# Using Visualization Tools for Inquiry-Based Science: A Longitudinal Study of Teacher's Stage of Development

Michael T. Charles
College of Education
Pacific University
USA
charlesm@pacificu.edu

Robert A. Kolvoord
Integrated Science and Technology
& Educational Technologies
James Madison University
USA
kolvoora@jmu.edu

**Abstract:** Scientific visualization tools have shown tremendous promise in drawing today's increasingly visual learners into in-depth inquiries in mathematics and science. But how successful are teachers in using these tools with their students in the chronically under supported technological settings of K-12 education? This paper describes teacher progress in using four visualization tools in terms of a stages of adoption model. Summary data are presented from thirty participants in this longitudinal study based on follow-up questionnaires and interviews that describe how some teachers have begun to integrate these relatively advanced scientific visualization tools into their teaching practice.

Scientific visualization tools offer a rich use of the more powerful computers that are becoming more and more plentiful in schools today. These are a set of inquiry-based tools, many of which were originally designed to help scientists understand and explore different datasets or physical phenomenon. Visualization tools have shown great promise in drawing today's increasingly visual learners into in-depth study of scientific and mathematical topics (Baker & Case 2000; Greenberg et al. 1993; Gordin & Pea 1995; Jonassen 2000; Thomas, Johnson, and Stevenson, 1996; Malinowski, Klevickis & Kolvoord, 2001).

Both the promise and the relatively advanced nature of this software leads to the question of how to get more teachers involved in using visualization tools in their classrooms. Many projects offer extended training for teachers in one of these more advanced tools, but extended training in the first exposure to a new tool is often too much, too soon. Project Visualization in Science and Mathematics (VISM) is a recently completed NSF-funded project intended to focus more broadly on the techniques of visualization and not so much on particular tools. The approach taken in Project VISM was to provide participants with a relatively brief look at several different tools versus an extended exploration of one tool.

This paper examines the question of teacher success in incorporating these tools into their teaching practice following a very successful three week summer workshop in which the teachers demonstrated their ability to use at least one of the tools to create at curriculum-related project. It was posited that teachers go through stages in adopting these new and relatively advanced technological tools into their own practice. The Apple Classroom of Tomorrow (ACOT) model describes four stages teachers can progress through in moving new technological tools into their practice: entry, adoption, adaptation, and innovation (Sandholtz et al. 1997). The VISM matrix (Charles & Kolvoord 2001) was developed based on this model. It describes each of these four stages in specific terms for each of the four tools that were taught in the VISM workshop. The four tools were:

- Image processing with Image J, NIH Image or Scion Image software
- Geographic Information Systems (GIS) with ArcView GIS software

- Molecular visualization with RASMOL and Chemscape Chime software
- Systems modeling simulations with STELLA software

The matrix was developed to assist in describing the way that teachers use these tools with students in their classrooms at the adopt, adapt, and innovate level, and how that use evolves over time.

In this paper we will use the VISM matrix to describe the progress of thirty teachers as they have used these tools with their students over the past one, two, or three years. Previously we have presented brief case studies that describe four teacher's efforts in using these tools in their classrooms (Charles & Kolvoord, 2003). These case studies, based on follow-on interviews of participants conducted one or two years following the VISM workshop, shed important light on the variety of implementation observed in this small group. The ACOT model suggests that each of these levels might correspond with the first, second, and third year of use of a particular tool. Our case study data suggested that the reality in the classroom was more complex than that, and this paper will continue to describe that complexity as it maps to more participants over a longer period of time. In this paper we will more broadly summarize the findings based largely on data gathered on a questionnaire that was given to participants at a weekend follow-on workshop in the summer of 2003. The central questions asked in both the interviews and the questionnaires were:

- Briefly describe 1 or 2 projects you carried out last year with your students using one of these visualization tools.
- What things helped you use the tools with your students, and what were your greatest obstacles in using these tools with your students during the year?
- Briefly describe what you think you accomplished this year based on your participation in the VISM workshop, and one thing you had hoped to accomplish but perhaps did not.

We will report on new insights gained into the obstacles that teachers face in doing inquiry-based science that uses more advanced technological tools against the back drop of increasingly high stakes testing environment of K-12 education. This brief paper is part of a series of papers we have written based on our experiences in Project VISM and the use of other scientific visualization tools in other projects. We began by describing the VISM matrix, then reporting some brief case studies, and now we are continuing our work by summarizing more broadly the work of the participants as they use scientific visualization tools to do inquiry-based science.

## References:


Baker, T.R. & Case, S.B. (2000). Let GIS be your guide. *Science Teacher* 67 (7), 24-26.

Charles, M.T. & Kolvoord, R.A. (2001) Teacher's stages of development in using visualization tools for inquiry-based science: The case of Project VISM (2001). Proceedings of SITE 2001. Charlottesville, VA: Association for the Advancement of Computing in Education.

Charles, M.T. & Kolvoord, R. A. (2003). Teacher's stages of development in using visualization tools for inquiry-based science. Proceedings of SITE 2003. Charlottesville, VA: Association for the Advancement of Computing in Education.

Gordin, D.N. & Pea, R.D. (1995). Prospects for scientific visualization as an educational technology. *The Journal of the Learning Sciences*, 4 (3), 249-279.

Greenberg, R.; Kolvoord, R.A.; Magisos, M.; Strom, R.G.; and Croft, S. (1993). Image Processing for Teaching. *Journal of Science Education and Technology*. 2,14-18.

Jonassen, D.H. (2000). Systems modeling as mindtools. In *Computers as Mindtools for Schools*. Columbus, Ohio: Merrill, Prentice Hall.

Malinowski, R., Klevickis, C., Kolvoord, R. (2001) Come see the molecules—using 3-D modeling programs to learn chemistry. *Learning and Leading with Technology*, 29 (4) 36-41, 61. Accessed at http://www.iste.org/L&L/archive.html

Project VISM (2003). Accessed at http://www.isat.jmu.edu/common/projects/VISM/

Sandholtz, J.H.; Ringstaff, C.; Dwyer, D.C. (1997). *Teaching with technology: Creating student-centered classrooms*. New York: Teachers College Press.

Thomas, D.A.; Johnson, K.; and Stevenson, S. (1996). Integrated mathematics, science, and technology: An introduction to scientific visualization. *Journal of Computers in Mathematics and Science Teaching*. 12 (3), 267-294.



**Acknowledgements**

This research was carried out as a part of Project Visualization in Science and Mathematics (VISM), a project of the Integrated Science and Technology program at James Madison University, with the sponsorship of the National Science Foundation. Project VISM was held during the summers of 2001-2003; more information available at http://www.isat.jmu.edu/common/projects/VISM/.