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

Research supports 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; and
- 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. Another study found that physics students who used visual representation tools outperformed those who did not use them when identifying forces and constructing free-body diagrams (Savinainen et al., 2013). 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). Causal diagrams, which illustrate cause and effect relationships, have been shown to improve comprehension of science concepts (McCrudden, et al., 2007). With respect to English Language Learners, Claire Sibold (2011) states that "it is important to explicitly teach vocabulary using effective strategies that will engage students in learning new words—for example, association strategies, imagery, and graphic organizers" (p. 26). 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. The *PowerCube* activity book provides many opportunities for students to order, compare, and organize numerical data (e.g., 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 studies and experts are in support of effective vocabulary development. Jalongo and Sobolak (2011) assert that students need to be actively engaged in vocabulary development to show vocabulary gains. Madeline Kovarik (2010) states that vocabulary instruction is critical, particularly for economically disadvantaged students who may come to school with limited background knowledge. A study of 21 sixth-grade classrooms by Kelley, Lesaux, Kieffer, and Faller (2010) shows that teaching academic vocabulary in meaningful and systematic ways helped to improve students' vocabulary and reading comprehension. The research of Burgoyne, Whiteley, and Spooner (2009) indicates that the difficulties that English Language Learners have in understanding texts are related to these students' significantly lower level of vocabulary knowledge. Sharilyn Daniels' 2009 study found that English Language Learners showed gains when they were provided with intervention that included exposure to vocabulary words, definitions, model sentences, and context. 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

Boredom has been shown to result in negative academic performance (Pekrun et al., 2014). Chow, Woodford, and Maes (2011) state that "student understanding and retention can be enhanced and improved by providing alternative learning activities and environments" (p. 259). 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). 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). A *Science Teacher* article describes how learning centers assist teachers in evaluating student content knowledge without penalizing them for language barriers. The authors believe appropriately designed science learning centers can accommodate English Language Learners and differentiate instruction for students (Martin & Green, 2012). 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.

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