Teachers Investigating Adult Numeracy (TIAN) is a collaborative project of the Center for Literacy Studies at the University of Tennessee and TERC, a Cambridge, MA, non-profit organization focusing on math and science. Funded by a grant from the National Science Foundation and support from six participating states, it draws on the work of two other projects: EMPower and Equipped for the Future. In developing and testing the TIAN professional learning model, our central question has been: What will it take to help the adult education workforce move closer in belief and practice to a more complete definition of mathematics proficiency?

This paper introduces the project’s assumptions and goals, describes the elements of the intensive model, and presents the accompanying research methodology and early findings on what changed for the teachers who participated in the professional development program.

An Overview of the TIAN Project

Teachers Investigating Adult Numeracy has been a 4-year collaboration (2005–2009) developing and testing a model for in-service professional learning that uses teacher investigations and reflective learning to engage adult education teachers in considering how to implement purposeful and effective mathematics instructional approaches.

TIAN’s primary focus is on teacher learning. The goals of TIAN are:
1. to increase and deepen teachers’ mathematical content knowledge
2. to increase the number and range of teachers’ instructional approaches
3. to increase teachers’ knowledge and use of state mathematics content standards
4. to increase states’ capacity to provide quality mathematics instruction.

A total of 40 Massachusetts and Ohio adult basic education teachers participated in the pilot phase of TIAN in 2005–2006, and 76 teachers from Arizona, Kansas, Louisiana, and Rhode Island took part in the field test in 2006–2007. In 2008, teachers from all six states were involved in a variety of activities to support, extend, and share what they had learned.
Assumptions

Our TIAN work has been based in two assumptions about learning and teaching mathematics.

1. Math is more than procedures

Research tells us that mathematical proficiency includes, but is more than, being fluent with procedures, and that effective math learning and teaching should also attend to conceptual understanding, strategic competence, adaptive reasoning, and a productive disposition (Kilpatrick et al., 2001). While this particular research refers to children learning math, we, the authors of this article and principal investigators of the Teachers Investigating Adult Numeracy project, believe this definition of mathematics proficiency holds true for all ages. In this article, we describe the professional learning model we believe is needed to support teachers who wish to base their instruction on this definition, describe the research conducted concurrently during the testing of the model, and present some of the initial data about the impact of the model on teachers involved in the field test years.

We have found that teachers tend to teach the way we were taught. That means teachers who were taught only math procedures now teach only procedures, while those who were taught skills, concepts, and strategies in an environment that encouraged reasoning, communication, and problem-solving, now teach that way. In adult basic education and GED classes, teachers often teach a range of subjects and few have extensive training in mathematics. As a result, in visits to ABE (Adult Basic Education) programs, we are much more likely to see teachers experimenting with innovative approaches to instruction in reading, writing, and social studies than in math. Additionally, the instructional emphasis in mathematics has been on procedures (Ward, 2000).

2. Quality professional development has some essential features

Research on teacher professional development tells us that effective teacher professional development in mathematics and science occurs over time and is not a “one-shot” activity. The intervention should be built upon activities that help instructors advance their own conceptual understanding of mathematics and the way adults learn so that instructors use this knowledge in planning instruction for learners. It helps instructors connect content and materials to authentic and real-world numeracy/mathematics situations (Sherman et al., 2006).

It is important that the professional development reflect the research on how adults learn (e.g., multiple problem-solving strategies, collaborative learning, and access to prior knowledge). The mathematical content within the professional development should reflect national (e.g., National Council of Teachers of Mathematics, American Mathematical Association of Two-Year Colleges, and Equipped for the Future) or state standards. In the TIAN model teachers engage with mathematics content as learners as well as instructors and connect the mathematics they are learning and teaching with their state’s standards.

The Professional Development Component: The Intervention

The professional development provided by TIAN is both extensive and intensive. Two processes for teacher change that have been shown to be effective in mathematics education play a central role in the model. The first is the opportunity for teachers to do mathematics themselves with an
emphasis on learning with understanding (Ball, 2000; Hill et al., 2005). In the first year, participating teachers attend three institutes; in each, they spend two days doing mathematics together, sharing their work, and analyzing how they can apply what they learn in their classrooms. They experience new approaches first-hand. The institutes and teacher meetings held between institutes are structured in ways that ask teachers to be learners of mathematics.

The second process shown to be effective is the opportunity to conduct close examination and discussion of student work. Between institutes, the participants teach lessons on data and algebra that they adapt from math materials they develop and from a curriculum called EMPower, developed by TERC (see http://adultnumeracy.terc.edu/EMPower_home.html). They document their planning and instruction in two detailed work samples in which they describe what they have done and why and how three students at different levels responded to the instruction. Some of these samples have been posted on the website to illustrate to other teachers how the lessons played out in an adult education classroom. (See http://adultnumeracy.terc.edu/TIAN_worksamples.html)

TIAN’s mathematical content centers on two strands of mathematical proficiency: algebra and data. While a comprehensive instructional program in ABE mathematics must also include the development of number and operation sense and geometry and measurement, we chose to focus on algebra and data analysis for several reasons. Algebra, the “gatekeeper” subject is, as Robert Moses (2001) believes, essential for full citizenship. Understanding the presentation of basic statistics in the media is also essential. Moreover, algebra and data analysis have received added emphases on the most recent edition of the GED exam and in the most recent sets of adult-focused standards. However, we have found both to be areas with which current teachers are uncomfortable, and which are often taught only to high level students. TIAN helps teachers build their confidence and competence in algebra and data by involving them in doing math as well as learning how to teach math.

TIAN gives participating teachers opportunities to learn new instructional approaches, including:

- Working collaboratively on open-ended investigations
- Sharing strategies and understandings orally and in writing
- Justifying answers in multiple ways
- Using contexts that are meaningful to adults
- Exploring a variety ways for entering and solving problems.

These instructional approaches are intended to increase students’ opportunities to learn and are supported by research on principles of effective teaching (Brophy, 1999; Bransford et al., 2000; Hiebert & Grouws, 2007).

One of the challenges of beginning to use new approaches to instruction, particularly approaches that are not based on rigidly sequenced published materials, is assuring that necessary content is covered at appropriate levels. Adult education mathematics content standards and curriculum frameworks can provide that structure. TIAN training includes each state’s standards, and teachers are helped to connect their instruction to their state standards.
In the United States, each state is responsible for the provision of basic education for adults. Thus, the state education staff plays an important role in shaping how the professional development project begins and how the work of the teachers is expanded and sustained. The model assumes that the teachers in the TIAN cadres will serve as change agents not only within their classrooms and programs, but across their state, and the state staff leads the organization of the cadre into regional groups. To support this process, during the second year of the state’s involvement, two goals were added:

- To increase the number of mathematics teacher leader/facilitators who would support their state’s efforts in improving instruction.
- To increase the ways in which the state could support the teacher leader/facilitators in expanding the number of teachers included.

With the new goals in mind, the TIAN Project provided additional web-based resources (TIAN Bundles) and supported leadership development among the six first-year cadres in various ways as the teacher leaders/facilitators led local groups, co-facilitated trainings, or met in study circles.

In November, 2008, the TIAN Project staff invited representatives from the six states to a 3-day leadership institute in Cambridge MA: The TIAN Facilitating Mathematics Professional Development Institute. The training was the culmination of the pilot and field test phases of the TIAN model, leaving each state with an increased capacity to further develop their adult education math instructional programs.

The Pilot and Field Test of the Professional Development Component

Six teacher cohorts from six states, for a total of 116 teachers, participated in testing the TIAN model, 40 in the pilot and 76 in the subsequent field test.

The teachers in the pilot cohorts were from Massachusetts and Ohio. We recruited these two states because we knew that they had state adult mathematics standards and were actively working to improve mathematics instruction in adult education. The teachers in field test cohorts were from Arizona, Kansas, Louisiana, and Rhode Island. We chose these four states from the twenty states that applied to be part of the field test. Our choices were based on our interest in having a diverse group of states regionally and in terms of level of state support.

The teachers and classrooms in the pilot and field test cohorts were somewhat similar. All were teaching in adult learning centers/programs sponsored by a school district, a city, a community college, a community based organization, or a correctional facility. The majority (75% pilot, 59% field test) taught in open-entry, open exit programs, where new students entered when space became available, rather than on a semester or course basis. A large majority (90% pilot, 80% field test) taught other subjects as well as math. Class size varied, with 4–18 students in pilot classes and an even wider range in the field test classes, with 2–37 students. Pilot classes averaged 9 and the field-test classes averaged 11 students. There was a notable difference between the two groups in math class time. On average the pilot teachers’ students spent 3.6 hours/week “doing math” in class, whereas the field-test teachers’ students averaged 5.9 hours/week.
All teachers participated in a year’s worth of TIAN activities. One such activity, from the third TIAN institute, is described below.

Potatoes are sitting in a bowl next to some vegetable peelers; a pile of pennies with coin wrappers are on a nearby table; on another table a bunch of envelopes are waiting to be stuffed. Twenty ABE teachers break into teams of four and rush to one of the stations to begin to do a “sample of work” to determine how long it would take to help out at a community event by peeling 50 pounds of potatoes for a huge potato salad, rolling 10,000 pennies, and stuffing 1,000 envelopes. Everyone is left to their own devices, and all five teams take different tacks: some have one team member do the work, while another records how long it takes to stuff of 10 envelopes; others count how many envelopes can be stuffed in a minute; others test out what can be done in two or five minutes. Some build up to 10,000 by calculating in their heads, others round numbers with confidence. Some use good old-fashioned paper and pencil computation or cross-products, others punch numbers into calculators. Everyone is on-task and having a good time.

Once they have completed the tasks at each station, the groups post their results on newsprint. The facilitator asks them to describe strategies, and why the strategies work or don’t. People seem amazed that there are so many ways to arrive at a reasonable answer. If one estimate is way off, the whole group focuses on why. The facilitator pushes the participants to compare, contrast, and make connections between the various strategies.

The teachers have “lived” the lesson they will be trying out in their classes. Next, the teachers examine student work. They read a classroom vignette that describes a dilemma that came up for a group of students and are asked, “What would you do next as a teacher that would be helpful?”

If you compare this active open-ended exploration of ratio and proportion with the typical way ratio is presented—setting up two ratios and cross-multiplying—, you get a sense of what goes on in a TIAN Institute as well as the extent to which we are encouraging teachers to stretch their mathematical understandings and classroom practices.

The Research Component

TIAN’s three goals for teacher-participants are:
Goal 1. To increase and deepen teachers’ mathematical content knowledge,
Goal 2. To increase the number and range of teachers’ instructional approaches
Goal 3. To increase teachers’ knowledge and use of state mathematics content standards.

To determine our success in meeting these three goals we collected and analyzed a variety of data from participating teachers. In this article we are reporting on our initial analysis of results regarding the last two of these goals; we will report on the first goal in another paper.

Initial Findings on Goal 2: Number and Range of Teachers’ Instructional Approaches

To examine changes in the number and range of teachers’ instructional approaches we have considered data from three sources:

1. 75-item questionnaires completed by the teachers before the first institute and after the last institute. These instruments asked for information about the teacher’s students, the teacher’s own math background, beliefs and math teaching practices, and use of state math standards.
2. Classroom observations conducted with a sample of participating teachers before the first institute and after the last institute. We used an open-ended protocol in which we asked
trained observers to take ongoing notes of teacher and student activities, paying particular attention to a set of student and teacher activities of particular interest based on our objectives. Additionally the teachers were interviewed before and after the observation about the class, their goals for that particular class, and their assessment of how the class went. After reviewing the first set of observations of field test teachers, we drafted an analysis rubric which lists a set of teacher and student activities and other features to be identified from observers’ notes. These rubrics were used to guide preliminary analysis of the observations. In the pilot year we conducted initial observations with half the participants. Due to resource constraints, in the field test we did initial observations of about 1/4 of the participants.

3. Phone interviews conducted with a sample of teachers one year after their participation in TIAN. In these interviews, teachers were asked about their current teaching situations and how TIAN had affected how they taught.

From pre-post questionnaires we found statistically significant increases reported in:

- finding real-life applications in algebra
- willingness to be flexible about sequence of topics presented
- using exploratory as opposed to didactic approaches to instruction
- encouraging students to use exploratory approaches to understand mathematical concepts versus learning rules
- having students write about and demonstrate mathematical understanding in a variety of ways.

From pre-post questionnaire items on important factors in planning a math lesson, we found that after participation in TIAN, teachers reported an increase in their consideration of individual student goals and consideration of pedagogical issues such as using a variety of strategies and interactive materials.

In pre-post classroom observations, 6 of 14 field test teachers showed changes that included increased use of real-life contexts, small groups, and hands-on activities. In follow-up interviews conducted a year after participation in TIAN, 11 of 17 teachers reported using real-life materials or hands-on materials in the their most recent math class and 9 of 17 had students work in small groups. All 17 teachers reported lasting changes in their understanding of how to teach math.

**Initial findings on Goal 3: Changes in Teachers’ Knowledge and Use of State Mathematics Content Standards**

We examined three data sources to determine how TIAN teachers reported any changes in how they used their state standards to plan mathematics instruction:

- A pre/post written assessment on state standards competed at the first and last institutes
- Questions in the pre/post questionnaire (for the field test)
- Phone interviews (one year later) with a sample of participants
Before their participation in TIAN, 11 of the 64 of the field test teachers who had completed the pre and post assessment showed evidence of a clear understanding of their state’s math content standards. After TIAN 21 teachers showed a clear understanding of the standards. Before TIAN, 17 teachers had no or very limited knowledge of their state standards. After TIAN no teachers reported no or limited knowledge.

From the pre-post field test questionnaires, we found teachers reported significant change in the influence of state standards on their decisions about what to teach (mean of 2.2 to 2.61 with 2 = “some influence” and 3 = “strong influence”). Seven of 17 field test teachers who were interviewed a year after participating in TIAN reported using standards regularly in planning instruction.

The results from these data from field test teachers indicate to us that TIAN has been successful in increasing participant’s knowledge of and use of their state math content standards.

Discussion

This article provides an introduction to the TIAN project and some initial indications of what teachers are taking from it. When we look across the results we report here, we see strong indications of change in the number and range of participating teachers’ instructional approaches in mathematics. At the end of their year’s involvement in investigating math they had moved away from lots of drill, a strict sequence of skills, the exclusive use of workbooks. They reported that they now used more hands-on activities, had students explore possible solutions, and increased communication about math. Nearly all the teachers we interviewed a year after their participation in TIAN continued to talk about this kind of change in their understanding of math instruction and in their practice. While this data is preliminary, it indicates that we should continue to develop this professional development model for adult education math teachers.

There are other questions we hope to answer based upon the data we have available. We believe the success of the model most likely depends on the extent to which the state level office staff provides support; we suspect states that make the greatest investment will see the most change. We also are interested in the extent to which the model supports increase in teacher math content knowledge.

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References


