Research Basis of the Underlying Premises of *DynaNotes™ PowerCube Kits*

There is an abundance of research supporting the underlying premises of the *DynaNotes PowerCube* and its coordinating activity book, including the use of:

- Earth and space instruction
- models, diagrams, and graphic organizers
- vocabulary development / reinforcement
- interesting learning center activities

Earth and Space Science Instruction

Students often struggle with Earth Science topics including concepts and cycles related to the Earth, sun, and moon. For instance, scores on the 2009 Texas Grade 5 and 8 Science TAKS™ tests indicated that the lowest statewide science objective was Earth Science (Heyrick, Pickhardt, & Guthrie, 2009). Only 57% of eighth grade test-takers could correctly "relate the Earth's movement and the moon's orbit to the observed cyclical phases of the moon" (p. 35) and only 75% of fifth grade test-takers could "identify the physical characteristics of the Earth and compare them to the physical characteristics of the moon" (p. 32). Additionally a study published in *International Journal of Science Educators* (Plummer, 2009) examined understanding of celestial movement among third grade, fifth grade, and eighth grade students. The overall accuracy of understanding showed little change across the majority of topics from the third grade to the eighth grade, with the exception of the apparent motion of the sun. The researcher concluded that her study supports what other researchers have also found – there exists a need for instruction to improve children's understanding of the nature of celestial objects and their actual motion.

The *PowerCube* and its coordinating activity book seek to improve students' knowledge of the sun, Earth, and moon and their associated movements using facts, examples, models, and activities.

Models, Diagrams, and Graphic Organizers

Models and graphic organizers are visual representations of concepts and ideas. Researchers Subramaniam and Padalkar (2009) investigated student knowledge of moon phases and they concluded that visualization and developing an ability to work with diagrams are important for science learning. The experiments of Carlson, Chandler, and Sweller (2003) demonstrate how chemistry students benefit from the use of chemistry diagrams as compared to a text-based format. Ives and Hoy (2003) assert that graphic organizers can be used when traditional instruction emphasizes language skills that the students do not possess.

One research study of seventh grade students found that as the number of opportunities to construct and interpret graphs increased, the students were able to more fully participate in graph construction and discussion (Wu & Krajcik, 2003). The researchers suggested that providing scaffolding and sequencing tasks were beneficial. Researcher Steven Nisbet (2003) states that representing numerical data in an organized way is not a natural skill. However, he found that after a series of lessons more middle school students were able to reorganize data and produce organized graphs. Causal diagrams, which illustrate cause and effect relationships, have been shown to improve comprehension of science concepts (McCrudden, et al., 2007).

The *PowerCube* and its coordinating activity book use models and graphic organizers to help students comprehend and apply space concepts including Earth's rotation, lunar cycle, tides, seasons, and properties of celestial bodies. Students apply information from the *PowerCube*'s labeled diagrams to complete Venn diagrams, bar graphs, and tables found in the activity book. Research shows that visual aids, like graphic organizers, diagrams, and models, are effective for many types and ages of learners. The *PowerCube* activity book provides many opportunities for students to order, compare, and organize numerical data (like planet diameters, surface gravity, and distances in space) to make the information relevant and meaningful. The *PowerCube* uses causal diagrams to visually explain such concepts as Earth's rotation on its axis and the resulting daylight and nighttime.

Vocabulary Development / Reinforcement

Research indicates that vocabulary development and reinforcement is strongly recommended for all students. Jalongo and Sobolak (2011) assert that students need to be actively engaged in vocabulary development to show vocabulary gains. Those students who speak English as a second language and those who are economically disadvantaged are particularly at risk of not making vocabulary gains. Medina et al. (2007) in *Science Teacher* proposes that English Language Learners may benefit from explicit teaching of new scientific vocabulary. Likewise, Madeline Kovarik (2010) states that vocabulary instruction is critical in content areas, and particularly so for economically disadvantaged students who may come to school with limited background knowledge.

The *PowerCube* activity book uses graphic organizers and writing assignments to reinforce space-related concepts and vocabulary. Critical vocabulary words are also reinforced visually by the *PowerCube*'s many colorful models and images.

Interesting Learning Center Activities

"Student understanding and retention can be enhanced and improved by providing alternative learning activities and environments" (p. 259) according to Chow, Woodford, and Maes (2011).

Researchers DeGeorge and Santoro (2004) state that "the power and effectiveness of hands-on instruction have been proven in a wide range of subject areas" and that "hands-on learning helps students to more readily understand concepts and boost their self-confidence" (p. 28). Carl Smith (2003) states that learning

vocabulary should be an "active process that engages students in entertaining activities."

Hands-on learning also positively impacts standardized test scores. Dunn and Dunn (2005) state that "when schools with underachieving minority, poor students in various sections of the nation introduced tactual and kinesthetic instruction, they evidenced statistically higher standardized achievement test scores in reading and mathematics within one year" (p. 273). Another study found that gifted middle school students were more likely to remain motivated and engaged when participating in hands-on activities (Rayneri, Gerber, & Wiley, 2006).

In her research study, Davis (2004) finds that the use of multiple intelligence learning centers leads to improved student achievement, behavior, and self-esteem for fourth grade science students. Irwin, Nucci, and Beckett (2003) in *Science and Children* qualitatively describe their success in using science learning centers to promote positive interaction among students of different backgrounds and ability levels.Researchers Terzian and Moore (2009) evaluated 11 summer learning programs involving economically disadvantaged urban students and found that the effective programs included hands-on, enjoyable activities that had real-world applications. Furthermore, researchers Bulunuz and Jarrett (2010) found that many teachers have a low conceptual knowledge of elementary level earth and space concepts. However, their research study showed that teacher understanding improved after using hands-on stations on these science concepts.

The *PowerCube* can be used as a part of a science learning center as a unique learning center activity. The interlocking panels of the *PowerCube* are fun and motivational for the students to flip, turn, and explore. A cube that reveals hidden panels is novel, fun, and entertaining.

References

Bulunz, N. and Jarrett, O.S. (2010) The effects of hands-on learning stations on building American elementary teachers' understanding about earth and space science concepts. *EURASIA Journal of Mathematics, Science, and Technology Education* 6(2), 85-99.

Carlson, R, Chandler, P., & Sweller, J. (2003). Learning and understanding science instructional material. *Journal of Educational Psychology*, 95(3), 629-40.

Chow, A. F., Woodford, K. C., & Maes, J. (2011). Deal or no deal: Using games to improve student learning, retention, and decision-making. *International Journal of Mathematical Education in Science and Technology*, 42(2), 259-264.

Davis, L. (2004). Using the theory of multiple intelligences to increase fourth-grade students' academic achievement in science. (Doctoral dissertation, Nova Southeastern University, 2004). *Eric Online ED491477*.

DeGeorge, B. & Santoro, A. M. (2004). Manipulatives: A Hands-On Approach to Math. *Principal*, 84(2), 28.

Irwin, L. Nucci, C, & Beckett, E. C. (2003). Science centers for all. *Science and Children*, 40(5), 35-37.

Dunn, R. & Dunn, K. (2005). Thirty-Five Years of Research on Perceptual Strengths: Essential Strategies to Promote Learning. *Clearing House: A Journal of Educational Strategies, Issues and Ideas* 78(6) 273.

Heyrick, K., Pickhardt, I., & Guthrie, J. (2009) *TEA Science Update*, Presented at 2009 Assessment Conference.

Ives, B. & Hoy, C. (2003). Graphic organizers applied to higher-level secondary mathematics. *Learning Disabilities: Research & Practice*, 18(2), 36-51.

Jalongo, M.R. & Sobolak, M. J. (2011). Supporting young childrens' vocabulary growth: The challenges, the benefits, and evidence-based strategies. *Early Childhood Education Journal*, 38(6), 421-429.

Kovarik, M. (2010). Building mathematics vocabulary. *International Journal for Mathematics Teaching and Learning*, October 2010.

Medina-Jerez, W., Clark D., Medina, A., & Ramirez-Marin, F. (2007). Science for ELLs: Rethinking our approach. *Science Teacher*, 74(3), 52-56.

McCrudden, M.T., Schraw, G., Lehman, S., & Pilquin, A. (2007). The effect of Causal Diagrams on Text Learning. *Contemporary Educational Psychology*, 32(3), 367-388.

National Science Education Standards (1996). Washington, D.C.: National Academy Press.

Nisbet, S. (2003). Getting Organized: The Role of Data Organization in Students' Representation of Numerical Data. *Paper Presented at the 27th International Group for the Psychology of Mathematics Conference, Honolulu.*

Plummer, J.D (2009). A Cross-Age Study of Children's Knowledge of Apparent Celestial Motion. *International Journal of Science Education*, 31(12), 1571-1605.

Rayneri, L. J., Gerber, B. L., & Wiley, L. P. (2006). The Relationship between Classroom Environment and the Learning Style Preferences of Gifted Middle School Students and the Impact on Levels of Performance. *Gifted Child Quarterly*, 50(2), 104-18.

Smith, C. (2003). Successful Techniques of Vocabulary. ERIC Topical Bibliography and Commentary. *ERIC Clearinghouse on Reading, English, and Communication,* ERIC Online ED480892.

Subramanian, K. & Shamin, P. (2009). Visualisation and Reasoning in Explaining the Phases of the Moon. *International Journal of Science Education*, 31 (3), 395-417.

Terzian, M & Moore, K. (2009). What works for summer learning programs for low-income children and youth; preliminary lessons from experimental evaluations of social interventions. *Child Tends* (ED510682).

Wu, H. & Krajcik, J. (2003). Inscriptional practices in inquiry-based classrooms: How do seventh graders construct and interpret tables and graphs? Presented at the Annual Meeting of the National Association for Research on Science Teaching, Philadelphia.