Engagement in Tennessee Mathematics

John B. Conway, Reid Davis
Jerry F. Dwyer

Abstract

The Mathematics Department at the University of Tennessee hired two outreach mathematicians in 2000. Outreach mathematicians are responsible for enhancing K–12 mathematics education, a goal formally recognized in very few research mathematics departments. Typical activities include school visits, presentation of teacher workshops, organization of service-learning and student volunteers, service on local and national committees, collaboration with education faculty, grant writing, and publication of scholarly articles. Research mathematicians find the role challenging because they must adapt to varying cultures outside of those encountered in regular teaching and research. Requirements for tenure and promotion differ somewhat from those for regular faculty and provide a challenge to the department and the university as much as to the candidates. However, the unique nature of the positions provides an opportunity for innovation and can serve as a model for other institutions

Introduction

Engagement is gaining prominence on campuses across the nation, often more visibly in the humanities than in the sciences or engineering. The University of Tennessee Mathematics Department, however, is making a major effort to incorporate outreach into a regular faculty role and adjust the parameters for tenure and promotion accordingly. This paper describes the development of that idea and the progress of the department toward an ideal that is both new and challenging in a research mathematics department.

The broad field of outreach across academic disciplines is being discussed more often in the literature. Byrne *(2002)* suggests that in the university of the future engagement will be a defining characteristic, and he provides criteria for a truly engaged university. Other authors develop a definition of the scholarship of engagement and a model to assess it *(Wise, Retzleff, and Reilly 2002)*. Finkelstein *(2001)* discusses defining, assessing, and documenting engaged scholarship in order to reduce the tension

between proponents of traditional and engaged scholarship. These broader discussions provide a context for the more narrow definition of engagement/outreach at the University of Tennessee Mathematics Department. This paper focuses on issues relevant to our work rather than the field of mathematics education in general.

Outreach on a broader front is gathering momentum at the University of Tennessee. In recognition of its charter as a land grant university, Tennessee has long had involvement in K–12 issues and help for teachers and students. This commitment is substantial: a full-time staff member in the College of Arts and Sciences is assigned to outreach efforts, and a program sends college faculty to spend a semester in residence at a local school. The advent of outreach faculty in the mathematics department has led other departments to express interest in outreach and to investigate similar possibilities.

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History of the Outreach Position

The University of Tennessee Mathematics Department has a long history of involvement in teacher training and offering courses for practicing teachers. Faculty have taken an interest in local K–12 schools and have often assisted in outreach efforts. The current head of the department decided that hiring a regular faculty member with a specific responsibility for outreach would be the best way to realize his vision of increasing the department's impact in that area.

The process of hiring began by convincing the faculty that such a role was acceptable in a research mathematics department. Issues of tenure and promotion had to be clarified and approval gained from the Dean of the College of Arts and Sciences. The college outreach director assisted in formulating a job description. The department at large favored some involvement in K–12 education, but nobody knew how best to go about it. The first search did not attract many suitable candidates and was put on hold for a year. The department learned some lessons from this and

refined its approach the second year. On that occasion a candidate was hired and began as an assistant professor. The post did not work well for him, and he moved to another university after only one year.

The department learned more important lessons from this hiring and refined the expectations further. A vacancy notice was issued in early 2000 and a number of suitable candidates applied and eventually the department hired the two assistant professors that coauthor this paper. Neither appointee was starting his career at the time of hire.

Reid Davis received his Ph.D. in mathematics at the University of Tennessee in 1991 and held a variety of positions in mathematics departments of local colleges in subsequent years. He held summer Eisenhower workshops for high school teachers and led arrangements for the first Tennessee Math Contest.

Jerry Dwyer obtained a Ph.D. in applied mathematics in Ireland in 1986 and taught in several locations throughout the world, including Africa. He worked with engineers on mechanics problems and with geologists on glaciological models. He coached several sports teams at different levels and developed a number of funded outreach programs at the University of Colorado.

Before coming to the University of Tennessee as department head in 1990, John Conway had been on the faculty at Indiana University for twenty-five years. Among his motives for seeking a department head position was his desire to have an impact on mathematics on a broad front, including K–12. Such a goal was particularly appropriate at a land grant university, which includes public service as a specific part of its mission.

Role of Outreach in the Department

There was some debate as to whether it would be more appropriate to hire a tenured faculty member, but this was not possible because of budgetary restrictions. Hiring two outreach mathematicians was seen as a means of providing mutual support. Lack of such support had probably contributed to failure of the first hire. Unlike the first search, the second fostered relations with the College of Education by including a mathematics education professor in the hiring committee.

At this time the university was starting a post-tenure review process, and the department had to develop a set of expectations for all faculty. It was decided that a separate set of expectations

for the outreach faculty should be written. These expectations were clear, but the department was reluctant to attach specific numbers. So for neither the regular nor the outreach faculty are there requirements about the number of publications or the percentage effort the various activities should receive.

The teaching requirement is similar to that of other faculty members, but the usual mathematical research and publication requirement is replaced by the development of a scholarly outreach program. The outreach mathematicians also must seek grants so that their work can be carried out on a larger scale. Traditional faculty are expected to achieve national recognition before receiving tenure. However, it is recognized that achieving a national reputation in outreach will be harder, and this is only required before becoming a full professor.

In many ways the new role is similar to that of faculty in mathematics education. But it is very important to emphasize that the outreach mathematicians are not doing "mathematics education." Indeed, in the departmental discussion leading to the decision to hire outreach mathematicians, one of the few consistent themes was that the department should not foster research in mathematics education. That was the mission of the College of Education, and the mathematics department was ill equipped to promote and evaluate such research. Outreach mathematicians are mathematicians doing work in education. Some

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mathematics faculty have adapted this role informally, but few institutions have previously offered formal recognition of outreach as part of the role of faculty in a major research mathematics department.

Before we proceed further we may ask the question: what is a scholarly outreach program in mathematics? It is a good question! The nature of the position allows us to define this for ourselves. So our answer to the question is a local one that is operational at the University of Tennessee. We have the freedom to take this unique role and develop it into a model. At the very least we must carry out activities that will enhance K–12 mathematics education. This can involve school visits, development of mathematics enrichment activities, service on educational committees, and

organization of teacher workshops. It is often necessary to seek funding to operate effective programs so grant writing becomes a part of the job. It is important that we describe all this reflectively in the literature. This transforms our work from service alone into a scholarly activity.

Outreach in Other Math Departments

Other universities are looking more closely at the concept of outreach faculty. Perhaps the most dramatic example is the University of Kentucky. After making a successful bid to obtain a Math Science Partnership grant from the NSF, Kentucky has instituted two chairs in outreach, one in mathematics and another in one of the science departments (yet to be determined). In addition, the mathematics departments at Texas Tech University and Iowa State University have conducted searches for mathematicians with a strong outreach role. Many attendees at recent meetings of the American Mathematical Society have expressed a strong interest in this approach to outreach.

Outreach Activities

The outreach mathematicians have pursued different types of activities. This is reflective of their different interests and personalities. The department recognized that such differences would exist before the positions were filled. Both approaches, however, are well within the parameters of what the department expects from these positions.

Dr. Davis has focused his efforts on two large NSF projects seeking to improve K–12 mathematics in rural Appalachia. The first is the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM: http://www.acclaim-math.org), a $10 million grant shared by Ohio University, Marshall University, and the Universities of Kentucky, Louisville, and Tennessee. He serves on its management team and on the sub-team that oversees the ACCLAIM doctoral program in mathematics education. Through this unique program, taught through the cooperation of the partner universities, teachers in rural locations can pursue the doctorate without relocating and giving up their jobs. It also has a heavy mathematics content requirement, making it an attractive project for an outreach mathematician. The second project is the Appalachian Mathematics and Science Partnership (AMSP, http://www.appalmsp.org), a

$22 million partnership between fifty-two school districts and nine institutions of higher education. Dr. Davis serves on the AMSP's mathematics advisory council and oversees the AMSP Explorers program at the University of Tennessee. This program gives undergraduate mathematics students a behind-the-scenes look at college and high school mathematics teaching.

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Both ACCLAIM and the AMSP seek to take graduate mathematics courses to teachers in remote locations. Distance education is essential for this work. Dr. Davis plays a leading role in the projects' efforts to adapt current mathematics courses for distance presentation, having taught discrete mathematics for teachers by videoconference in spring 2002 and the history of mathematics online in spring 2003. The UT Mathematics Department is also putting its long-standing master of mathematics degree courses online, starting with a probability and statistics course for teachers taught by Dr. Davis in fall 2003. Teachers are the exclusive audience for this degree; through distance education the department hopes to reach out to middle and high school teachers for whom enrollment in a traditional on-campus degree program is impractical. ACCLAIM and the AMSP are supporting this effort.

Dr. Davis chairs the mathematics department's mathematics education committee and advises all students enrolled in the master of mathematics degree. He has served on a search committee to hire a new professor of mathematics education, and he currently serves on one doctoral committee in mathematics education. In fall 2000 he was in charge of arrangements for the Tennessee Math Contest, an annual daylong competition on the UT campus in which high school students from throughout the state compete for full scholarships on the basis of mathematical prowess. He is slowly learning the literature of mathematics education, and he seeks to inform the mathematics department about the hot issues in that field. He is also the secretary/treasurer of the Smoky Mountain Mathematics Educators Association, the local affiliate of the National Council of Teachers of Mathematics.

Dr. Dwyer makes frequent school visits to provide mathematics enrichment for the kids. This is most often to the elementary grades. Anecdotal evidence suggests that they are clearly beneficial. He is conducting surveys as a formal investigation in order to write about the value of these visits and promote the idea among our colleagues and among the greater mathematics community. He is also offering a series of workshops to enhance teacher content knowledge

Dr. Dwyer is a strong advocate of service-learning, in which students receive class credit for performing activities in the community. He has introduced service- learning to several of our lower-level classes and placed a special emphasis on it in our mathematics classes for elementary teachers. The facilitation of university faculty visits to local schools has been well-received here. Many faculty are happy to visit schools and give some kind of talk or presentation, but do not have the time to make arrangements and are pleased when an outreach mathematician can do this for them.

Challenges

One of our greatest challenges is avoiding excessive and inefficient commitments. The department's expectation that we secure outside funding for our work indicates the scale considered appropriate for our endeavors. The needs are infinite, and we must choose a small number of activities promising large returns. Tutoring one child is valuable and satisfying but inefficient. Setting up service-learning tutorial services or deepening mathematics teachers' knowledge of their field expands the scope and impact of our outreach.

Working closely with colleagues in mathematics education, both in our College of Education and through the ACCLAIM grant, brings unexpected pleasures and challenges. Their field, however, is a social science in which intuitive definitions, case studies, and observational studies predominate. Rigorous definitions and experimental studies are seldom available, and the field does not value them highly. This grates on our mathematical senses. There is a nagging feeling that we are not really mathematicians if we are not doing mathematics research. Therefore, we try to include a little mathematical research and writing in our jobs even though the department does not expect it of us.

Publishing in education or outreach presents a new set of challenges. Subject matter appropriate to this field is closer to the

style of papers in the humanities or social sciences, and we have no training or background in that. We lack both knowledge of the literature and time for acquiring such expertise. However, we also lack time to write technical mathematical papers. For those reasons our publications must fall somewhere between mathematics and education. Topics could include articles in popular teaching magazines and informal notes on curriculum and class notes for teachers. We have become familiar with some of the journals of the mathematics teaching community and with the popular press on the major mathematics issues.

This new role differs from that of regular mathematics faculty in that we have to interact with many different cultures outside the department. Traditionally mathematics research is done in private in ones own office with little interaction with others. Mathematics outreach requires that we work with the College of Education, with the local school district, with funding agencies, and with many local community organizations. This requires a high level of communication and administrative skills. It also demands a less flexible approach to time management and makes the outreach mathematician more sensitive to local conditions such as parking and traffic. It is more difficult to be productive when one is hampered by such travel restrictions. In larger cities a single school visit could involve several hours away from the office.

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Tenure, of course, is a big concern. The issues facing institutions as they try to develop criteria for recognizing faculty participation in outreach are addressed in recent articles *(Holland 1999; Keener 1999)*. Before we were hired the department wrote guidelines for granting tenure to outreach mathematicians, trying to keep these close to the guidelines for research faculty. The department appears content with these standards, but the process of evaluating us for tenure will show whether appearance matches reality. In addition, the college and university may disagree with the department's position. For instance, the department does not regard publication as a crucial part of our work, but the college is uncomfortable granting tenure in the absence of publications.

Because outreach mathematician is a new role and the department is reluctant to give credit for prior work in the area. Thus the new appointees received no reduction in the time to tenure even though both had extensive relevant experience. Traditional research faculty often get reductions based on prior work in their area of expertise. In this way the outreach mathematicians are in a special category. The shadow of tenure decisions is restrictive; hiring outreach mathematicians at the tenured level would make better work possible.

On the other hand, from the department's point of view, this is a new venture and it wants to give the full probationary period to vetting the concept of the position as well as the people. The department has a long-standing tradition of interest in teacher training and something like outreach, but it has been well over thirty years since anyone was hired who did not have a traditional research program in mathematics. From the beginning the department has viewed the position of outreach mathematician as dynamically defined. True, the expectations were laid out explicitly, but there is considerable leeway in how those expectations are met. K–12 is a broad area, and adding the possibility of outreach to community colleges broadens that landscape further still. The department wanted to allow maximum time to define the role of outreach mathematician as well as to ascertain how the individuals fit themselves into that role.

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This past fall (2002) both outreach mathematicians went through the department's formal third-year review. This has the form and procedures of the tenure review and is meant to inform the tenured faculty and assistant professors of any potential difficulties and allow adequate time to address them before the tenure decision. In the case of the outreach mathematicians, the department decided that this would also be the time to re-examine the entire concept of outreach and its role in the mathematics department of the University of Tennessee. Both the two outreach assistant professors and the program emerged from this review

with strong endorsements. There were some minor adjustments in the program, but the path has been cleared to tenure.

Results

There have been several promising developments. The local K–12 county mathematics coordinator has invited the department to have a representative on their next textbook-choosing committee. The advent of the No Child Left Behind funding has seen neighboring school districts turn to the University of Tennessee mathematics department for help in making their middle school teachers "highly qualified." Our outreach mathematicians are edging toward involvement on a broader geographical front, and outreach activities are gaining favorable attention from our department's financial donors.

The Tennessee Math Contest now enjoys sponsorship from the Pro2Serve Corporation and grows annually, drawing over six hundred students, plus teachers and chaperones, in 2002. The ACCLAIM doctoral program enrolled fourteen students in its first cohort starting summer 2002. Given the national shortage of mathematics educators, this cohort promises to provide a dramatic infusion of mathematically trained educational leadership into rural Appalachia. Further, the master of mathematics program, which has struggled to produce one or two graduates annually in recent years, now has over twenty East Tennessee teachers ready to enroll in summer or fall of 2003, taking advantage of the chance to participate by distance education.

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Over the past two years an average of twenty-five students have been placed in service-learning opportunities. Faculty and graduate students have been active in school visits and female graduate students have led math clubs for middle school girls. This program has been funded by a national mathematics organization for two years. The department of Mathematics, in conjunction with the department of computer science, has also obtained major funding from the National Science Foundation that enables us to offer forty-five scholarships to needy students from the local Appalachian district. These scholarships enable

poorer students to major in mathematics or computer science and fund mentoring to ensure that they are successful.

Conclusion

Few major research mathematics departments formally incorporated outreach activities as a regular faculty task. It will be another two years before we can definitely speak of the success of the venture, but it is already attracting favorable notice. Recent articles *(Conway 2001; Dwyer 2001)* in a premier mathematics magazine have inspired many responses from institutions that are grappling with ways to develop similar programs. The university officials are enthusiastic about the aims of this program.

Our major challenge is to be of service in the K–12 community while finding time to write scholarly articles. But we must also maintain our identity as mathematicians. We must keep that role and walk the fine line of producing scholarship in outreach. In many ways we have the opportunity to lead the way, and perhaps our efforts will help to define outreach scholarship in mathematics.

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About the Authors

•John Conway was born and raised in New Orleans; he received his B.S. in mathematics from Loyola University in 1961. In 1965 he received a Ph.D. from Louisiana State University and

joined the faculty of the Mathematics Department at Indiana University, where he remained until 1990. He then accepted the position as head of the Mathematics Department at the University of Tennessee, where he is today. During his career he has had nineteen doctoral students and written seven books and many research papers. He is currently on the Board of Trustees of the American Mathematical Society.

•Reid Davis received a B.A. in mathematics and German from the University of Tennessee in 1982 and then spent a year in Germany as a Fulbright scholar. Upon returning he worked briefly at Technology for Energy Corporation, developing software for power plant monitoring. He returned to graduate school in 1985, receiving the Ph.D. in mathematics from UT in 1991, with a specialization in enumerative combinatorics. He served on the mathematics faculties of several area colleges and had the chance to pursue various outreach opportunities, which led to his hiring as an outreach mathematician in 2000.

•Jerry F. Dwyer (Ph.D. National University of Ireland) is an assistant professor in the Department of Mathematics and Statistics at the Texas Tech University. He has taught a wide range of mathematics and engineering courses and has published mostly in the area of applied mathematics with applications in mechanics. In recent years he has organized numerous outreach and service-learning programs at the University of Tennessee and the University of Colorado.