We asked them about the history, goals, philosophies, successes, failures, and evolution of the project. Although analysis of these interviews is ongoing, in this paper we report some preliminary findings.

HISTORY AND SUCCESSES OF THE MODELING PROJECT

Modeling, as a theory-based instructional technique, was conceived between 1980-85 with the goal of making instruction in physics reflect the activities of practicing physicists. The instructional techniques were established by Malcom Wells in his classes from 1985 to 1993 and were formalized by David Hestenes [4]. These instructional techniques formed the foundational curriculum for the Modeling Workshop Project. Evidence for the success of the Modeling approach to physics came from the development of the Force Concept Inventory and led to a pilot workshop project. Modeling gained support from the National Science Foundation during 1990 and held the first Modeling Workshop for high school physics teaching during 1991. Malcom Wells led the initial workshop, which lasted six weeks and included teachers from Arizona. During the summer of 1992, the project expanded to two workshops and included a follow-up workshop for the initial participants. The major support for the project came from a national

dissemination grant in 1994 and expanded the workshops to initially include sites in Arizona and Chicago.

As the number of workshops grew, so did the scope and emphasis. The group of initial workshop participants in 1991 made a commitment to participate in three successive years. The initial workshop focused on Modeling in mechanics, using technology to support teaching and help manage classroom discourse. In subsequent years, the participants began to develop curricular materials that covered electricity and magnetism as well as refining materials for the mechanics curriculum. Many of the participants in the initial workshops went on to become workshop leaders in subsequent years. The leadership team understood that growing the project would require additional leaders and vetted participants to begin leading workshops on their own.

The training of workshop leaders through the national dissemination grant expanded the reach of the project. In 1998, an initial leadership workshop helped train new workshop leaders, and initiated an on-going effort to develop new curriculum, including Modeling Chemistry and Modeling for Physical Science. In addition to expanding the scope of the workshops, leaders were encouraged to work with faculty at local universities to submit proposals to hold local Modeling workshops. Jane Jackson was essential in coordinating local high school physics teachers with faculty, and providing templates for proposals.

Modeling workshops helped teachers gain a better understanding of the content of physics by acting as both participant and teacher in the physics curriculum. Additionally, participating teachers saw significant improvements in conceptual understanding in their students as measured by the Force Concept Inventory. The Modeling Workshop Project Final Report 1994-2000 tracked the FCI scores for students of teachers in Modeling Workshops, the scores are reported in Table 1 [5].

Table 1. Posttest FCI scores for students of Modeling Workshop Participants.

Pre-Workshop	Post-Workshop	Post Follow-up Workshop
42%	53%	69%

By training workshop leaders and encouraging them to submit proposals for local workshops, the leadership team allowed local leaders to adapt the workshops to their particular circumstances and needs. This gave leaders a sense of ownership and encouraged strong allegiance to the workshop project. As a result, at this point over 1500 teachers have

participated in a Modeling Workshop, which represents over 8% of all physics teachers nationally. The numbers are even greater in Arizona, where over 70% of teachers in the state have participated in Modeling Workshops [6]. In light of the conceptual gains for both teacher and student, and the broad participation in the workshops, it is not surprising that in 2002 the U.S. Department of Education cited the Modeling Workshop Project as one of two outstanding educational reform efforts nationally [7].

DATA COLLECTION AND ANALYSIS

Open-ended, semi-structured telephone interviews were conducted with five leaders of the Modeling Project: Larry Dukerich, David Hestenes, Jane Jackson, Colleen Megowan, and Greg Swackhamer. All interviews were conducted by Eric Brewe and then transcribed for analysis. Although a detailed analysis is ongoing, the preliminary analysis reported here is based on identification of dissemination-related patterns and themes in the interview transcripts. All three authors engaged in this process.

WHAT MAKES MODELING DIFFERENT?

In many respects the Modeling Project is similar to other reform efforts. It is based on a good idea, backed up by research which indicates that the modeling approach helps students deepen their conceptual understanding, improve their problem solving skills, and develop more positive attitudes toward science. Additionally, the modeling project faced many of the barriers so common to dissemination in general. Our interviewees indicated that the Modeling Project was significantly impeded by lack of sufficient funding, resistant teachers, and either a lack of administrative support for the reforms or, in some cases, outright resistance on the part of administrators and policy makers. However, the Modeling Project was able to overcome these barriers.

Although every dissemination approach is unique, there are many aspects that are common. For the purposes of this paper, when we speak of the standard dissemination approach we refer to an approach similar to the model of reform advocated by the NSF CCLI program [8]. In other words, an approach which begins with a good idea, demonstrates the effectiveness of the idea through peer-reviewed research, uses research to develop the idea as well as supporting materials such as curriculum and teachers guides, then disseminates the idea nationally through talks, papers, books, and workshops aimed at potential adopters. In this model of dissemination ideas and/or

curriculum are developed by educational researchers and then distributed to teachers with some sort of training or guidance in their use.

This method of reform assumes that education researchers are in the best position to develop ideas and curriculum and that the most effective way of dissemination is to give teachers ready-to-use materials that they can implement more or less as is in their own classrooms. There are a lot of reasons why this method of reform makes sense. Teachers don't have the time or resources to continuously test and refine curriculum to the extent that a researcher can. In addition, once someone has put considerable time, effort, and money into working out the most effective method or curriculum, this project should be shared and used by others so they do not have to reinvent the wheel themselves. The basic idea is to develop the best possible project then share with others so they can use it too. In theory it is a great idea, but in practice, it has been limited in its impact.

The Modeling Project Focused on Building Community

Modeling differs from this standard approach. Standard curriculum development and dissemination is focused on a specific idea, methodology or curriculum. Although the Modeling Project appears on the surface to be focused on a specific set of "Modeling" curricular materials and strategies, the interviewee's descriptions reveal that Modeling Project was actually largely focused on the building of a community of "Modelers". Instead of developing and disseminating a product, the project built a community around the idea of teaching through scientific models. Throughout the interviews we found an overarching theme of community building exemplified in quotes like the following: *"Here is an important thing about the modeling program, it is the building of the community and the treatment of the dignity of the members of the community that is so important..."*

A great deal of deliberate effort went into building relationships and in developing communication avenues between modelers. For example, an effort was made to bring the same potential modelers back to Arizona State University each year so that they would get to know each other and feel comfortable turning to each other for support. Additionally, a listserv was created specifically for modelers to communicate with each other and to have support for their attempts to reform their own classrooms. As of this writing that listserv has over 1500 members. Even within the original leadership of the modeling project, our interviews indicate that each person brought something unique to the project and that the project

was not the result of any one (or even two) people, but rather the result of the unique contributions of everyone. Because the project so successfully built a community of modelers, it appears that even if all the initial instigators of the project were to discontinue their involvement, the project itself would go on. Ownership of the project does not fall with any one person or small group, it is shared by all and newcomers are welcoming and encouraged. Recently, the modeling community has established The American Modeling Teachers Association as a means to support the community of modeling teachers. [9] The establishment of this association was done independent of the original leaders of the Modeling Project, even to the extent that the initial listserv post to the modeling community announcing the association included the statement *"Both Dave Hestenes and Jane Jackson are aware and supportive of the organization; they are lifetime honorary voting members."* The modeling community can and does function independently of any particular individuals.

This theme of community building manifested itself in both the curriculum development and dissemination activities used by the modeling program. Each is discussed below.

Community-Based Curriculum Development

Although some curriculum was developed by the original implementers of the project they did not attempt to distribute the curriculum as is. Instead they deliberately encouraged workshop participants to work on refining existing curricular materials as well as developing their own new materials. The workshop participants were then encouraged to share their work with others to serve as a basis for future curriculum development. The leaders of the Modeling Project did not ask the workshop participants to develop curriculum because the curriculum needed to be developed (the leaders were capable of developing high quality curriculum on their own), rather the leaders asked the participants to develop curriculum because it was recognized to be an effective way of giving ownership to the participants. As one interviewee said *"A major part of [the success] is this social aspect, and one of them is raising the level of importance of the teacher. Making it so that it is their theory, getting them involved in developing the materials, and all of that stuff."* It appears that the intended effect was achieved. By encouraging potential adopters to become involved in the development process, teachers came to feel a sense of ownership in the project which appears to have increased their interest and commitment toward

adoption. Additionally, the Modeling Project itself benefited by having a collection of curriculum inspired by the ideas of many, a curricula which is therefore likely to be better than what any one person alone would have produced. This community-based approach is still ongoing in the Modeling community with no plans to cease this community-based development.

Community-Based Dissemination

In the standard dissemination approach there are usually a few leaders who take nearly all the responsibility for writing articles, giving talks, and most importantly, running workshops. The Modeling Project diverged from this model of dissemination. Rather than targeting potential adopters in the first workshops the initial leaders *“were really trying to take teachers that were not of variable quality, we were trying to take people we thought were the best teachers that we thought could lead workshops elsewhere or that could serve as role models for other people to follow.”* The Modeling Project has always encouraged others to join in the dissemination effort, to assume leadership positions, and, just as with the curriculum development, to build ownership in the project. As one interviewee said, *“I became absolutely convinced right then, in the first workshop, that the workshop should not be taught by faculty and it must be taught by teachers and this is one of the crucial things that has made modeling work. It has to be taught by the practitioners themselves who have a great stake in it.”* It appears that by encouraging and supporting others to take initiative in the dissemination efforts, the modeling project has benefited from both a large number of people to help with the dissemination and also from having a very enthusiastic group of disseminators who feel a personal connection to the project.

Another feature of the community-based dissemination is the availability of the Modeling materials in editable Microsoft Word format. As one interviewee described this decision, *“[We decided to make the curriculum available] in Word so it is editable and teachers could choose to take it and change it to suit their styles rather than change their styles to suit the materials.”* This is, of course, contrary to some dissemination efforts that do not think it is appropriate for teachers to make modifications to the curricular materials.

CONCLUSION

The standard approach to dissemination is hierarchical, with a small group of individuals developing a idea or

curriculum to be disseminated and then providing a product to adopters, while retaining ownership of the product and its dissemination. It is an approach that can be characterized as top-down. The Modeling Project did not follow this approach. Their approach was more grassroots and focused on the building of community and the giving away of ownership. It appears that the grassroots approach offered numerous advantages. By giving ownership to the adopters, in addition to curriculum and ideas, the project has developed and has benefited from a very large (and still growing) group of highly enthusiastic implementers/leaders. The project has taken on a life of its own, outside the initial instigators of the project, which has positioned it to survive and grow well into the future.

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