Research Basis of the Underlying Premises of the *DynaNotes*™ *SmartClings*™ - Graphs

There is an abundance of research supporting the underlying premises of the *DynaNotes SmartClings-Graphs* instructional sets including the use of:

- graphing skill development
- graphing instruction and support
- manipulatives and hands-on activities

In September 2009, the *DynaNotes SmartClings - Graphs* instructional set was selected as a winner of the prestigious *Learning*® *Magazine 2010 Teachers' Choice*℠ *Award.* According to *Learning*® magazine, the awarded educational products were judged in classrooms by a panel of teachers across the country. The products were evaluated in terms of "quality, instructional value, ease of use, and innovation."

Graphing Skill Development

The National Science Education Standards describe the importance of gathering, analyzing, and interpreting data. The National Council of Teachers of Mathematics Process Standards state that "instructional programs from prekindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas." Oxgun-Koca (2001) states that although the teaching of graphs in mathematics classes is often "an end in themselves, many subject areas such as science or social studies utilize graphs to represent and interpret data" (p. 2). Therefore, the ability to construct and interpret graphs is crucial for all students whether or not they pursue a science or math related career.

Yet research shows that younger students have difficulty working with graphs due to the higher mental operations that are required. Connecting a graph with a concrete representation or relationship can help support the understanding of graphs (Vogel, Girwidz, & Engel, 2007). A research study of fourth and fifth grade students found that students often performed poorly on graph interpretation questions found on high-stakes tests and that students with learning disabilities performed significantly lower than their typically performing peers (Parmar & Signer, 2005). Even at middle school a study found that "students showed a preference for lower-level tasks such as 'reading the graph' over more distant predictions and generation of abstractions" (Nathan & Kim, 2007).

Additional instruction, like the hands-on graph construction and interpretation activities included in *DynaNotes SmartClings,* can develop graphing skills.

Graphing Instruction and Support

Graphing and interpretation skills need to be taught and supported. 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.

The *DynaNotes SmartClings – Graphs* instructional sets develop students' graphing skills by guiding students through increasingly more challenging graph construction and interpretation activities. The graph feature pages and the CD-ROM's step-by-step answer key provide support for students at different ability levels.

Manipulatives and Hands-On Learning

The use of manipulatives and hands-on learning has been advocated by many researchers and educational organizations. The National Science Education Standards state that "learning science is something students do, not something that is done to them" and that the "active process implies physical and mental activity." 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 – particularly math" and that "hands-on learning helps students to more readily understand concepts and boost their self-confidence" (p. 28). "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).

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). 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.

DynaNotes SmartClings – Graphs sets use static cling pieces as hands-on manipulatives. The students actively construct graphs based on realistic data by selecting and adhering graph titles, labels, and data to the graph cards. This hands-on approach is fun and motivating, while reinforcing critical graphing and interpretation skills.

References

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.

References, continued

Crews, H. (September 2009) *Learning® Magazine Teachers' Choice℠ Awards Winner FAQ Sheet.*

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

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.

Nathan, M & Kim, S. (2007). Pattern Generalization with Graphs and Words: A Cross-Sectional and Longitudinal Analysis of Middle School Students' Representational Fluency. *Mathematical Thinking and Learning: An International Journal,* 9(3) 193-219.

National Academy of Science (1995). *National Science Education Standards - Online.*

National Council of Teachers of Mathematics (2000-2004). *Principles & Standards for School Mathematics-Online.*

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.*

Ozgun-Koca, S. (2001). The Graphing Skills of Students in Mathematics and Science Education. *ERIC Clearinghouse for Science, Mathematics, and Environmental Education.* ERIC Online. ED464804

Parmar, R. S. & Signer, B. R. (2005). Sources of Error in Constructing and Interpreting Graphs: A Study of Fourth-and Fifth-Grade Students with LD. *Journal of Learning Disabilities*, 38(3), 250.

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.

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).

Vogel, M., Girwidz, R., & Engel, J. (2007). Supplantation of Mental Operations on Graphs. *Computers & Education*, 49(4), 1287-98.

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.