

## Brain calisthenics for whole-brain learning – CAIS school makes the New York Times



# Changing the Face of Learning: Perceptual Learning, the Path to Expert Pattern Recognition

Recently, New Roads School in Santa Monica, California was featured in a New York Times article that discussed the use of perceptual and adaptive learning modules to improve student learning, entitled “Brain Calisthenics for Abstract Ideas,” (New York Times, June 6, 2011. <http://www.nytimes.com/2011/06/07/health/07learn.html>)

New Roads has participated in the research and development of perceptual learning modules for the last ten years. At that time, the Center for Effective Learning (C4EL) was established to act as its educational research arm to address the problem of integrating research validated learning theory into the classroom. C4EL has three primary objectives:

- **Maintain an intimate knowledge of current educational and cognitive research**

This provides opportunities for faculty to develop professionally while staying in the classroom, e.g. publication of articles and ties with the research community.

- **Develop classroom strategies to implement the positive results of this research**

By taking advantage of the demographic diversity at New Roads, researchers are able to collect data from a representative range of ethnic, economic, and social strata within the student body. New Roads currently has working collaborations with researchers at UCLA, Loyola Marymount, and UC Berkeley.

- **Disseminate these results to the broader K-12 community**

To date, the most widely disseminated results to come from these collaborations have been our work with UCLA in field testing and helping develop a plan for the distribution of perceptual and adaptive learning modules (see Photo 1).

The collaboration came about when the two authors met as Co-Principal Investigators on an National Science Foundation grant to study learning in intelligent systems. At that time, Dr. Kellman’s group had finished a perceptual learning module that trained airplane pilots. The results were astounding. Discussion immediately occurred about applications in K-12 education, and work on this has continued for the past fifteen years. These efforts have developed perceptual and adaptive learning techniques that have been field-tested at New Roads School (under research grants to the UCLA Human Perception Lab from the National Science Foundation and US Department of Education). Results have shown strong learning gains, and they indicate the promise and widespread applicability of the technology.

In early work done specifically at New Roads, we explored the use of perceptual learning to help students recognize patterns that would link word problems to equations to graphs in various combinations. For example, students were given a word problem and then asked to choose the graph that represented the word problem. Another example would be giving an equation with three word problems to see if the student could match the equation to a corresponding word problem. The results clearly indicated improvement. More importantly, when assessed at a later time, the learning was retained. In traditional settings, learning diminished rapidly. What is more exciting is that younger students intuited slope and intercept before formal training.

What is Perceptual Learning?

Perceptual learning techniques address areas of learning that fall outside of most conventional instruction. Traditionally, instruc-

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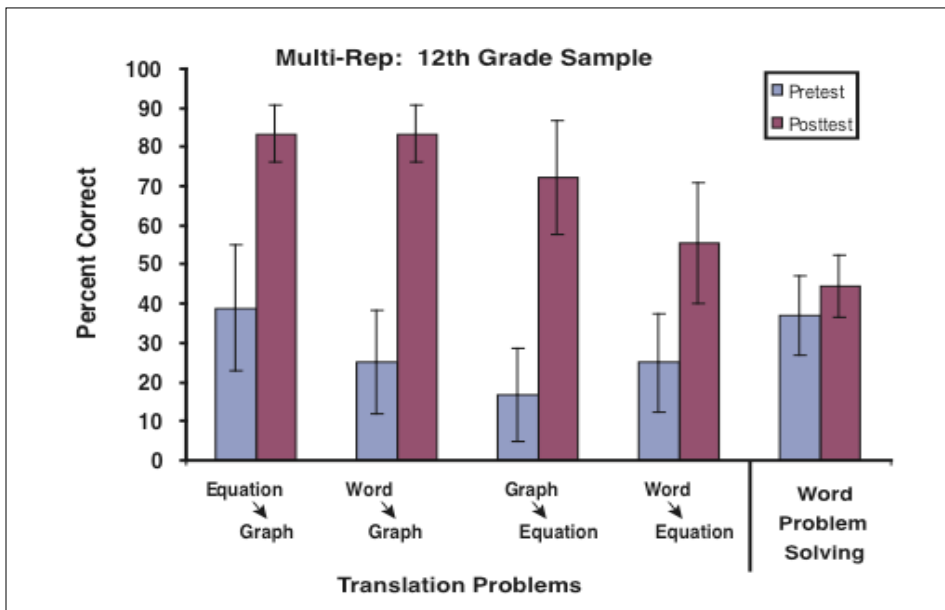
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tion focuses on declarative knowledge—facts and concepts that can be verbalized, along with procedures. Yet, studies of expertise consistently indicate that an altogether different sort of learning—perceptual learning—does most of the work in distinguishing experts and novices in any field. Perceptual learning techniques tap into human abilities to optimize the pick-up of information for any learning domain. With appropriate learning experiences, students come to recognize crucial patterns, select relevant information, process it in larger chunks, and do so with less effort and cognitive load. They gain expertise.

list the parts of a bicycle. Most people *picture* a bicycle, and list the parts easily. On the other hand, what if you had been given a list of parts to memorize, and then asked to give the parts-same task, but without the picture, without the opportunity for pattern recognition. This explains why some students find areas of study easy – they see the pattern, and some find things to be hard – they are sifting through irrelevant information and forming meaningless lists.

While the importance of pattern recognition and information extraction has been recognized in high-level analyses of learning and education in the United States, such as

PLMs use many short interactive trials in which the learner classifies, discriminates, and extracts structure, or maps structure across multiple representations (photo 2). Opportunities to recognize patterns, not the passage of time, advance expertise. Since PLMs improve pattern processing and fluency outside of class, we are exploring the potential for them to make classroom time more useful. We anticipate that interactive learning techniques embodied in Perceptual Learning Modules may overcome many obstacles in traditional instruction as students are better prepared to participate in classroom discussions.

An important aspect of Perceptual Learning Modules is that they employ adaptive sequencing techniques to utilize the learner’s performance (accuracy and speed) on short interactive learning trials to determine when various items or categories recur. Learning is arranged for each individual to optimize efficiency and to direct learning effort and time where it is needed most. Using the New Roads Classroom Management Learning Tool, we distribute modules to individual students or groups of students as needed. Software routines track performance continuously, leading to mastery of all categories or items in a learning task for each individual.

For facts, or procedures, adaptive sequencing algorithms ensure that all items are learned and well retained. For complex classifications, these methods produce fluent pattern recognition, i.e. the ability to recognize and classify novel instances. Be-

## *We know that traditional instruction has had little impact in producing the expert pattern recognition, fluency, and intuition required in many learning domains.*

In problem-solving situations, experts recognize what kind of problem they are looking at, a prerequisite to effective use of facts or procedures. These experts selectively pick up information relevant to a task and ignore irrelevancies, whereas novices pick up both relevant and irrelevant information. This confuses the novice and slows him down as he sifts through irrelevant information. Experts pick up larger pattern chunks than do novices, and they discover new relations that novices do not see. Expert information recall is also faster and more automatic, allowing experts to focus on higher-level structure while novices get bogged down in slow processing of basics. An analogy would be if you were asked to

the National Research Council report, *How People Learn: Brain, Mind, Experience, and School*,” (Bransford, et al, 2000 ), most educators have never heard of it. Until recently, this would not have mattered, as there were no viable techniques for explicitly addressing perceptual learning in instruction. But now, perceptual learning modules are changing that, bringing perceptual learning potential into the classroom.

### **Perceptual Learning Modules**

Perceptual Learning Modules are individualized computer-delivered programs that accelerate the growth of pattern recognition and fluent information extraction skills.

cause the PLMs include continuous, embedded assessment, individual performance automatically triggers elaborated feedback examples, short online lessons, or teacher interventions. Learning strength is continuously assessed based on performance data. This informs the adaptive sequencing algorithms so individual students get the optimal sequence of items to maximize their learning benefit. The algorithm adjusts parameters according to principles of learning and memory, such as automatically increasing the time between each item as the student demonstrates learning. Learning and formative assessment are combined, giving the learner objective information

about progress and directing effort where it is most needed.

Perceptual Learning Modules also allow multi-level, multipurpose assessment. Because student progress is continuously tracked, teachers are able to see overall progress, particular areas of success and difficulty for each student, and an aggregate picture of strong and weak areas for entire groups of students.

### Perceptual Learning Modules, Changing the Face of Learning at New Roads

Though we have been testing and helping to develop PLMs for the past ten years, New Roads School is only in the beginning phases of integrating the full potential of Perceptual Learning. PLMs have been shown to be effective in the research lab and in field-testing, but we are just now beginning to integrate them in a sustainable way into the classroom. Teachers are being trained and the New Roads School Learning Tool shows

excellent promise for easy dissemination of PLMs. We know that traditional instruction has had little impact in producing the expert pattern recognition, fluency, and intuition required in many learning domains. Research results indicate, and we anticipate success, in reaching students who have struggled with learning in the past. We know of no developments in learning and learning technology that have equally broad implications for learning across many disciplines.

This past year, I (Joe) had a student struggling with the multi-rep PLM. Her accuracy was poor, and she was taking a very long time on each question. I asked her if she saw any patterns. Her response was yes, but she thought it was cheating to use them. Once she started allowing the patterns to form meaning, her accuracy met criteria as did her time on task. There was also clear evidence that she was able to transfer the learning to novel situations. We have found that the use of perceptual and

adaptive learning modules enables students to tap into the natural way the brain works. Interestingly, 100% of our students can distinguish between a dog and a cat, but there is no text that can be written that completely differentiates one from the other. One can always find an exception to the “rule.” There were no tests, no lectures, and no board work to teach cat and dog. Kids were exposed to lots of examples over time with immediate feedback, i.e. perceptual learning. That model of perceptual learning is powerful, but it takes a long time to accomplish. With PLMs, we are able to greatly speed up the presentation of examples with feedback that establishes pattern recognition for high-level learning in many disciplines. Perceptual learning is “Brain Calisthenics for Abstract Ideas.” Welcome to the “new face of learning.”



Photo 1

The Center for Effective Learning has three primary objectives:

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Photo 2

