TEACHER-IN-RESIDENCE PROGRAM AT CALIFORNIA STATE UNIVERSITY, CHICO

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Abstract

California State University, Chico has incorporated a Teacher-in-Residence program within the Department of Mathematics and Statistics. The purpose of this program is to have an elementary school teacher take a leave of absence from his or her classroom in order to work half-time in the Department of Mathematics at the University and half-time for the Chico Unified School District as a Mathematics Resource Specialist.

Background

California State University (CSU), Chico is one of 23 campuses in the California State University system. Located in a rural area approximately one hundred miles north of Sacramento, CSU, Chico is a residential campus of nearly 16,000 students. Founded in 1887 as a state normal school, the campus takes pride in its long tradition of professional development for both pre-service and in-service teachers. Teacher training continues to be an important component of the campus mission. At the present time, over 1,400 students are liberal studies majors, the most popular major on campus and the major most students elect to pursue in order to earn a multiple subjects credential, the credential needed to teach in elementary schools.

The Department of Mathematics and Statistics is the largest on campus in terms of number of students served. We have a steady number of mathematics and statistics majors, but we are primarily a service department. The Department consists of 21 tenured or tenure-track Ph.D. faculty, about one-third of who are actively engaged in work in mathematics education. We rely heavily on part-time faculty members, currently employing 45 adjunct faculty who teach a variety of courses ranging from remedial mathematics to mathematics for future elementary teachers to calculus.

The normal model for teacher credentialing in California requires that students earn bachelor's degrees in a subject area and then enter into a "fifth year" practicum, which includes the student teaching experience. Students who choose to become elementary teachers usually become liberal studies majors, a cross-curricular major that the University has created for these students. The major includes courses that ensure that California State Standards and requirements are completed; such as, child health, foreign language, psychology of teaching, and cultural and temporal concepts. Students in the liberal studies program are required to take six semester units

of lower-division mathematics. The Department of Mathematics offers a standard year-long course that parallels the content of traditional mathematics for elementary teachers texts, such as those by Long and DeTemple, Peterson and Musser, and Bassarear, to name a few [1-3]. In addition, liberal studies majors are required to take at least one upper-division class from the College of Natural Sciences. Possibilities include two mathematics courses specifically designed for these students or various science classes that all include a lab. For many students, aversion to mathematics is only exceeded by their fear of science; hence, most liberal studies students take three semesters of mathematics. Finally, all liberal studies majors must choose an area of concentration. While child development is the most popular area of concentration, mathematics is second-most popular, with nearly 18% of liberal studies majors choosing a mathematics concentration. The concentration in mathematics requires a total of eighteen units, which includes twelve units of special mathematics courses specifically designed for this major.

The Teacher-in-Residence Program

Our Teacher-in-Residence (TIR) program was initially begun with a grant from the ExxonMobil Foundation. The grant, the University, and the Chico Unified School District each contributed one-third of the TIR salary. The TIR remained a full-time employee of the District, but was put on special assignment. As a result, s/he would not lose fringe benefits, seniority, or accrued time in the retirement system. However, the TIR's return to his/her regular classroom or even previous school was not guaranteed, only a teaching position somewhere within the District.

The program has many goals, but an encompassing goal is to develop better links between the University and the K-6 mathematical community. At the University level, we hope to produce college graduates who are better prepared to teach elementary school mathematics, while we also help University faculty better understand the needs of future teachers. At the elementary school level, we hope the program will help classroom teachers develop a better understanding of mathematics and that this will produce elementary school students with a deeper knowledge of mathematics.

TIR Roles

It will become immediately clear that the roles that the TIR performs cannot be broken down as those at the University and those at the District. There is far too much overlap of those roles and it is perhaps the reason why the TIR program has established a partnership between the District and the University at the departmental level where one did not previously exist.

Teaching in the Department is a major component of the TIR's University job. The TIR teaches two sections of mathematics courses for future elementary teachers. However, if this person only taught two sections, the Teacher-in-Residence would be no different than any of the other multitude of part-time instructors who teach in the Department. Consequently, in addition to teaching, the University duties of the TIR include activities designed to involve our full-time faculty, and increase their awareness and understanding of the mathematical needs of elementary teachers.

Each semester, one of our full-time faculty members team-teaches a section of the course entitled, *Mathematics for Elementary Teachers* with our Teacher-in-Residence. The team usually meets several times a week to plan, discuss, and reflect upon the coursework; other faculty teaching the same course often attend these meetings as well. The TIR gives a unique and extremely beneficial perspective to these discussions. Collaborations between University faculty and the Teacher-in-Residence are proving so fruitful for our faculty that we provide an opportunity for all new mathematics education faculty to team-teach one course with our Teacher-in-Residence.

While team teaching allows both the University faculty member and the elementary school teacher to grow professionally, it also gives the University students a much richer classroom experience. For example, since the Teacher-in-Residence has immediate access to elementary children, often a mathematics problem is assigned to both the University students and to an appropriate grade of elementary children. Once the University students have worked on the problem, they are then given the elementary children's work on the very same problem! Subsequent class time spent analyzing student work provides the University students an early contact with children's mathematical thinking that has rarely been part of our classes in the past. These child-centered activities validate the necessity of the mathematics coursework and foster a level of excitement that keeps University students engaged in and enthusiastic about mathematics (see Appendix).

While providing easy access to the work of elementary students is an important contribution, our Teacher-in-Residence has been able to establish an even stronger link between our pre-service mathematics education courses and the elementary classroom. Most sections of

Mathematics for Elementary Teachers now have an elementary class visit their University class at least once per semester. Each time, we learn more about how to make these occasions most profitable for the University students and not just a fun opportunity to work with children. The TIR arranges the visit, provides expert help in designing appropriate activities for the visiting class, and attends the visit to act as a facilitator between the University and the elementary environments. While scheduling and other details can sometimes be difficult, the value of the experience to our pre-service teachers makes the effort worthwhile.

Thanks in part to interactions with our TIR, University faculty who teach the mathematics courses for pre-service elementary teachers have become much more professionally active in this area. We have initiated a mathematics education seminar series that meets to share ideas, discuss mutual concerns, and become a learning community. As an example, we read Liping Ma's *Knowing and Teaching Elementary Mathematics*, much like a book club activity where we covered the book chapter by chapter with appropriate discussion questions [4]. We invited several key elementary school Teacher Leaders to become part of this "book club" and all of us gained a profound understanding of elementary mathematics.

In June 2001, CSU, Chico was able to send a team to San Diego for the American Association of State Colleges and Universities meeting on "Improving the Mathematics Preparation of Elementary Teachers"; there was never any question about whether our Teacher-in-Residence should be part of the team. The TIR has become a valued member of the Department by providing an insight into the needs of pre-service and in-service teachers that is not possible for those of us who work outside of the elementary school community. These insights have improved not just our work in individual courses, but are leading us to rethink our mathematics program for prospective elementary teachers. The University is close to requiring three courses for liberal studies majors; we have decided that this would be an advantageous time to consider restructuring the program and include more content in proportional reasoning and algebraic thinking.

While the contributions of the TIR are far more significant than what we would expect from a part-time faculty position, this person also has another "half" position at the Chico Unified School District. This dual role is possible, in part, because the TIR has a two- (or three-) day-per-week teaching schedule; for the rest of the week, the TIR works as a Mathematics Resource Specialist. Rather than working throughout the school district (fifteen elementary schools), he or

she works at a particular school site. Different sites have been identified as needing an infusion of mathematics reevaluation based on statewide mandated testing. The TIR has an office at that site and works as a peer coach, does requested teach-ins in various classrooms, conducts "lesson study" professional development workshops with the teachers at that site on a bi-weekly basis, and acts as an on-site resource for all mathematics curricular issues.

The efforts of the TIR have improved the atmosphere at the two schools at which the TIR has been housed. Not only have the mathematics scores of the students improved substantially, there is a new level of professionalism that has been observed at these schools. More teachers have begun to attend mathematics in-service programs and conferences. The TIR has started mathematics Olympiad activities at one of these schools where no such program ever existed. Although the program is still very small, it is a step in a new direction for the school.

In addition, the TIR have been involved in some Districtwide mathematics activities. The TIR is a member of the Districtwide mathematics task force committee. This committee makes decisions on mathematics instruction and assessment within the District. The most significant accomplishment at the District level is probably the inauguration of a new in-service program available to all elementary teachers. The TIR co-directs this forty-hour program that meets after school over a seven month period and which has been developed with University mathematics faculty input.

As a result of the two different jobs the Teacher-in-Residence occupies, the blended benefits to both the District and the University are numerous and robust. The student-centered benefits are readily apparent. In addition to the visits from elementary school classes mentioned above, we now have an extensive mathematics tutor program at various elementary schools. The program uses pre-service teachers to go out into the schools and tutor in mathematics. The University students attend a bi-weekly seminar where they are given very detailed ideas, activities, and assessment tasks. They work closely with the classroom teachers to help individual students more fully understand specific mathematical ideas. The seminars are co-taught by the TIR who also serves as an on-site coordinator for the tutors.

Lessons Learned

There is no question that this TIR program is not without its own set of obstacles. The University was not permitted to hire an elementary teacher that did not have a master's degree in mathematics to teach in the Department. Indeed, both of our TIR have a strong mathematics background in elementary mathematics and not the breadth of coursework normally seen in our traditional part-time staff. The support of the mathematics education faculty allowed us to depart from normal hiring practices to hire a TIR. Now that we have had the chance to see the benefits of the TIR program, we feel that searching for a teacher that has a profound understanding of elementary mathematics is probably more advantageous than seeking someone that generally doesn't exist.

Grant funding is no longer available to pay one-third of the cost of such a person, but both the District and the University are seeking ways to continue the program. Institutionalization is not in place as of yet, but reorganization of funding has been found to continue it in the near future. Most universities and districts will need to find creative ways of financing such a person as part-time university wages do not match one-half of a senior, fully-benefited teacher.

It would not be fair to say that the TIR has become a regular member of our Department. Just as part-time faculty members are in some sense second-class citizens, this can be said to apply to the TIR as well. However, the accomplishments and benefits that the TIR has had with those faculty, both full-time and part-time and who have an interest in elementary mathematics education, have earned our TIR full status in these circles. It is a comfort to have on staff a person who knows the elementary classroom when we chart curriculum decisions for future elementary teachers. Mathematics education faculty, or those who have interest in such matters, need to take an active role in ensuring that a TIR is allowed to share his/her expertise in a university setting. A university is an entirely new working environment for a TIR and someone must help a TIR understand this setting.

Summary

The Teacher-in-Residence program has multiple benefits to both the University and to the District. The role that the Teacher-in-Residence plays at the District level is similar to that of a Mathematics Specialist in a larger district. This dual TIR gives the District a Mathematics

Specialist for less than half the cost. Smaller districts, such as the Chico Unified School District, can thus more easily afford a Mathematics Specialist.

Much larger benefits happen at the University level. Mathematics faculty have benefited tremendously from professional conversations with an elementary teacher. It seems that Ph.D. mathematicians who are not trained in mathematics education, but are truly concerned about mathematics for prospective elementary teachers, are much more open to enter into conversations on specific issues because such lack of knowledge can be couched in terms of, "What do you think is the most effective way of ...?" or "How important is ...?" What has then transpired is that everyone, even those who are mathematics education faculty, expresses their uncertainty about particular issue, and then professional dialogues begin. Now we find it common to have questions such as, "Does anyone have a good activity to use to have students understand conditional probability?" or "How much time does anyone spend on area formulas of two-dimensional figures?" raised by faculty. These types of conversations rarely occurred previously.

Having elementary classes come visit University mathematics classes has become commonplace. One of the unexpected benefits that has come from this is a belief growing among University students of a need to learn more mathematics. Quite often, the reasoning of elementary children "blows our students away" as they find it almost incomprehensible that children can have such sophisticated ways of thinking. Initially, many University students believe that there is only one way to do something, and traditional paper and pencil algorithms are the only way to approach mathematics. These visits completely alter their beliefs.

The classroom tutor program that was discussed as one of the duties of the TIR has now gained both University- and District-level recognition. Unfortunately, University funding for these student learning opportunities has dried up with the current financial crisis in California. However, one elementary school has shuffled some of their funding around to pay the University tutors because the school finds them to be better trained and able to teach those elementary children who need help in mathematics.

In short, there is a definite place for an elementary teacher in a university mathematics department. The Teacher-in-Residence brings an important perspective to bear on the mathematics courses for prospective elementary teachers. The TIR can benefit all faculty and

undergraduate students taking elementary mathematics courses, not just the students in his/her specific classes.

References

[1] C.T. Long and D.W. DeTemple, *Mathematical Reasoning for Elementary Teachers*, Addison-Wesley Longman, Boston, MA, 2000.

[2] B.E. Peterson, G.L. Musser, and W.F. Burger, *Mathematics for Elementary Teachers*, John Wiley and Sons, New York, NY, 2002.

[3] T. Bassarear, *Mathematics for Elementary School Teachers*, Houghton Mifflin, Boston, MA, 2004.

[4] L. Ma, *Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States*, Lawrence Erlbaum Associates, Mahwah, NJ, 1999.

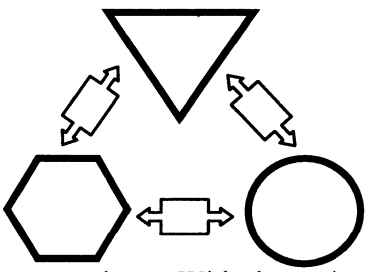
[5] W.R. Speer, D.T. Hayes, and D.J. Brahier, "Becoming Very-Able with Variables: Addition Using Algebra Networks," *Teaching Children Mathematics*, **3**(6) (1997) 305.

[6] J. Ferrini-Mudy, G.Lappan, and E. Phillips, "Experiences with Patterning," *Teaching Children Mathematics*, **3**(6) (1997) 282-88.

Appendix
Joint University and Classroom Problems

Example I. Algebra Networks

Algebra networks are described in "Becoming Very-Able with Variables: Addition Using Algebra Networks" in the "Investigations" section of the February 1997 issue of *Teaching Children Mathematics* [5]. See the figure below. Typically, the teacher presents the problem to the students by placing beans or some other kind of counter in the triangle, circle, and hexagon. Students are then asked to write the sum of the number of beans in the circle and the triangle in the rectangular space between these two figures. The same is done for the sum of the number of beans in the circle and the hexagon, and in the hexagon and the triangle. When everyone agrees on the sums, the students remove the beans and, with just the sums remaining, the students attempt to determine the original number of beans in each of the three figures. Of course, in this example, students know there *is* a solution. But what if we randomly write numbers in the three rectangles? Can we be certain there is a solution? Could there be more than one solution?
The algebra network problem appeals to a wide variety of students. This is especially significant



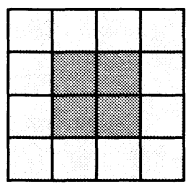
in our courses for future elementary teachers. With the assistance of our Teacher-in-Residence, we have been able to introduce the problem to our University students while an elementary teacher simultaneously introduces the problem to fifth graders. After introducing the problem and providing time to share ideas about how to approach such problems, we ask the University students to create an appropriate problem for the elementary students to solve. By the next class meeting, we are able to return the elementary school students' solutions and reasoning to the University students. The University students then analyze and critique the reasoning of the elementary students. The typical outcome of this activity is a profound sense of uneasiness on the part of the University students. The solution paths of the elementary students are often much more sophisticated than the pre-service teachers expect; in fact, elementary students often discover techniques we have not discussed in our University classroom.

Example II. Swimming Pool Problem

This is a well-known problem that can be used at many different levels. It is a wonderful problem environment that engages elementary children in rich algebraic thinking (from "Experiences with Patterning" by J. Ferrini-Mundy, G. Lappan, and E. Phillips in *Teaching Children Mathematics*) [6].

Take **two** colors of tiles, so we can all talk about the water and the pool decking mathematically and not refer to the specific color of tiles. Let's agree that:
Dark Tile = Pool Water
Light Tile = Pool Decking

Tat Ming is designing square swimming pools. Each pool has a square center that is the area of the water. Use the Dark Tile to represent the pool water. Around the water, there is a pool deck that forms a border and goes entirely around the pool. Use the Light Tile to represent the pool deck.



Here is a 2 x 2 pool

Let's generate some questions:
How many tiles are there altogether for each pool?
How many dark tiles? How many light tiles?
Are there more dark tiles than light tiles? Always? Never?
What patterns do you see in the dark tiles? In the light tiles? In the total number of tiles?
Can you predict how many tiles there will be in the next pool size?
Given the number of Pool Water tiles, can you determine the number of Pool Deck tiles? Vice-versa.
What numbers work for the number of Dark Tiles?
What numbers work for the number of Light Tiles?
What is the fractional relationship between the Dark Tiles and the Light Tiles used for each pool size? Between Dark Tiles and Total Tiles?
Can you tell me what 'pool 11' looks like?
Make a graph of the number of Dark Tiles used versus the pool size.
Make a graph of the number of Light Tiles used versus the pool size.
When do the Dark Tiles overtake the Light Tiles needed?

Similarly, University students are shocked at how many patterns elementary students find. They first question the validity of many of these patterns, which results in their interest in looking deeper into the mathematics involved.