Blueprint for Technology Implementation

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What challenges follow a successful implementation of computer calculus reform? Trickle down, of course, taking the best from the experience to implement in entry level classes. After all, entry level college mathematics is *not* calculus for most students. At Dowling College, fewer than 10% of our students take calculus while 80% take one of the two entry level courses, precalculus and prestatistics, targeted in this project.

Calculus reform at Dowling took the form of the C^4L project *Calculus Concepts, Computers and Cooperative Learning*. This project's innovative instructional model focuses on students working in groups, constructing mathematical concepts in computer laboratory experiences and classroom tasks (2).

The Dowling College *Mathematics, Concepts and Computers* project targets college entry level mathematics students in precalculus and prestatistics courses. Each year we have roughly 150 students in 10 sections of precalculus and over 200 students in 15 sections of preststiatics taught by both adjunct and full-time faculty at several different sites. We expanded our reform efforts so that this larger portion of our mathematics students may benefit from the innovative pedagogical techniques that go hand in hand with computers and calculators: laboratory investigations often of real world problems resulting in written reports produced in a collaborative learning setting.

The project content and structure includes four elements: *Facility Development, Curriculum Development, Faculty Development* and *Student Development*.

Facility Development: From the Calculus experience we learned the value of a computer lab dedicated to mathematics instruction. Lab aids accustomed to the general needs of word processing and spread sheets users fled from the queries of our calculus students. A mathematics lab needs aids who can distinguish a software question from a mathematical question. They must be trained to answer the first kind but just focus or redirect the second kind. Further, a dedicated lab provides a location for cross fertilization of mathematical experiences, the kind of intellectual support and camaraderie now recognized to enhance the probability of success in mathematics. It is the job of mathematicians to convince administration that ours is a laboratory science with laboratory needs as compelling as biology, chemistry and physics.

Fortunately, an NSF ILI grant provided 50% funding for a mathematics computer laboratory classroom consisting of a Windows network of 15 student stations (486 cpu 33mhz 80mb ram 16mg super vga monitor) providing Derive, a computer graphics and algebra system.

Curriculum Development: Both courses targeted are long standing service courses whose topics are defined by the quantitative needs of client disciplines. We kept content,

schedule and credit structure unchanged. Client disciplines applaud efforts to improve instruction but balk at suggestions that enlarge the mathematics components of their degree requirements. Laboratories were added as an additional instructional technique intended to *replace* traditional teaching methods where we felt they could be more effective.

Initially the team of 4 co-investigators, 2 full-time and 2 adjunct, formed a pilot group. They selected, adapted and classroom tested computer lab experiences, enhanced and modified them were necessary during the first year of the 30 month project. There are many workbooks available, we especially liked David Mathews' Derive investigations (1).
Without changing the existing syllabi we were able come up with a variety of enriched exercises.

Faculty Development: . At Dowling, the multiple sections of the targeted courses are taught by a number of faculty, many of whom are adjuncts. All instructors came together for a summer workshop in the new computer lab. They learned how to use the network and software as the students do, by doing the labs themselves. A great deal of editing took place and a draft solutions manual was produced.

Faculty also addressed the most challenging aspect of instructional reform, actually changing their approach to teaching. The two elements: a constructavist approach to teaching mathematical concepts and the integration of cooperative learning are indeed difficult long term goals. Implementation strategies were an ongoing topic of discussion throughout the 30 month project.

Student Development: Laboratory experiences emphasized the construction of mathematical concepts in cooperative groups and recording observations in the form of written reports. These elements are a departure from the students' expectations of traditional mathematics instruction. Creating and maintaining productive groups is a challenge but labs and group work are becoming more common. However, producing prose for a mathematics assignment is still novel. First attempts were often disappointing so students were encouraged to resubmit written reports to either elaborate or more clearly articulate their observations. This practice is consistent with the idea of first and second drafts of any written work.

Analysis of success and retention through student grades was not statistically significant in the first year. The goal of this project , to reduce the number of D, F and W grades, was not reached. On the other hand, anectdodal evidence collected through students' written evaluations is encouraging. The project structure is portable and adaptable to the needs of other institutions.

References

1. Mathews, D. M., Precalculus Investigations using Derive, Harper Collins College Publishers, 1994.
2. Monteferrante, S., *Implementation of Calculus, Concepts and Computers at Dowling College*, Collegiate Microcomputer, Vol XI (2), May 1993, 95-98.