

Introduction

Beginning in 1998, the UMR Computing and Information Services (CIS) department began exploration of visual indexing as applied to online instructional systems. The *BrainTrax* development team created online instruction for Algebra and Calculus. The Algebra *BrainTrax* system alone provides over 350 web pages of tightly encapsulated, high quality mathematical instruction, bound together in visual context. In addition to content, the Algebra Brain includes an Interactive Example and Testing System (IETS) that provides students with a step-by-step problem-solving mechanism. The *BrainTrax* development team is also creating an interactive game mechanism that will be used in conjunction with the Algebra Brain. It will reinforce the algebraic concepts while immersing the students in a fun environment.

Summary of Events to Date

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| Fall 1998 | Work begins in earnest to produce a viable framework for visual indexing instructional systems. |
| Spring 1999 | A prototype mockup is tested within the St. James schools. Student response is positive. |
| Summer 1999 | Work begins on a visual index to support UMR's Algebra and Trigonometry classes in conjunction with Math Department approval. |
| Fall 1999 | Algebra and Trigonometry visual indexes reach a level of stability. Students are polled and respond with a request for Calculus support. |
| Spring 2000 | The Calculus visual index development timetable is advanced to produce a Calculus I (Math 8) visual index in conjunction with the class. End of semester student surveys indicate 62% of respondents (or about 25% of the spring Math 8 class) desire visual indexes to support their future classes. |
| Summer 2000 | Demand for the <i>BrainTrax</i> system increased so that we were required to support creation of a Calculus II visual index (Math 21), increased Flash video production for Calculus I and II, and creation of an online Interactive Example/Testing System (IETS) aimed specifically at mathematics. |
| Winter 2001 | Due to increased demand for Algebra support, the <i>BrainTrax</i> team overhauls the Algebra Brain to be accessible to students from 8th grade Algebra on up through college-level Algebra. |

To date, students attending UMR have performed most of the labor on the *BrainTrax* project. These students work under the direction of Mark Bookout, of the CIS department. The Mathematics and Statistics department has contributed significant funds for the project, as well as significant faculty time. The Computer Science department has also contributed funds for support of the IETS; the CIS department has contributed the remainder of the funds.

Future Vision (present through summer 2001)

Currently, the *BrainTrax* project has the following objectives:

1. Increase the effectiveness of the Algebra and Trigonometry visual indexes to include a wider audience.
2. Stimulate learning through interactive real-world examples.
3. Insert as many interactive examples as possible into the new IETS.
4. Insert "instant information" for key formulas and concepts across all math visual indexes.
5. Work with high school instructors to develop materials for general use in Missouri schools.
6. Certify student performance levels in algebra.

Implementing the Vision

Instructors at higher learning institutions (e.g. University of Missouri – Rolla) have noticed a disturbing trend among incoming freshmen. They have determined that many incoming freshmen are inadequately prepared for the level of mathematics instruction offered at UMR and therefore do poorly in upper level mathematics classes, most notably Calculus. The failure is not necessarily due to a lack of understanding of calculus concepts, but appears to be based in a poor grounding in the fundamentals of lower level courses such as Algebra and Trigonometry.

To address this concern, the *BrainTrax* team adapted visual indexing technology while creating the Algebra Brain. The *BrainTrax* Brains--web-delivered learning aids--target those students who are struggling with understanding mathematical subject material. So far the *BrainTrax* team has targeted Algebra, Trigonometry, and Calculus as being primary candidates for inclusion in visual indexes. These are the fundamental math courses required at any technological institute. Students who are interested in pursuing engineering or the sciences will be required to take these courses at some point during their higher education. Those who are better prepared in high school will most likely be more successful at the collegiate level.

A recent survey of Calculus I students at UMR indicated that fully 54% learned something about calculus from the *BrainTrax* visual index system that they did not learn in class. One of the major benefits of using the Calculus Brain is that it increases comprehension and retention of the material. Similar or greater benefits are expected from the new and improved Algebra Brain.

Although the *BrainTrax* system is currently only oriented towards mathematics, the same framework can be redirected towards the development of other subject areas, particularly science or even history.

Finally, the *BrainTrax* team and the Department of Mathematics and Statistics are jointly interested in pursuing fielding mathematical visual indexes into area high schools. This activity has three objectives:

1. Increase comprehension of algebra and trigonometry within students at the high school level.
2. Prepare college-bound students to be successful during their first semester.
3. Support Missouri math teachers with online instruction aids.

Students who receive the benefit of all three objectives will be better prepared to meet the challenges of higher education, particularly in the fields of science and technology.

Other Support Opportunities

Several UMR faculty members have supported the *BrainTrax* project in various ways. These faculty members include:

Dr. Henry Metzner – Engineering Management
Dr. Leon Hall – Mathematics & Statistics
Dr. Stephen Clark – Mathematics & Statistics
Dr. Matt Insall – Mathematics & Statistics
Dr. Richard Hall – Psychology
Mr. Tom Akers – Mathematics & Statistics
Mrs. Mary Kirgan – Mathematics & Statistics

Additionally, the following public school teachers are also involved with reviewing the current visual indexes and with developing instructional methods that incorporate the visual index technology in the classrooms of public schools:

Steve Blakely – Rolla
Eddie Keilbach – Tuscumbia
Roberta Rudolph – Platte City
Herbert Turner – Waynesville
Kathryn White – Rolla

Success of Visual Indexing Technology

The graphs below illustrate the results of survey taken by Calculus I students during their final exam at the end of the Winter Semester 2000. The first two graphs indicate that over half of the students who returned the survey found the content in the Calculus I Brain useful to some degree. The final graph is a very strong indicator that many students would like to benefit from visual indexing technology in other classes, such as physics, chemistry, or even other mathematics courses.

Note: The Calculus I Brain was identified to the responding students as "the Calc Brain".

