

Tracy Huebner

Balancing the Concrete and the Abstract

Beginning this month, we are fortunate to have two experienced researchers writing the "What Research Says About . . ." column on alternate months. Each of our columnists has an impressive depth of research expertise.

This month's columnist is Tracy Huebner, Senior Research Associate in WestEd's Innovation Studies Program, which creates and disseminates user-friendly information to support educators who want to understand and effectively implement promising policies and practices. WestEd is a national nonprofit research, development, and service agency, found online at WestEd.org.

Next month, columnist Jane L. David will return. Jane is Director of the Bay Area Research Group in Palo Alto, California. Coauthor with Larry Cuban of *Cutting Through the Hype: A Taxpayer's Guide to School Reform*, she has 35 years of experience studying schools and districts.

A teacher's most essential job is to help students gain and retain knowledge—to take true ownership of what they have learned. Good teachers know they must organize instruction so that students internalize key concepts, apply the knowledge in new settings, and build on it in future years as they advance through their studies (and lives). This is the essence of true learning.

Teachers foster such learning through myriad large and small decisions about instruction. One decision teachers face is when to present new knowledge in concrete terms (for example, through manipulatives), when to present it in abstract terms, and when to combine these approaches.

What We Know

Research shows that presenting knowledge in both concrete and abstract terms is far more powerful than doing either one in isolation (Pashler et al., 2007). This is particularly true in math and science classrooms.

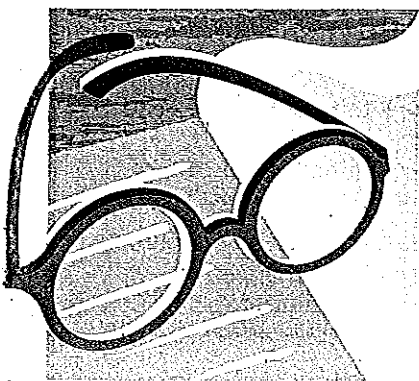
For example, a 2003 study showed the bene-

fits of initially presenting concepts in a concrete fashion and then, over time, augmenting that initial presentation with progressively more abstract representations of the concepts—a method known as *concreteness fading* (Goldstone & Sakamoto, 2003). In this study, concreteness fading was used to teach students about *competitive specialization*, a scientific principle that explains how parts of systems can self-organize without a central plan or leader.

To represent this abstract concept, a computer-generated simulation showed three ants moving toward three pieces of food. Each ant moved to the piece closest to it, ensuring that each one had its own food supply as opposed to all three crowding around the same piece; the ants self-organized themselves for an even distribution of the resources available.

In the study, teachers first introduced students to the concept by showing them the simulation of the ants and the food. They then replaced the simulation with more abstract representations of the ants as small dots and the food as larger blobs. Later, teachers showed the concept of competitive specialization in other contexts, ultimately representing the concept with letters and numbers. The study found that students who were taught using concreteness fading performed better than students who were taught about the concept of competitive specialization in an abstract way.

To transfer knowledge learned from a concrete example to an abstraction, students need appropriate guidance. For example, in a 2002 study by Ainsworth, Bibby, and Wood, two groups of elementary students who learned about the mathematical process of estimation using pictures showed better understanding of estimation than did students who had never been exposed to the graphic representations. The researchers concluded that the introduc-



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tion of concrete visual aids helped the students learn deeply about estimation.

What You Can Do

Teachers can put this idea to work in their classrooms by initially focusing on presenting concrete examples and demonstrations, perhaps using manipulatives, hands-on tasks, or visual representations. For example, a science teacher teaching the concept of genetics may begin with Mendel's famous pea plant experiments. The teacher might use actual pea plants or photos, showing how plants with different traits (short or tall, purple or white flowers, and so on) can be cross-fertilized to produce different traits.

Next, the teacher helps students connect those same concepts to more abstract representations, explicitly pointing out how the concrete and abstract representations relate to each other. In our example, the teacher might label the plants or photos with letters that represent the different genetic traits. (Mendel, for example, labeled first-generation plants with *P*, second-generation plants with *F1*, followed by *F2*, and so on.)

The teacher should also help students apply what they've learned in new contexts, so that students gain a more flexible understanding of the concept in a range of situations with varying levels of abstraction. The science teacher in our example might take the concepts of dominant and recessive genes and show how they work in other species, including humans. She could loop back to discussions or representations of pea plants as an anchor to reinforce the core concepts being taught.

Educators Take Note

By moving between concrete and abstract examples, teachers enable students to gain deep understanding of the core concept, apply their new knowledge in different situations, and acquire true ownership of what they have learned. This approach, which is widely applicable across various disciplines and age groups, is just one example of a research-based practice that, coupled with other strategies, can make a difference in student learning.

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Author's note: The studies mentioned here and many others are described in an excellent resource from the Institute of Education Sciences at the U.S. Department of Education, *Organizing Instruction and Study to Improve Student Learning* (Pashler et al., 2007). This publication cites only high-quality research about learning. It includes several key recommendations for helping students take ownership of new knowledge.

References

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