Usability News

**August 2003**, *Vol. 5 Issue 2*

**| Volume 5 Issue 2 | Past Issues | A-Z List |**

Usability News is a free web newsletter that is produced by the Software Usability Research Laboratory (SURL) at Wichita State University. The SURL team specializes in software/website user interface design, usability testing, and research in human-computer interaction.
Barbara S. Chaparro, Editor

---

# CADUCEUS: Using the Web to Share Student Misconceptions and Solutions

**By Rebecca Langrall**

To improve classroom teaching in a steady, lasting way, the teaching profession needs a knowledge base that is articulated, evolving, and shared. In spite of the continuing efforts of researchers, archived research knowledge has had little effect on the improvement of practice in the average classroom (Hiebert, Gallimore & Stigler, 2002). We are exploring the possibility of improving practice taking the knowledge of excellent practitioners as our starting point.

CADUCEUS (Computer Aided Design Uniting Concepts in Education for UnderStanding) is a database-driven interactive web site designed for K-12 teachers. Its goal is to preserve and advance the knowledge base of teaching by gathering and disseminating useful examples of pedagogical content knowledge (PCK) related to teaching for conceptual understanding.

## Rationale of CADUCEUS

Comprised of insights into students' error patterns and effective instructional representations and strategies to address those patterns, PCK distinguishes the expert teacher of content from the content area expert (Shulman, 1986; Stengel, 1997). Typically the fruit of years of experience crossing and recrossing particular curricular terrain with various groups of students, PCK is now an expected program outcome for pre-service teachers (INTASC, 1992; NCATE, 2000).

Why focus on conceptual understanding? Experienced reflective teachers have been found to possess integrated conceptual frameworks into which the details of subject matter fit (e.g., Gudmundsdottir & Schulman, 1987; Leinhardt & Smith, 1985; Magnusson, Krajcik, & Borko, 1999). Such frameworks permit flexibility in organizing learners' experiences with content. Teachers with weaker content knowledge lack such frameworks, resulting in a piecemeal approach to knowledge and the overuse of lecture, text, workbooks, worksheets, modeling, individual seatwork, and the chalkboard. For many students, such approaches render knowledge non-memorable and/or inert.

Current best practice in teaching includes multiple reinforcements using kinesthetic and visual activities via models and manipulatives, role-plays and simulations, real-life applications, and games (Zemelman, Daniels, & Hyde, 1998). Along with cataloguing error patterns, the CADUCEUS web site includes visual representations of concepts and links to relevant interactive exercises, guided by the understanding that learners who grasp content conceptually are better able to use knowledge in new contexts (National Academy Press, 2000).

Reflecting on successes and failures with successive groups of students, good teachers constantly evolve their PCK. CADUCEUS aims to facilitate this process by making teacher insights widely available and accessible to further refinement. One data source is undergraduate teacher education student interviews of veteran teachers about their PCK development. Before it is catalogued for the site, PCK content from interviews is shared with classmates who then look for themes:

*"A common theme I found while listening in our PCK groups was how teachers **adapted and learned from their mistakes**. A sign of a good teacher is someone who recognizes what doesn't work (after making an attempt), thus changing to something that does. The teachers were very creative and seemed to adapt to the learning styles of the students."*

## Features of the CADUCEUS Web Site

Currently, the CADUCEUS database web site is in the prototype stages. It consists of over 20 error patterns identified by teachers in the content areas of Math, Science, Language Arts, Social Studies, Health, and Physical Education. For each error pattern identified, concept information and demographics of the target student audience are identified along with proposed response strategies and references (see Figure 1 for example).

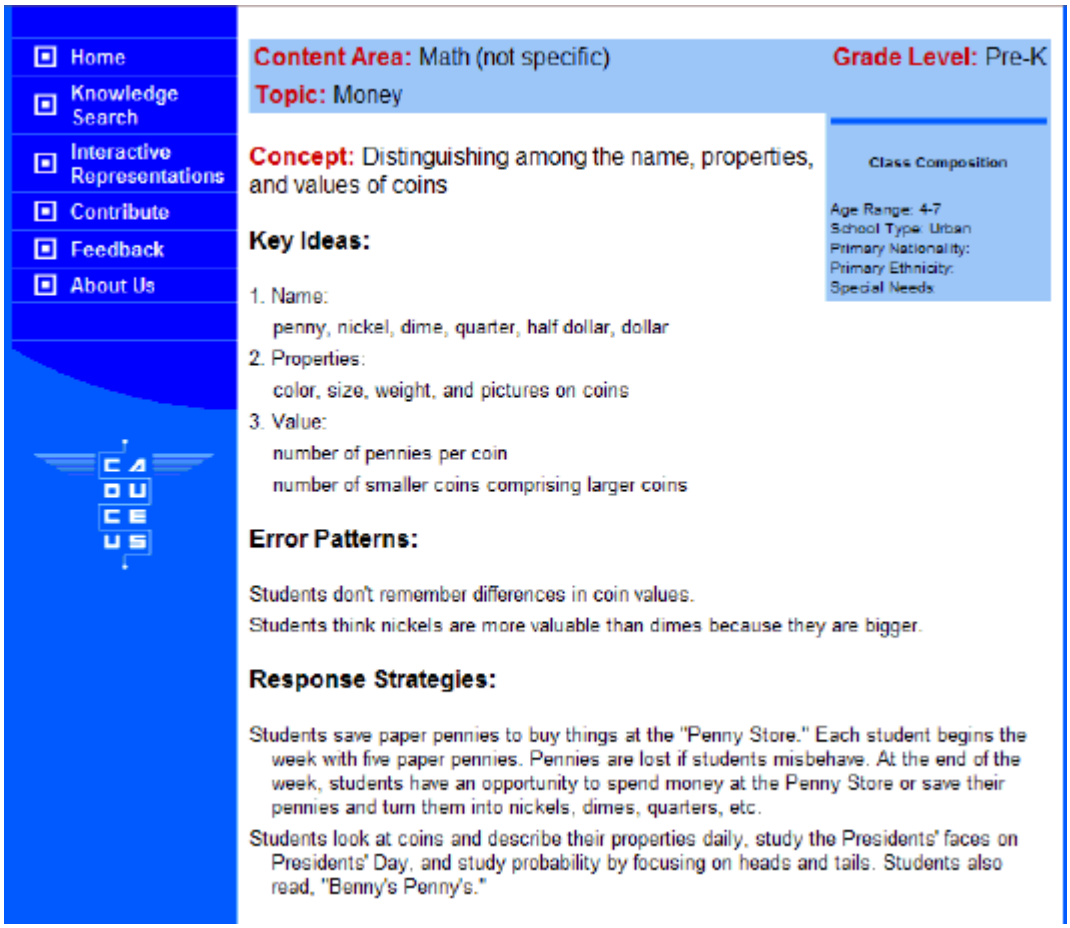
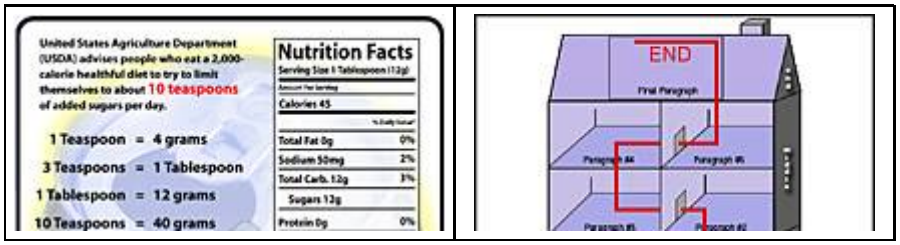



**Figure 1. Caduceus site displays key concepts, error patterns, and response strategies.**

While the database is still in its infancy, it is expected to grow substantially. In addition to error patterns, the CADUCEUS site will host a number of interactive graphical exercises, demonstrations, and conceptual maps to illustrate key concepts and strategies (Figure 2). The interactive tools are geared toward students and teachers and are designed to be both engaging and informative. Usability testing of early iterations of the site showed the importance of careful design of the interactive exercises. In one particular exercise, portions of the page dynamically changed upon mouse-over. Several users did not recognize this feature and therefore missed out on critical content.



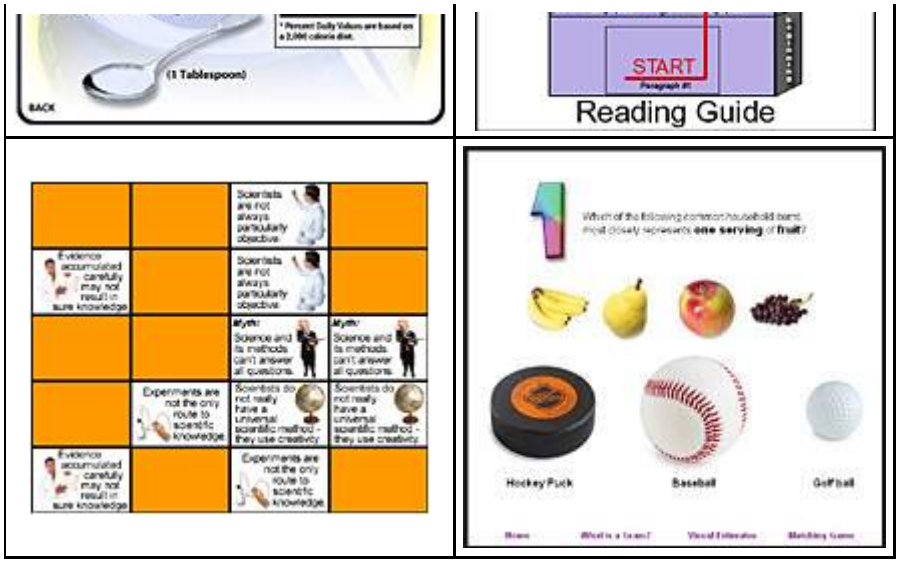



**Figure 2. Examples of interactive exercises and games on the CADUCEUS site.**

## Future Goals of CADUCEUS

Future goals of the Caduceus site include:

- numerous additions to the database by teachers nationwide.
- contributions that take maximum advantage of the audio and video streaming capabilities of Internet2 (so that brilliant ideas do not die with their inventors).
- additions of interactive components akin to the thought experiments and anchoring intuitions Clement (1994) has described in discussing the ways experts solve problems.

In this way, the hope is to take a step forward in fulfilling the criteria practitioners' knowledge must have to become a professional knowledge base for teaching: "public, … represented in a form that enables it to be accumulated and shared with other members of the profession, and … continually verified and improved." (Hiebert, Gallimore and Stigler, 2002, p.4).

*Readers are encouraged to visit and contribute to the CADUCEUS site at http://education.wichita.edu/caduceus.*

## REFERENCES

Clement, J. (1993). Using bridging analogies and anchoring intuitions to deal with students' preconceptions in physics. *Journal of Research in Science Teaching, 30*(10), 1241-1257.

Gudmundsdottir, S., & Shulman, L. (1987). Pedagogical content knowledge in social studies. *Scandinavian Journal of Educational Research 31*(2), 59-70.

Hiebert, J. Gallimore, R. & Stigler, J.W. (2002). A knowledge base for the teaching profession: What would lit look like and how can we get one? *Educational Researche, 31*(5), 3-15.

Interstate New Teacher Support and Consortium, (1992). *Model Standards for Beginning Teacher Licensing and Development: A Resource for State Dialogue*. http://www.ccsso.org

Leinhardt, G. & Smith, D.A. (1985). Expertise in mathematics instruction: Subject matter knowledge. *Journal of Educational Psychology, 77*(3), 247-271.

Magnusson, S. Krajcik, J. & Borko, H. (1999). Nature, sources and development of pedagogical content knowledge for science teaching. In Gess-Newsome & Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education*. Dordrecht: Kluwer Academic Publishers.

National Council for the Accreditation of Teacher Education. (2000). *Unit Standards*. http://www.ncate.org

National Research Council. (2000). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Stengel, B. S. (1997). Pedagogical knowing: Reconstructing teachers' subject matter knowledge. *Educational Foundations, 11*(3), 29 – 52.

Zemelman, S., Daniels, H., & Hyde, A. (1998). *Best practice: New standards for teaching and learning in America's schools*. Portsmouth, NH: Heinemann.

---