

Teaching the *Limit Concept* in Calculus with Technology
A Proposal to the ACS Technology Center
Teaching with Technology Fellowship

Background: Rationale for Overall Project

Teaching the *Limit Concept* in Calculus with Technology aims to enhance the core content of the Calculus courses at Morehouse College. Calculus is the core requisite for science and engineering majors and is one of the most difficult aspects of undergraduate mathematics education. Many difficulties exist in the teaching and learning of Calculus.

It is well known that *Limit Theory* is the basis of Calculus. The major concepts of Calculus: continuity, derivative, and definite integral are all defined by limit. Limit concepts are usually taught in Calculus I and are studied in the first year of undergraduate school. The limit concept is new for most beginning calculus students, and is different from arithmetic operations. The limit is the bridge (or fundamental concept that bridges) from elementary math to advanced math and from static math to dynamic math. Thus, the limit concept requires the learners to study math with different thinking and study methods to advance from elementary mathematics. For many freshmen, recently graduating from high school with a little background in advanced math, this is a serious challenge and many experience difficulty in understanding the limit concept. Thus, the limit concept in Calculus becomes one of the most critical points for teaching and learning.

This problem, as experienced on the campus of Morehouse College is a common concern in mathematics education all over the world. For example, while attending “The 9th International Congress on Mathematical Education (ICME) in Japan in 2000” and “The 10th ICME in Denmark in 2004,” I took part in the activities of the Task Group for Calculus. These meetings revealed to the participants that while the teaching and learning of the limit concept continues to be a much-discussed topic, it is also a topic that is both important and difficult.

From my teaching practice, I feel at this time, many students need new approaches and powerful tools to help them to overcome the difficulty in studying limit concepts and to realize a smoother transition from their secondary mathematics education to learning a more advanced level of post-secondary mathematics.

Computer technology is a powerful tool and a helpful aid in teaching and learning mathematics. Its components: computation, visualization, and animation could be helpful in developing new approaches to the teaching of the limit concept and ultimately to help students to overcome their difficulty in understanding this important concept.

In keeping with the above theme, I propose the following project that will allow me to develop instructional material and support documentation to aid in the learning of Limit Concepts.

Description: Part of the Project To Be Done Under ACS Funding

This project supports two major goals: 1) to investigate how to incorporate computer technologies into the teaching and learning of the Limit Concept of functions in one variable, vector functions, and functions in several variables, and 2) to develop new instructional material to enhance the teaching of the Limit Concept with the aid of computer technologies and to assist students in learning the Limit Concept. To realize these goals, the proposed project consists of three parts:

1. Limit of functions in one variable,
2. Limit of vector functions, and
3. Limit of functions in several variables.

This work will be presented at the “11th International Congress on Mathematical Education in Mexico in 2008.”

ACS funding will support the development of instructional material and support documentation (User Guide) for item 1, limit of functions in one variable in the Summer of 2006.

Timeline: Deliverables/Milestones for ACS Funded Part of Project

During the Summer of 2006, from June 1 through August 31, the funding will enable me to 1) prepare and collect data (6/1 – 6/30); 2) develop instructional material and computer source code (7/1 – 7/31); and 3) write support documentation and debug computer source code (8/1 – 8/31). The results will be used for a pilot class in the Fall of 2006.

Technology: Technical Requirements for the Project

To realize the goals of this project, the following items are needed:

1. Windows-based PC
2. Computer Lab
3. Math Software: Mathcad, Maple, Math Lab, Flash MX, MsWord, Adobe
4. Internet access

All of these items are available in our college and department.

Other Support: Institutional and/or Outside Support for Project

No other funding is needed for this part of the project. This part of the work can be realized with the hardware and software currently housed in the College’s Mathematics Department.

Learning Outcomes: How the Project Will Enhance Teaching/Learning

Teaching the Limit Concept with technology will enhance students’ learning by introducing them to using computer technology to study and master mathematics. By using mathematics software as study aids, students will be able to make use of visualization, animation, and computation to change the abstract concept to vivid pictures and quantitative relations so that it becomes easy to understand. Lastly, this project will offer opportunities for hands-on access to computer-based math experiments to enable them to explore the Limit Concept so that they can deepen their understanding.

Likewise, teaching the Limit Concept with the use of computer technology will encourage teacher-led demonstrations that make it easier to teach abstract concepts. Teaching with this technology transfers the focus of teaching and learning from the instructor to the students so that students become active partners rather than passive auditors. Ultimately, the instructors are required to have a better understanding of both math and computer technology to facilitate the learning process.

Curriculum: How the Project Will Be Integrated into the Curriculum

There are several ways to integrate the material into the curriculum, which includes teacher-led PC demonstrations in classroom, computer-based math experiments in computer labs, computer-based group work, and computer-based assignments.

Assessment: How the Project Will Be Evaluated

The proposed project will be evaluated by its outcome, students, and via conferences. The evaluation by outcome is based on instructional material and computer source code; student evaluation will consist of an end of semester survey and evaluation of course, with special emphasis on course materials. Conference evaluation consists of presentations at conferences wherein the Principal Investigator will collect the thoughts and reviews of colleagues. Outcome should be based on the assessment of whether students grasp the concept better than before.

Collaboration and Dissemination

To disseminate the results of the materials prepared under this initiative, I will post all materials on my Morehouse College faculty Website for comments and feedback from those who view the site, in addition to presenting at conferences that I am scheduled to attend.

Respectfully Submitted,
De Ting Wu, PhD