James Madison University

From the SelectedWorks of Robert A Kolvoord

2001

Teacher's stages of development in using visualization tools for inquiry-based science: The case of Project VISM

M. Charles
Robert A Kolvoord, *James Madison University*

Available at: https://works.bepress.com/bob_kolvoord/48/

Teacher's Stages of Development in Using Visualization Tools for Inquiry-Based Science

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 undersupported 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 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 the summer workshop. 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). Table 1 summarizes the VISM matrix (Charles & Kolvoord 2001) which was developed based on this model. It describes each of these four stages in very specific terms for each of the four tools that were taught in the VISM workshop. The matrix was developed to assist in describing the way that teachers use these tools with students in their classrooms, and how that use evolves over time.

Tools	**Entry**-competent in using *the tool* at the workshop	**Adopt** *the tool* into their teaching practice (Year 1)	**Adapt** *the tool* into their teaching practice (Year 2)	**Innovate** with *the tool* in their teaching practice (Year 3)
Image processing: *NIH Image* or *Scion Image*	Skill set taught to participants: • Open an image • Manipulate LUTables • Measure/set scale • Profile plot/surface plot • Stacks and animations • Capture their own JPEG images • Average images • Copy/Paste images	Participants select one of the workshop activities and successfully use it with students (preferably on a regular or recurring basis).	Participants significantly modify one or more of the workshop activities into their own teaching practice.	Participants bring in their own images and apply a variety of image processing skills as part of a student-initiated inquiry.
Geospatial Analysis: *ArcView GIS*	Participants successfully completed the identified activities in the workshop • ArcView project intro • Exploring Projections • GeoProcessing Wizard	Participants successfully do one or more activities from the workshop with their students	Participants significantly modify an activity from the workshop to fit the needs of their curriculum/students/ technical constraints and incorporate found data.	Participants can create their own GIS activity using an original data set/source
Molecular Visualization: *RasMol* and *Chemscape Chime*	All participants were successfully able to: • embed Chemscape Chime structures within a web page • write scripts to interact with and animate the Chime structures. They used these skills to create tutorial websites on molecules that they selected as part of the "mineral web."	• Participants use existing .pdb file collections to manipulate molecules to create graphics, make measurements, and show molecular properties. • Participants use the web page they created in the workshop to teach a concept in their curriculum. • Participants use the list of .pdb resources (for their content area) with students.	• Participants are able to find and download .pdb files from Internet sources and use those to write scripts in RasMol. • Participants are able to write animated scripts in RasMol that tell a molecular story related to their teaching.	Participants are able to embed Chemscape Chime structures within a web page and write scripts to interact with and animate those structures to create tutorial websites on molecules they have selected.
Systems modeling: *STELLA*	Participants put an interactive front end on an existing STELLA model and adapt it for their own use in their teaching.	Participants operate a STELLA simulation with their students. Participants read & interpret STELLA system diagrams with their students.	Students can name and document an existing STELLA model , e.g.: • Given a generic system diagram and a physical description of a system, students can name and document the model and input the equations that run the system	Students can build their own STELLA model from a written description of a system with the assistance of the participants.

Table 1. A matrix of the stages of tool use by the participants in the VISM project

In this paper the VISM matrix will be used to help 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 four 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. In this paper we will summarize the findings from thirty participants and relate their work to the stages of adoption model in the VISM matrix. 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.

Follow-on interviews

Follow-on interviews are being conducted to determine how teachers were using the VISM tools in their teaching practice. The questions for these interviews were based on some of the written pre/post evaluation questions that each participant completed during the workshop. The interviews were conducted over the phone or face to face. Following the interviews summaries were emailed to the interviewee for comment and correction. The interviews were open-ended, conducted with a starter list of key questions which included:

- 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.

Four interviews have been conducted so far. One of the teachers interviewed participated in Project VISM in the summer of 2001 and three of the teachers participated in the pilot group in the summer of 2000. More interviews are planned across multiple years as well as some limited visits to classrooms, but already some interesting findings have emerged. In the initial interviews, there is one example of a teacher who has reached the innovate level of use, though under exceptional circumstances. There are two teachers who are clearly adopting/adapting the tools into their practice, and actively seeking further training in the use of one particular tool. There is one participant who did not use these tools at all, but instead has made effective use of a different visualization tool that came to his school. This variety in implementation seemed worthy of fuller description even as interviews are ongoing.

Initial findings

The initial findings from these interviews is briefly summarized in Table 2. Further discussion of these interviews that describe how these four teachers have begun to integrate these relatively advanced scientific visualization tools into their teaching practice will be held during the session. A discussion of issues related to bringing scientific visualization tools into classroom teaching practice will conclude the presentation.

References:

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

Berman, H.M.; Westbrook, J.; Feng, Z.; Gilliland, G.; Bhat T.N.; Weissig, H.; Shindyalov, I.N.; & Bourne, P.E. The Protein Data Bank. *Nucleic Acids Research*, 28 pp. 235-242 (2000). Accessed at http://www.rcsb.org/pdb/

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.

Geographic Information Systems in the Classroom (2000). *Educator's Guide to Computers in the Classroom*, 1, 1-5.

Getting to Know *ArcView GIS 8.0* (2001) Editors of ESRI Press.

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 (2000). 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/.

Tool	Teacher one (Jim)	Teacher two (Greg)	Teacher three (Bill)	Teacher four (Dan)
Image processing *NIH Image/ Scion Image*	Innovate Physics Image project—photographing and dropping a ball and determining acceleration rate of gravity. Adapted from a VISM participant. -90 minutes period to do -90 minute period to analyze	Adopt Completed Travel USA activity with 9th grade computer apps course—part of a population sampling activity. 1 period activity	Adopt Demonstrated one NIH Image activity to students No student activities or projects. 1 period activity	None
Geospatial Analysis *ArcView GIS*	Innovate Used from first week of school to last week in Environmental Science course. Class research question: Should we put water out or not for illegal immigrants to reduce mortality rates? Plotted paths where illegal immigrants could come across on an image of the southwest. -2 week activity Students did research and created ArcView themes of economic indicators for 6 border crossings between AZ and Sonora. Helped build an economic database of information. Published to website: http://victoria.ciad.mx/sonar_e-atlas/ -8 week project	Adapt 11th/12th grade elective course on GIS with 22 students each time. Students completed GIS projects from the ESRI text "Getting to Know ArcView 8.0" text Multi-week projects–course focuses on the use of the tool in mapping	Adopt Demonstrated one GIS activity re the distribution of volcanoes. No student activities or projects. 1 period activity	None
Molecular Visualization *RASMOL* and *Chemscape Chime*	Adapt RASMOL activity: RASMOL model of a number of different inorganic solid structures which they then observe the shape of and predict the polarity. 1 period lab activity (90 minutes)	None	Adopt Demostrated 3D capabilities of visualization software. No student activities or projects. 1 period activity	None
Systems modeling *STELLA*	Adopt Teacher created STELLA model of immigration rates with or without "watering holes" used by group to answer research question. 1 period activity	None	None	None
Comments	Innovate level in NIH Image/ Scion Image and ArcView prior to VISM	Pursuing further instruction in ArcVIEW GIS after VISM	Intends to begin doing activities/projects with students in more advanced courses next year	Adopted probeware/ astronomy software instead of VISM tools

Table 2. A summary of levels of use of the VISM tools by each of the teachers