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*(What I Did With My Summer Stipend)*

## Learning Differential Equations Through Computer Experiments

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This past summer, supported by a faculty summer stipend, I designed a computer laboratory-based course in differential equations. My goal was to allow students to conduct computer investigations which would reinforce the main concepts of the subject and lead to the discovery of connections and new concepts.

My main work was the development of appropriate computer experiments and the writing of supplemental material (handouts) which would help students to synthesize the theoretical results of the subject with phenomena observed on the computer. I taught my newly-designed course for the first time in the Fall 1994 quarter.

The focus of the course was the construction and manipulation of mathematical models. A mathematical model is a set of equations that describe the interdependence of the various components of a given system.

When the modelling of a system involves describing the rates of change of its various components, the equations which make up the model are differential equations. Because of their importance in modelling, differential equations have been and continue to be a very active area of mathematical research—an area in which the use of computers has come to play a vital role.

Before computers, it was not practical (and in many cases not possible) to compute these numerical solutions. Today, the easy availability of computers has eliminated the necessity to restrict the study of differential equations only to theoretical analysis.

The course I designed to take advantage of this computerization met one day in the class-

room and one day in the computer lab each week. Classroom days were used mainly for lecturing on theoretical material and for helping students to work carefully through the mathematical details of theorems and homework problems.

On lab days students investigated concepts currently under consideration. Each student worked at his/her own computer on a specific experiment that everybody was to try. Students volunteered to share their observations and to explain why these observations were expected based on theory. This often led

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ties with the preschool children. Mrs. Kathy Dudek, Counselor at Kennesaw Elementary School, obtained two grants totaling \$500 from the Cobb County Schools Action Research and the Cobb Commission on Youth. Materials such as a play kitchen, farm animals and puzzles were purchased to enhance the learning experiences for the preschool children.

The collaborative program was held every Monday morning for two hours over an eight week period of time at Kennesaw Elementary School.

Parents were asked to fill out a survey before and after attending the STEP program. Evaluation results indicated that the parents did not see any areas of the program that “needed help.” Written comments were very positive as well. The parents stated that they had learned new skills to improve management techniques and felt they could guide their children to be more responsible and that they could handle conflict resolution at

to lively discussions and arguments which called for further experiments to be conducted.

In addition to three traditional written exams, three projects were assigned throughout the quarter. The projects each involved an applied problem which called for the use of computation and mathematical theory. For example, the first project involved the construction of a model based on Newton’s Law of Cooling which described the fluctuations in water temperature of an outdoor swimming pool in response to the air tem-

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home more effectively.

The preservice teachers (KSC students) evaluated their participation as being a very positive experience. They experienced exposure to classroom teaching earlier than most teacher education programs provide; learned about preschool development; gained a better understanding of the needs of exceptional, at risk, and culturally diverse students; and were able to process their experiences with other practicum students in their class.

### Conclusions

The perspective of each individual involved in this project can unfold into discrete and unique versions of the same story. These differences are not only unavoidable but valuable, as they add rich layers to our understanding of what a true collaborative relationship among colleges, public schools and community agencies can be as we continue to explore ways we can work together.

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apparent resolution. Indeed, sometimes I get stuck for months or years. At such moments I am usually not sure if I will ever succeed. Often, this is a time for shuffling scraps of paper, constantly shifting notes from one pile to another.

Finally, there comes the writing itself and here I must find the correct voice. Who is my audience and how do I want to speak to them? Should I be technical and academic or folksy and personal? Since there is no perfect answer, and even if there were, I might not be able to achieve it, this too is a time for trial and error. In the end, I just jump in and find out what happens.

Because I am a morning person, most of my writing is done at home before I begin my teaching day. I sit in front of my computer and try to be myself. I have learned that if I don't like what I'm doing, most likely no one else will either. I also need quiet, but nowadays, for some reason, I usually have the radio tuned to country music. Not that I listen, but it seems to sooth me. Some days, of course,

are better than others, but the idea is to persist until something useful emerges.

Up to this point, most of what I do is done alone—(oh, by the way, did I mention how lonely writing can be, because it can)—it is only now that I try to find out if what I've been working on has any value. It is here that I pester friends and colleagues for their reactions, risking the destruction of my personal relationships. While I always tell myself not to take criticism personally, that I should allow myself to learn from it, in truth, it invariably hurts. The only solution I know is to give myself time for the sting to go away, and then to go back and make the necessary changes.

It is here, also, that being a teacher helps. It is only now that I am prepared to share my ideas with students and to receive their feedback. Usually their reactions surprise me, but they are an ideal vehicle for refining the organization of my writings and its mode of expression. I firmly believe that if my students don't understand what I am saying, or if they think it foolish, readers

will have a similar response, so I take their comments very seriously. This, of course, entails another round of soul-searching and word-smithing, but it is worthwhile.

Yet, even this is not the end, for books require publishers, and publishers do not always recognize the merits of what we writers produce. Sad to relate, I have my share of unpublished manuscripts. But if I am lucky, and a good publishing house gives me a contract, there is more editing to do, this time with a professional editor. In many cases it can be another year before everyone agrees to the final shape of the book.

I get fatigued just thinking about the process, but I love having books in print. The possibility of influencing how people regard important issues is exhilarating. It is also hard, frightening and lonely work. But book writing can be as rewarding as teaching. Indeed, it is part and parcel of the same thing, hence for those of us who love learning and love sharing what we learn, it can be a blast.

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perature. Working in groups of three or four, students were given two weeks to complete each project and each student was required to submit a carefully written report of the results. In several instances, I was surprised to find that a group had conducted their experiment beyond what was assigned and had arrived at more detailed results than what I had expected.

In discussing this approach with colleagues at other institutions, I learned about the *Consortium for Ordinary Differential Equations Experiments (CODEE)*, a group of faculty at

colleges and universities who design and use computer experiments in teaching differential equations. I have contributed an article based on an experiment which I designed to a newsletter which they publish quarterly. Also, I plan to attend a regional workshop which they will sponsor this summer through support from the National Science Foundation.

Overall, I believe that my summer project has resulted in providing the necessary foundation for a revitalized differential equations course which will continue to evolve and improve.

### **Help us with *Reaching Through Teaching***

As you can tell from the articles in this quarter's issue, we have many faculty members teaching and learning about teaching through in-class experience.

We would like to invite you to participate in this important exchange of ideas by submitting to the Spring issue.

Articles may cover your research or teaching practices, or explore your philosophy of teaching. Submissions should be sent to Richard Welch by May 1.