Meridian Middle School Computer Technologies Journal

Print this Meridian Article

Getting the Jump on Technology Integration Using Java Applets for Staff Development

Ali Mahdi Ahmad and Jan Farnam

Issue 2, Volume 9, 2006

View Online
http://www.ncsu.edu/meridian/sum2006/gettingthejump/index.htm

Abstract

Technology-based staff development helps teachers meet the demands of educating 21st-century students by supporting and encouraging teachers to integrate technology effectively into their curricula. The authors use online java applets as a staff development tool. The professional development model in this article provides just-in-time assistance as middle school teachers locate applets, integrate them into their scope and sequence, implement lessons, and evaluate student success. Teachers report that math and science applets have increased their pedagogical and content specific skills as well as their self-efficacy in integrating technology into their curricula. Applets permit interactive exploration of math topics, encourage discovery learning, strengthen students' visual literacy skills, reveal students' misconceptions and learning difficulties, and promote a deeper understanding of difficult mathematical concepts. These data are promising and show that instructional technology succeeds when it is supported by school leadership and aligned with standards, curriculum, teacher professional development, and assessments.

Introduction

No Child Left Behind mandates adequate yearly progress for students and implies the need for professional development for teachers in content, pedagogy, and content specific pedagogy so that teachers cultivate the abilities and resources to educate 21st century students. Creating professional development opportunities that not only enhance teachers' content and pedagogical skills, produce meaningful, measurable student results, and integrate technology across the curriculum is challenging. Golden (2004) points to the way “technology is fundamentally changing education, making the classroom more student-centered and learning more student-driven” (p. 1) and recommends integrating technology with ongoing professional development.

Students using platonic solids applet from National Library of Virtual Manipulatives

We began our study with two interesting problems: student math scores were low and teachers' integration of technology into their curriculum was minimal. Our middle school students' math scores on the state's standardized test hovered perilously at the 40th percentile, clearly a score unacceptable to our many stakeholders. Our goal was to design an ongoing program of professional development that would target improvement in both of these areas. Becker (1994) suggested that teachers use computers more effectively when they have access to high levels of teacher technology training and ongoing support from technology coordinators. Based on Becker's advice, our site-based professional development involved collaboration, mentoring, and coaching in which teachers from all disciplines used math applets to improve students' math achievement.

Rationale for Professional Development of Teachers

Our professional development model provided peer coaching and ongoing, just-in-time support for novice, developing, and technology-implementing teachers. It involved job-embedded training in which technologists worked with teachers to plan, implement, and assess technology-integrated lessons. We recruited math teachers and non-math teachers to work together to develop, implement, and assess the program. Although work was done in all content areas, this article focused on improving students' math scores while simultaneously encouraging technology-shy and technology-resistant teachers to use applets with their students. Applets, as discussed in this article, are interactive, animated objects that learners manipulate to construct their own understandings of specific science and math concepts. Math applets are free and widely available on the Internet.

Our first professional development goal involved math teachers in selecting applets that would strengthen areas of weakness within the math curriculum. During the first stage, technologists worked collaboratively with teachers to identify student weaknesses in math. Using disaggregated data, teachers selected five targets for improvement in student math scores.

Next, teachers located websites with applets for the targeted deficits: platonic solids, factorization, transformation, and 3-D visualization and the relationships among percents, fractions, and decimals. Teachers then developed a sequence for using the applets. Finally, the teachers pioneered a program using selected animated manipulatives with a limited number of students in tutoring sessions. Success with these colorful, user-friendly applets for reinforcing concepts, encouraging exploration, and promoting higher order thinking among students, paved the way for teachers expanded use of the applets.

Our second professional development goal was to improve self-efficacy of teachers towards integration of technology into their own content areas. Our plan involved enlisting the help of non-math teachers to bring students into the computer labs to use the math applets. We could do this because our teachers were grouped as “blocks” of teachers. Each block of five teachers included math, science, history, language arts, and reading instructors. From the onset, technology integration among our teachers ranged from full acceptance, to timidity, to outright refusal. Our goal was to scaffold successful technology integration, group support, and productive student-engagement for our technology timid and refusing staff. Our success was a credit to the math teachers' leadership and the support that they received from their blocks. Teachers' cohesiveness and willingness to support each other helped them overcome their timidity and reassess their willingness and ability to integrate technology into their own curriculum.

Students using interactive math tools at BrainAbility.

“Block” teachers were responsible for the same group of students each day. Student groups varied among blocks but usually ranged from 150-180 students. Teachers within a block had common planning time, and an advisory period each day during which time all teachers reinforced math skills. Normally, math teachers prepared packets of materials for the other teachers to use during advisory period. We proposed that non-math teachers would bring their students into the computer labs during advisory period to use the math applets. The technologists and math teachers would implement a pretest, engage the students in the use of the applets, and then administer a post-test. Although the non-math teachers were there in a supervisory capacity, they were encouraged to observe, participate, and explore the math applets with their students. We anticipated that the engaging nature of the applets would not only motivate students but also help teachers overcome their technology-timidity. We further anticipated that observing successful collaboration would cultivate a desire on the part of non-math teachers to integrate applets into their own content areas.

Rationale for Using Math Applets

Research finds that applets allow for interactive exploration of math topics, encourage discovery learning, and strengthen students' visual spatial visualization skills (Keller, Wasburn-Moss, & Hart, 2002). Applets often expose students' misconceptions and learning difficulties and promote a deeper understanding of difficult mathematical concepts.

By using online, interactive math applets, we were able to implement a professional development model that enabled teachers to develop their awareness of visual learning (Ahmad & Farnam, 2004). The primary reasons we used applets were: 1) students' success rates, and 2) turn-around time from initial teacher training to classroom implementation and assessment. Additionally, we felt that non-math teachers also would find applets easily adaptable into their content areas.

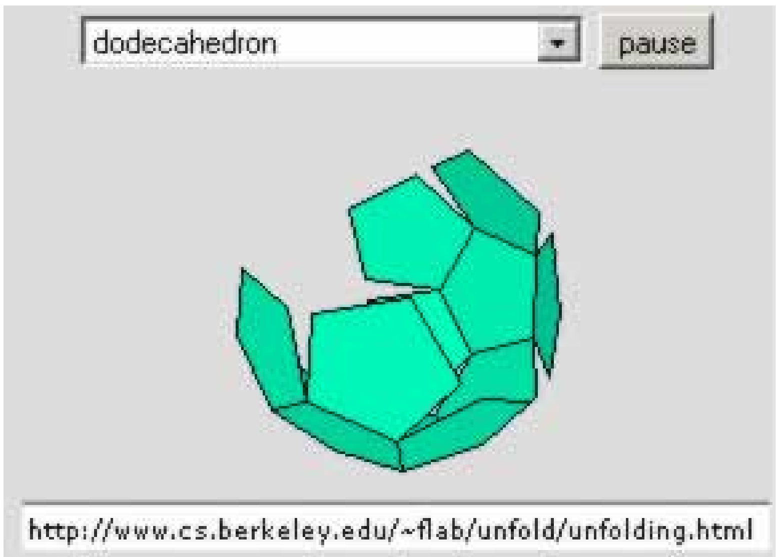

Figure 1. Platonic solid Net Diagram created by Francois Labelle.

Applets varied in level of sophistication. While some were mere animations, others allowed students to manipulate variables and observe responses. For direct instruction in a single computer classroom, teachers projected applets onto a screen, but we felt that the power of the applets for our experiment would best be manifest in a computer lab, allowing each student independently to manipulate applets and engage in authentic inquiry.

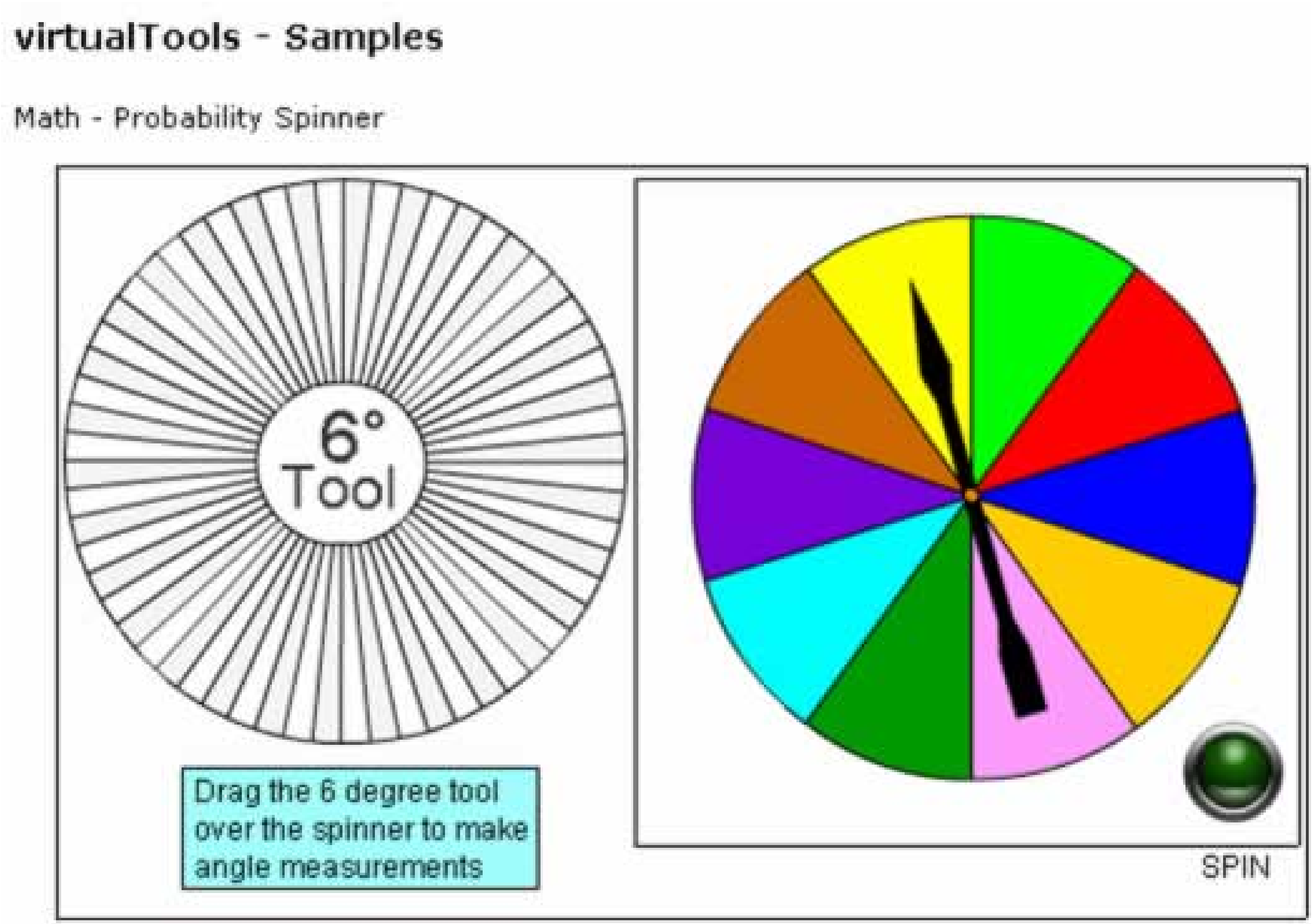

Figure 2. Interactive spinner from BrainAbility.

Research suggests that 21st-century students tend to be visual learners. Visual literacy (VL) is “the critical ability which will enable [people] to use visual images accurately and behave appropriately” (Christopherson, 1997, p. 69). VL is becoming an integral part of student learning for the digital generation. Healy (1998) asserts, “It is likely that visual literacy will increasingly infiltrate other disciplines...[but, visual literacy] skill[s] must be taught and linked to important learning” (p. 301). By working collaboratively with teachers to select math applets that are connected directly to the curriculum's scope and sequence, our professional development activities promote visual learning skills that are timely, relevant, and effective.

Context of Our Professional Development

This study involved a middle school, serving primarily low social economic and minority students, which achieved double-digit gains in its scores on the state's standardized math test. In order to maintain achievement gains, the staff developer, math curriculum leader, technology coordinator, and representatives from the math department implemented a campus-wide plan to increase math instruction and enlist the support of other non-math teachers. First, using disaggregated student data, district benchmarks, and the state curriculum framework as its guide markers, the committee generated scope and sequence and tied it to a calendar that delineated the amount of time afforded to each sub-objective.

Raising scores and maintaining gains in math scores would become a whole campus effort, with math teachers offering tutoring before and after school and non-math teachers implementing a 30-minute, mid-day session. Non-math teachers supported and facilitated the campus plan for increasing math proficiency. Math teachers developed lessons which non-math teachers could implement during these 30-minute, mid-day sessions. By enlisting non-math teachers, math teachers could reach four times as many students.

Math Teachers Develop and Revise Plans

The technology coordinator/staff-developer showed math teachers how they could use search engines to locate interactive applets to enhance instruction. A rubric for rating the applets helped in the selection process and revealed the wide-ranging quality and appropriateness between applets. Three sites provided the majority of applets that our math teachers needed for their projects: 1) the National Library of Virtual Manipulatives website (http://nlvm.usu.edu/en/nav/vlibrary.html); 2) the Shodor Interactivate website (http://www.shodor.org/interactivate/); and 3) the MathsNet website (http://www.mathsnet.net/geometry).

From Selection to Implementation

Successful training sessions involved hands-on activities, continuous training, modeling and mentoring, and the availability of follow-up training (Roblyer, 2000). Our math teachers and the technology coordinator collaboratively constructed web pages with links to task-related applets. They also created a calendar for each grade level, which depicted the math concept of the day and a link to the applet that would support the strategy. Next, math teachers shared implementation plans with the non-math teachers. The math teachers, curriculum coach, and technologists provided ongoing peer assistance for non-math teachers. Mentors described applets, explained their targeted use, and demonstrated the integration process as they coached their fellow teachers. The technologists provided just-in-time support as non-math and math teachers brought their students to the computer labs during the mid-day sessions. Non-math teachers supervised students' use of the math applets during the mid-day math sessions.

Sample Data for One Block

During 180 minutes of traditional instruction over a period of one week, one of the math teachers used overhead acetates, models, manipulatives, and dittos to assist students in learning about platonic solids. Five days later, students were administered a 5-question assessment in which they were asked to name the platonic solids, draw the shapes, and describe their attributes (edges, faces, vertices). This test served as a pre-test for the lab phase of the study. Results on the pre-test indicated that 87% of the students were unable to name more than two of the shapes, 97% were unable to draw more than three of the shapes, and 50% correctly identified the number of faces in three or more of the solids. Less than 10% could identify the number of vertices and no students were able to identify the number of edges in all of the platonic solids. Thirteen students were absent on one or more days or failed to complete the tests, therefore data was computed using data from the remaining 100 students. Students received instructions during the first five minutes, spent 20 minutes on the computer manipulating applets, and completed their session with a 5-minute post-assessment.

Table 1

Pre-Assessment : *Identifying Names and Characteristics of Platonic Solids*

Name of Platonic solid	Net Diagram	Faces	Vertices	Edges	Correct Responses
5	5	10	30	90	0
60	8	50	40	5	1
20	20	30	22	5	2
14	60	7	6	0	3
1	3	2	2	0	4
0	0	1	0	0	5

The first post-test indicated improvement in two areas: the shapes and faces of platonic solids. During the session, students discovered that using the shift key and clicking on the vertices and edges colorizes the lines and points, facilitating counting accuracy. Students spent the majority of their time exploring the tetrahedron, hexahedron, and octahedron.

Table 2

First Post-Assessment: Identifying Names and Characteristics of Platonic Solids

Name of Platonic Solid	Net Diagram	Faces	Vertices	Edges	Correct Responses
0	2	0	10	22	0
10	0	2	40	16	1
50	30	11	28	38	2
27	60	22	6	20	3
8	8	34	12	2	4
5	0	21	4	2	5

The first post assessment indicated that the students continued to have difficulty with the names and shapes of the dodecahedron and the icosahedrons. Two days later, we administered a second 20-minute session, this time asking students to focus on net-diagrams, names of the figures, and number of faces and vertices. Students wrote the names of the solids on paper as they worked with the animations at Platonic Solids. Students explored net diagrams at Nets, Unfolding Polyhedra.

Table 3

Second Post-Assessment: Identifying Names and Characteristics of Platonic Solids

Name of Platonic Solid	Net Diagram	Faces	Vertices	Edges	Correct Responses
0	0	0	10	22	0
10	0	0	20	10	1
10	2	2	48	36	2
68	1	12	6	24	3
7	81	15	12	4	4
5	16	71	4	4	5

The second post assessment showed that students more closely associated the faces and names with the net diagrams for each platonic solid. Although we encouraged students to verbalize the name of the solid as they counted the faces, edges, and vertices, post assessment clearly indicated more work was needed in this area. However, we began to see an emerging understanding of the relationships between faces and vertices as students worked with the animations.

During the third session with the online platonic solids, students were encouraged to look at relationships among the edges, faces, and vertices as they explored the platonic duals using Euler's formula and the applet Platonic Duals.

Table 4

Third Post-Assessment: Identifying Names and Characteristics of Platonic Solids

Name of Platonic Solid	Net Diagram	Faces	Vertices	Edges	Correct Responses
0	0	0	0	0	0
0	0	0	0	0	1
0	1	0	0	8	2
3	1	0	3	8	3
12	6	5	2	2	4
85	92	95	95	82	5

After 23-minute sessions in the lab, more than 90% of the students in this block were able to draw the net diagrams, recognize the shapes and number of the faces of the platonic solids, and determine the number of vertices. More than 80% of the students were able to name the platonic solids and to apply Euler's formula to determine the number of edges for each of the platonic solids. Teachers reported that the use of math and science applets increased their pedagogical and content specific skills. They also observed that applets strengthened students' visual literacy skills while revealing students' misconceptions and learning difficulties.

Comments on Targeted Areas

Seventh Grade Project-Platonic

Initially, students identified the names of the five platonic solids, the shapes of their faces, and the number of faces found in each. Students visited Math World where they rotated images and looked at net diagrams. The Platonic Solids and Platonic Duals were helpful in cultivating students' understanding of platonic solids, whereas Nets and Unfolding Polyhedra helped them understand net diagrams, and Euler's formula helped them recognize the mathematical relationship among the edges, faces, and vertices.

Students' active construction of knowledge increased as they engaged in the interactive process of identifying and manipulating edges and vertices. Platonic Duals assisted students in understanding Euler's formula $F + V = E + 2$ as indicated in the following table:

Table 5

Euler's Formula

Name of Platonic Solid	Shape of face	Number of faces	Number of edges	Number of vertices
Tetrahedron	triangle	4	6	4
Hexahedron	square	6	12	8
Octahedron	triangle	8	12	6
Dodecahedron	pentagon	12	30	20
Icosahedron	triangle	20	30	12

As students explored the concept of platonic duals, they discovered that Euler's formula enabled them to calculate edges and vertices when the number of faces is known. For example, the number of edges for hexahedra and octahedra are 12. (For the hexahedron: 6 faces + 8 vertices = 12 edges + 2; conversely, for the octahedron, 8 faces + 6 vertices = 12 edges + 2.)

Sixth Grade Projects-Factoring and Relationships among Decimals, Fractions, and Percents

Applets at Utah State provided excellent assistance for teaching factoring, comparing fractions, and relationships among decimals, fractions and percent. Our sixth-grade math teachers commented on the ease and speed with which students learned these concepts using the applets. In an independent standardized evaluation taken in spring 2006, 81% of our sixth graders mastered factorization.

Eighth Grade Projects-Three-D Visualization

Teachers liked the 3-D visualization applets: 2-D, 3-D, and house-building. Students rotated 3-D applets to determine what 2-D representations of the figure would look like from the right, left, top, and bottom. Color-coding of student responses helped teachers know how students were progressing. Immediate feedback enabled students to correct their responses and provided for deeper engagement. The MathsNet transformation site helped students learn about dilations, translations, and rotations. Teachers supplied their students with additional instructional scaffolding supported by transformation applets.

Extensions

Many teachers who were using applets in 2005 have begun writing their own curriculum and linking to several websites that contain applets. Several of the non-math teachers requested support from the technology coordinator to imbed applets within their curriculum. Use of science applets was especially effective in teaching plate tectonics: ring of fire, plate movement, ridges and zones, timeline, collisions, rocky relationships, and spreading. Science teachers also used web quests, which contained links to animations to teach about rocks and minerals. Teachers who worked collaboratively to develop these units were able to share their experiences and lessons with other science teachers in the district. We also observed a 100% increase in the use of the virtual science labs on CD-ROMs.

Summary

The two goals of our professional development model using applets were to increase student performance and to increase teacher confidence with technology. As illustrated above, we saw short-term gains as demonstrated by the pre and post assessments. We also saw long-term gains in some areas as indicated by state standardized testing. Additionally, we found that teachers' self-efficacy for classroom usage of the computer labs increased during the 2005-2006 school year as indicated by the state's self-assessment of technology proficiency administered in February 2005 and April 2006. Computer activities for students ranged from drill and skill to Internet research and the production of multimedia products.

Comparison of data from 2005 and 2006 teacher self-efficacy surveys indicted teachers were moving beyond the awareness level, the lowest level, and were currently scoring at levels three and four, the target level. During the 2004-2005 school year, 20% of teachers self-assessed their skills at the awareness level. With the 2005-2006 spring survey, no teachers assessed their skills at the awareness level. Additionally, the researchers have observed teachers being more outgoing in creating their own technology-integrated lessons resulting in more student-created multimedia projects.

Teachers responded enthusiastically to ongoing support received while integrating technology into their curriculum. This just-in-time support increased teachers' self-efficacy for technology integration and enhanced student learning. Integrating applets into the curriculum proved to be an efficient, effective way to promote student engagement, activate higher order thinking, and reduce student frustration. Teachers indicated that math applets helped their students visualize difficult concepts. In most cases, math teachers introduced the math concept of the day during classroom time. Then, non-math teachers, using applets during the mid-day sessions throughout the week, supported the classroom activities. Examination of pre-post surveys showed that students improved their understanding of math concepts after a 20-minute session of interactive engagement with the math applet. Follow-up surveys indicated that most students had retained and built upon their ability to understand the concepts that math applets targeted. Additionally, teachers reported that peer collaboration and the use of applets encouraged them to create and implement technology-rich lessons plans.

About the Authors

	**Dr. Ali Mahdi Ahmad**, associate professor of math at New Mexico State University-Doña Ana Branch Community College, has taught at middle school, high school, community college, and at the university levels. He has presented at several local and national conferences and received honors for his excellence. Awards include the Donald Roush award from New Mexico State University and National Institute of Staff Development excellence award. Email: aahmad@nmsu.edu Send correspondence to: Ali Mahdi Ahmad, Ph. D Associate Professor Department of Mathematics/Physical Sciences General Studies Division New Mexico State University-Doñna Ana Branch College (505) 527-7687
	**Jan Farnam**, a doctoral candidate at the University of Texas at El Paso, is the technology coordinator at a middle school in El Paso where she is actively involved in action research in science, math, and technology. She is a fellow with the Teacher Leaders in Research Based Science Education Program, funded by the National Science Foundation's Directorate for Education and Human Resources. Email: jfarnam@sisd.net

References

Ahmad, A.M. & Farnam, J. (2004). Constructivist principles in middle school staff development: An electronic bulletin board experience. *Meridian: A Middle School Computer Technologies Journal, 8*(1). Retrieved March 10, 2006, from http://www.ncsu.edu/meridian/sum2004/msstaffdev/index.html

Becker, H. J. (1994). How exemplary computer-using teachers differ from other teachers: Implications for realizing the potential of computers in schools. *Journal of Research on Computing in Education, 26,* 291-320. Retrieved March 10, 2006, from http://www.citejournal.org/vol1/iss2/seminal/article1.htm

Christopherson, J. T. (1997). The growing need for visual literacy at the university. In *Visionquest: Journeys toward visual literacy* . Proceedings of the International Visual Literacy Association 1996 annual meeting, Cheyenne , Wyoming . (ERIC Document Reproduction Service No. ED 408 963). Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2/ content_storage_01/0000000b/80/26/be/22.pdf

Dye, B. (1996). Three dimensions. [Computer software.]. Norfolk, England: MathsNet. Retrieved from http://www.mathsnet.net/geometry/solid/ and http://www.mathsnet.net/transform/refindex.html

Fiedorowicz, Z. (1997). Euler's formula. Retrieved February 20, 2006, from http://www.math.ohio-state.edu/~fiedorow/math655/Euler.html

Golden, M. (2004, July). Technology's potential, promise, for enhancing student learning. Retrieved August 10, 2005, from http://www.thejournal.com/magazine/vault/A4891.cfm .

Healy, J. (1998). *Failure to connect*. NY: Simon & Schuster.

Keller, B., Wasburn-Moss, J., & Hart, E. (2002, June 21). Improving students' spatial visualization skills and teachers' pedagogical content knowledge by using on-line curriculum-embedded applets. Retrieved March 10, 2006, from the National Council of Teachers of Mathematics Web site: http://illuminations.nctm.org/downloads/IsoPaperV4.doc

Labelle, F. (1999). Unfolding polyhedra. [Computer software.]. Retrieved from http://www.cs.berkeley.edu/~flab/unfold/unfolding.html

Roblyer, M. D. (2000). The national educational technology standards (NETS): A review of definitions, implications, and strategies for integrating NETS into K-12 curriculum. *International Journal of Instructional Media, 27*(2), 133-146.

Testing Data Services. (1998). Brainability: Virtual tools: samples. [Computer software.]. Retrieved March 14, 2006, from, http://www.brainability.com/index.cfm?p=17

Utah State University. (1995). National library of virtual manipulates. [Computer software]. Retrieved from http://matti.usu.edu/nlvm/nav/vlibrary.html

Weisstein, E. W. (1995). Platonic solid. [Computer software]. Champaign, IL: Wolfram Research, Inc. Retrieved from http://mathworld.wolfram.com/PlatonicSolid.html

---

Meridian: A Middle School Computer Technologies Journal
a service of NC State University, Raleigh, NC
www.ncsu.edu/meridian/
Volume 9, Issue 2, Summer 2006
ISSN 1097 9778

Email Meridian at meridian_mail@ncsu.edu