

Computers in the Classroom: Are Teachers Reluctant to Change?

電腦於教學中的運用：老師們懼怕改變嗎？

Li-Yan Wang 王麗雁

Assistant Professor / University of Cincinnati / USA

美國辛辛那提大學 藝術學院 藝術教育助理教授

Abstract

Articles describing benefits of computer-mediated learning environments filled education technology literature. Yet, ironically research studies also show that computers are not widely used in the classroom. Some identify teacher's reluctant attitude as a major reason for the slow adoption. With limited examples of how computer technologies are currently used in K-12 art classroom, the author questions the assumption that teachers are unwilling to embrace technology and argues that literature should provide more information on how computers are currently used. The paper gives an overview of twelve Ohio art teachers' cases and concludes that these art teachers use computers in three ways: as an art making tool, as a research tool, and as a communication tool. The author takes a closer look at the relationship between education technology theories and practices and calls for a more sophisticated understanding of education reform with the use of computers in teaching art.

Keywords: computer, technology, art education, america

摘 要

科技教育理論常描述將電腦運用於教學的各項好處，然而研究卻同時指出電腦仍未被普遍的運用於課堂中。有人認為這種現象該歸究於老師們懼怕改變且對電腦懷有排斥抗拒的心態。筆者認為老師們的確對教學方式的決定扮演舉足輕重的角色，然而預設立場認為所有的老師都抗懼電腦並將一切歸究於他們卻不合情理，尤其是在文獻資料中將電腦融入藝術教學的實例極為匱乏的情況下。本文作者有鑒於此提供了十二位在美國俄亥俄州幼稚園到高中美術老師的教學經驗做為參考，發現電腦在藝術創作、研究分析及溝通上扮演了許多的功能。作者同時指出理論與實務上相呼應與相抵觸的地方，提供大家在以電腦為輔的教育改革聲浪中進一步思考的方向。

關鍵字：電腦，科技，藝術教育，美國



Are Teachers Reluctant to Change?

In response to my e-mail titled “Teachers are reluctant to change?” posted at ArtsEdNet, Sheldon Turner, an elementary school art teacher, described his frustration and the need to know how to use computers in teaching art: “I have been interested in using the computer with students as part of their art education, but it has been difficult... I will change if I know how” (personal communication ◦ November 18 ◦ 1999).

With limited examples of how computer technologies are currently used in American K-12 art classrooms, I believe that the teacher’s attitude, often described as reluctant, is not a major reason for the slow adoption of the use of computers in teaching art. This paper questions the assumption that teachers are unwilling to embrace computer technology. It takes a closer look at the relationship between education technology theories and practices and calls for a more sophisticated understanding of educational reform involving computers in the art classroom.

What the Literature Claims

Many researchers believe that computer use makes possible a more learner-centered environment (Dunn ◦ 1996). Sandholtz, Ringstaf, and Dwyer (1997) compared traditional teacher-centered classrooms with learner-centered ones. They described traditional teacher-centered classrooms as didactic, with instructional emphasis on memorization and accumulation of facts; learner-centered ones were described as being interactive, with instructional emphasis on inquiry, invention, and transformation of facts. With current educational reform movements supporting problem solving, concept development, and critical thinking, technology is seen as a potential catalytic contribution to this paradigm shift. With the use of computer technology, students no longer have to learn the same thing at the same speed, at the same time as their peers. Students can be encouraged to pursue their interests, take active roles, and be responsible for their own learning (Gregory ◦ 1996).

Such flexibility and freedom, some researchers believe, challenge the existing power relationships between teachers and students (Adams ◦ 1985). Teachers would no longer be considered the sole owners of knowledge, as they would work and learn

side by side with their students (Gregory • 1995) facilitating the learning experiences. Teachers, students, and even parents can then participate in a community of learners who engage in collaborative learning processes (Dunn • 1996 ; Kozma & Schank • 1998).

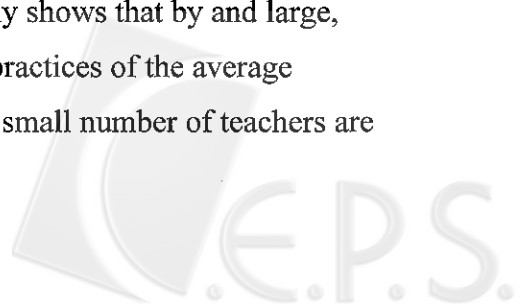
Many individuals believe that the Internet opens up a window to the world; the classroom no longer has to be confined within four concrete walls. Global communication has become a reality as students are able to access online databases, solve real-world problems (Williams et al. • 1998), transgress space barriers and communicate with experts to acquire new knowledge and skills in split seconds.

Multimedia environments that incorporate text, images, videos, animation, and sound present information in an engaging way. Greh (1997) believes that teachers who use multimedia technologies can bring content to life as they personalize material and make it relevant to students' lives. Movies, music, and visual elements can all become part of the art learning process as opposed to traditional black and white handouts. Nonlinearity -- a concept used in Internet and multimedia design -- takes advantage of the complexity of the human brain and individual learning styles (Sewell • 1990). For this reason some believe it to be a better strategy for presenting information to students than a more traditional linear method. Gregory (1997), for example, argues that the human mind does not think in linear terms. Rather it operates through a multitude of pathways linked by meaningful, interesting, and even illogical associations. Nonlinear instructional technology “fits the specific needs of a wide range of individuals with a variety of learning styles and rates” (p. 138).

Last but not least, a key feature of computer technology is interactivity. Sewell (1990) believes that the computer is the only teaching medium that possesses such potential. He believes that interacting with computers promotes more active learning among students of all ages and abilities.

Why Computers Are Not More Widely Used in Classrooms?

Although the claims regarding the positive impacts of computer technology on education are abundant, the education literature ironically shows that by and large, computers have not been fully integrated into the daily practices of the average classroom. Plomp (1996) observes that only a relatively small number of teachers are



currently using computers for instructional purposes. "The types of use are not very advanced, not using the full potential of the new technologies" (Plomp , 1996 , 128). In comparison with 1996, the computer hardware and software costs have significantly dropped, and more teachers are now able to use computers for instructional purposes. Yet, questions remain concerning the extent to which the potential of computer technology is being realized.

Why is computer technology not being used more creatively in most classrooms? Lack of equipment, training, funding, professional development, and administrative support are reasons that researchers and teachers have identified. In addition, several researchers argue that teachers are the ones to be blamed.

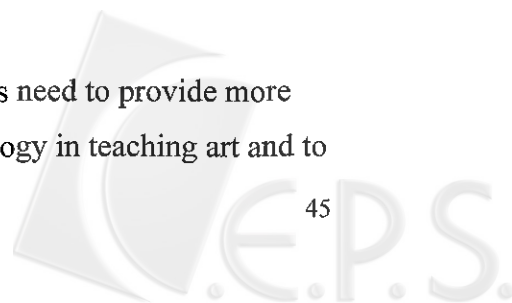
Gregory believes that "teachers - including art teachers - have been reluctant to embrace the promise of this new technology"(10). This viewpoint, Lai (1996) thinks, is perhaps because teachers "are not willing to give up their control," feeling threatened by the new relationship of teaching and learning. Evans-Andris (1996) similarly noted that "the supply of computers prior to its demand by teachers generated anxiety, feelings of encumbrance, and hesitation among teachers"(13).

Although the image of student-centered classrooms, global communities, and active student inquiry made possible by the use of computer technology sounds appealing, living up to such high expectations is certainly not easy. When reality fails to meet expectations, teachers receive the blame. Diane Rosikins, another art teacher, describes the frustration this way: " I feel teachers are given very little time to train in new areas and are expected to pick things up on their own" (personal communication , November 18 , 1999).

Just as Rosikins reported, although compelling visions are provided in the literature without much practical guidance, teachers are often expected to find their own ways of achieving these goals. While limited examples of how computer technology can be used in the K-12 art classrooms are provided, art teachers continue to be blamed as reluctant to change or unwilling to give up their control.

Need for Detailed Accounts of Computer Use in Art Classrooms

Instead of blaming teachers, I believe that researchers need to provide more convincing examples of successful uses of computer technology in teaching art and to



explain in detail how computers can be used for specific goals in specific situations in the art discipline. More and better research is needed (Trotter , 1998). Trotter believes that "A more-nuanced discussion of classroom technology - one that emphasizes the circumstances under which it is most effective - is long overdue" (Trotter , 1998 , 7). Stokrocki (1997) similarly notes that not much is known about those teachers who are using electronic technology in the classrooms. With existing studies largely focused on subject areas such as math, reading, and writing, the use of computer technology in art teaching is largely ignored.

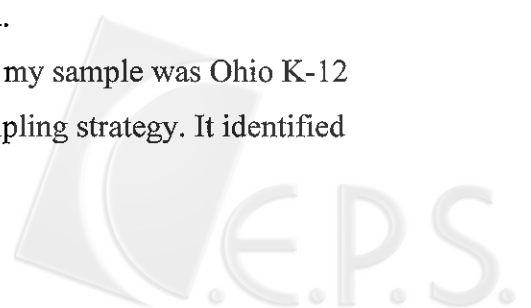
This paper takes a closer look at theories and practices of computer-mediated art instruction in Ohio, the United States of America. From a practical perspective, it is written for teachers who are enthusiastic, but frustrated about using technology in their art classes. Rather than having an expert tells them what to do, I hope to offer, by providing an overview of twelve of their colleagues' experiences, useful and practical information that can help them in their teaching praxis. I also hope my study will generate further communication, reflection, and debate among art educators and researchers about the merits and efficacy of computer use in art classrooms.

Methodology

My primary data gathering took place through interviews with twelve art teachers in Ohio. In order to provide breadth in my findings, I employed a multiple site or collective case study method (Stake , 1994). The cases were similar and yet different in various ways, but each one of them was also unique, influenced by the particular teacher, his or her vision, and the circumstances in which they taught.

As a researcher, I situate myself in the interpretivist/constructivist paradigm. I subscribe to some assumptions about the nature of knowledge and reality that underlie my research. Realities are mostly socially constructed. Knowledge is created in interaction between the researcher and the research participants. Therefore, my role as a researcher must be more of an orchestrator and facilitator of the inquiry process (Guba & Lincoln , 1994), rather than as an outside expert evaluating successful computer use against some nominal "objective" standard.

The population of art teachers from whom I drew my sample was Ohio K-12 art teachers recommended to me through a snowball sampling strategy. It identified



cases of interest "from people who know people who know people who know what cases are information-rich, that is, good examples for study, good interview subjects" (Patton , 1990 , 182). In all, thirty art teachers were identified as potential participants. From this group, twelve art teachers were selected for more in-depth interactions. The criteria used in the selection included: Each art teacher was recommended to me at least twice; each art teacher indicated an interest in participating in my study; each teacher had some experience using computer technology in his or her teaching; each teacher's school system provided sufficient technology support so he or she felt that his or her general needs were being met, and the school environment was not so limiting that it created impediments to teaching. Diverse uses of computer technology in teaching art were, to the greatest extent possible, represented among the chosen cases.

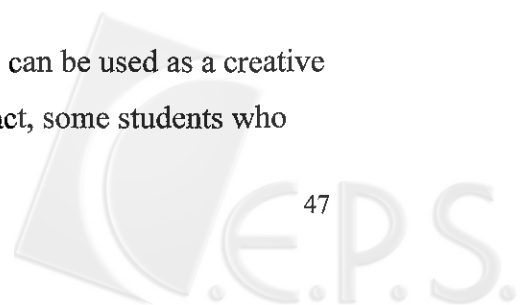
Data was collected using a variety of strategies: classroom observation; open-ended, in-depth interviews with participants; informal conversations with students; examination of artifacts such as written information about particular schools; study of curriculum materials; course syllabi; students' work; e-mail correspondence with participants; and my own research journal.

Cross-Case Findings

Based on my observation of the twelve cases, art teachers use computers in art classrooms in three ways: as an art making tool, as a research tool, and as a communication tool. In the following section, I compare my findings with existing research in order to find the commonalties and discrepancies. On the one hand, the art teachers with whom I worked in part, actualized predictive visions of possible uses for computers in the art education context provided in the literature. Noticeably, these teachers arrived at these ways of teaching primarily through self-study, persistence, and risk-taking, rather than through pre-service teacher training. On the other hand, I discovered that some of the suggestions provided in the literature have yet to be partially or fully implemented.

An Art Making Tool

Some art educators believe that computer technology can be used as a creative tool (Dunn , 1996 ; Freedman , 1989 ; Greh , 1986). In fact, some students who

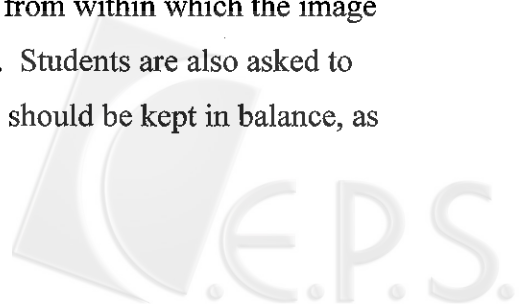


believe themselves incapable of drawing have stated that computers turn them artists (Freedman , 1989). This conclusion may be due to the fact that these students are able to experiment more easily on the computer than is common in other media (Freedman , 1989 ; Greh , 1986).

Taking risks or experimenting with modifying images, an essential step for art creation, is difficult for some learners. In traditional art-making activities, it can be intimidating for students to make what they believe to be errors. In the electronic art environment, students of all ages are reported to have a greater willingness to “make mistakes” or enlarge upon the “happy accident” than when they are using non-computer based media (Freedman & Relan , 1992). This sense of confidence-building and spirit of experimentation that comes with the use of computer technology as an artistic tool may help students’ understanding and appreciation of the process of artistic creation.

The art teachers who participated in my study have explored some of the possibilities of computers as tools for artistic creation and production. Among the various possibilities, the most common use was for creating computer graphics. In high schools the most widely used graphics program was Photoshop. Micah and Hilary, two teachers who participated in my study, teach computer graphics classes that are specifically designed to use the computer as an artistic medium. Two other art teachers, Gary and Cheryl, include computer graphics in their regular art curricula. Their students are asked to create computer-mediated images, as well as critique and redesign advertisements. In addition to graphics, Gary’s and Micah’s students also create animation. Bessie has her fifth grade students use a multimedia program to retell their families’ histories. Over-all, these teachers regard computer-mediated images as a valid art form, whether they teach a separate computer graphics class or include the medium in general art classes.

In terms of instructional strategies, Hilary, a high school art teacher, developed the Hozho Balance Circle Project to explore concepts of harmony and balance. Her students choose a specific artwork from a particular cultural group. Take Navajo, a Native American group, for example. After exploring the characteristics and meanings of the work and researching the cultural group from within which the image originates, the students present their findings to the class. Students are also asked to reflect upon the major factors in their own lives they feel should be kept in balance, as



well as on the major factors they need to consider and keep in balance as members of the world community. Students then create graphic designs that incorporate the cultural symbolism that reflects their ideas of personal and community balance.

It is a source of frustration for these art teachers, however, that other people do not regard computer-mediated artworks, especially computer graphics, as valid forms of artistic expression. Hilary talked about the low level of acceptance of computer graphics in local and national student art competitions. The skeptical attitude of one of Ingrid's colleagues, who believes that photography and computer graphics are not art, also makes Ingrid, a high school photography teacher, uncomfortable. Another example of frustrations mentioned by Ingrid focuses on one of her Advanced Placement students. This student, who is very interested in digital media, created a series of artworks on the computer. While Ingrid is supportive of the student's interest, she is also concerned that the student's work will not be considered valid or strong by judges. Two art teachers, Micah and Hilary, feel that students are more receptive to thinking of computer graphics as legitimate art than adults are. Despite this challenge, the art teachers in my study continue to integrate computers in their teaching, encouraging students to explore the potential of making art using computer technology.

I did not find, however, spontaneous discussion among my research participants on the impact of computer technology in art. Freedman (1997) argues that the formation of, and debate about, aesthetic questions is a necessary aspect of teaching about technology-based images. Such questions constitute an important part of helping students become critical thinkers about their works and the domains of art in general. Given the relatively brief history of using computers as art tools, answers to these questions are still evolving, not just in schools, but in the larger communities. Such questions as: What is a work of art? What makes a work of art valuable? How does computer technology challenge our previous assumptions about art? Who is the artist? What roles do software designers play in creating digital art? How should computer graphics be displayed? What are the unique qualities of computer-mediated images? Finally, how should these images be judged? These questions invite creative thinking and rich discussion in the classrooms.

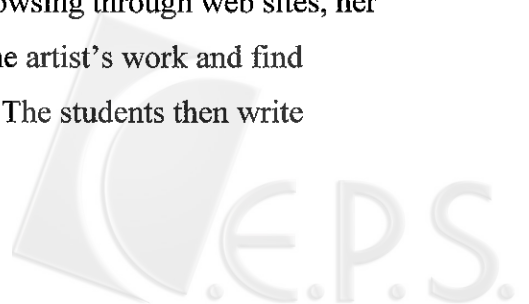
A Research Tool

In addition to assisting in the art creation process, computer technology can be used as a research tool (Dunn ◦ 1996). The technology-mediated learning environment provides for a level of visualization not possible with traditional media. In the multimedia environment, a vast number of artworks can be studied in interdisciplinary contexts enhanced by the simultaneous use of audio, text, animation, video, and graphics. Students can explore resources that are relevant to their own interests, and they can access information which is presented in engaging ways. Thus, it is possible for students to assume the role of active and independent inquirers, rather than only a role of passive knowledge receiver. By using computer technology as a research tool, students can pursue their own interests, looking for information from other sources than those their teachers present to them, thereby being responsible for their own learning (Gregory ◦ 1995).

The Internet and CD-ROMs give students access to art exhibitions, and information about artists, artworks, and museums that would otherwise be difficult to locate or be unavailable to them in print, slide, or poster format (Koos & Smith-Shank ◦ 1997). Online discussion groups provide a means to confer with others in the process of analyzing meanings and exploring methods. "In what seems like the blink of an eye," Dunn (1996) observes that the role of teachers has "evolved into functioning as facilitators who can point students toward information that will lead them to new knowledge" (p.9). Dede (1998) similarly suggests that students should use computers to search out and sort vast amounts of information, generate and analyze new data, articulate meanings, and transform their own thinking and understanding.

The art teachers in my study do have students use computer technology as a research tool. Angela's elementary school students, for example, use *With Open Eyes*, *Van Gogh*, and *Leonardo Da Vinci* to learn about artists and their works. They explore CD-ROMs at their own pace and engage in interactive activities provided on them.

Another common use of computer technology for research is as a method for locating information about particular topics. For example, Cheryl's students are asked to conduct online research on artists of their choices. Browsing through web sites, her students must download at least three digital images of the artist's work and find information about the artist and his or her specific style. The students then write



reports that include these images, their critiques of them, and interesting facts about the artist and artwork. The research project serves as a foundation for a studio activity in which the students each design a set of placemats, a cup, and a bowl that reflects his or her understanding of the artist's style. People within and outside of the school community are eventually invited to attend a special gathering in which the students present their works and during which students raise funds to be used to help homeless people or others in need in their communities.

Cheryl, Francis and Hilary have students conduct research and write art reports using computers to access information. Over-all, they felt that their students enjoy using CD-ROMs and the World Wide Web. Although the students are given freedom to choose an artist or artwork to investigate, they are not usually asked to generate their own research questions. During my observations, it became apparent that this research process is primarily teacher-directed. Cheryl and Hilary, for example, provide handouts and questions to their students. These work sheets serve as a starting point. Often the students just fill in the blanks and report back what they have read without offering further analysis or interpretation. It is true that when the students write their reports, the process involves a certain amount of locating, analyzing, and transforming available information, as described by Dede (1998). However, when the students' only roles are to answer teachers' questions and to report back what they have read on the Internet, it is questionable if the full potential of active learning facilitated by the use of Internet is explored.

A Communication Tool

The use of computer technology supports discussions, debates, and collaborative efforts without the necessity of people being in the same physical place, thus enabling the interconnection of communities of learners. Students, as well as teachers, are able to converse and collaborate with others all over the world. Technology, in other words, becomes a medium that facilitates the formation of global learning communities. Classrooms extend beyond four concrete walls. Students can participate in on-line conversations as they articulate their points of view and reflect on perspectives provided by their conferees. The use of on-line discussion, emails, chat rooms, and computer conferences do not necessarily replace face-to-face real-life interactions. Still, these experiences can support learners in unique ways as they engage in reasoned dialogue, collaborate with remote and diverse audiences, and

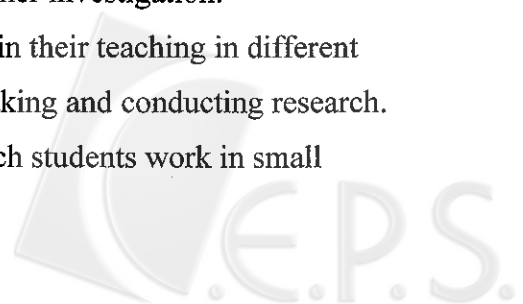
learn to express themselves (Jonassen , Peck & Wilson , 1999). Dede (1998) suggests that digital technologies can be used to interweave schools, homes, workplaces, libraries, museums, and social services to reintegrate education into the fabric of community.

Two teachers, Elbert and Irene, make good use of the communication potential of the Internet. They are instructors for online courses, and they use technology to engage their students in collaborative learning, even though students and teachers are physically remote from each other. Their students come from a variety of locations and diverse backgrounds. Through the Internet, these students are able to communicate with and learn from one another through email exchange. Irene commented that the distance learning course has helped her move from a traditional, lecture format of teaching to a more collaborative and communicative one which students respond well.

However, most of the other art teachers with whom I worked have not explored the potential of online discussion, emails, chats, and computer conferences in their works with students. Some of the teachers do, however, use email for personal communication, but no collaborative projects that involve students and teachers at other locations were discovered during my research.

I asked Ingrid and Micah what they thought about starting a collaborative project with teachers and students at another geographic location. Both of them said they felt that it was a good idea, but it was not what they were particularly interested in doing at that moment. Ingrid's concern is that she does not know with whom to work. It would be important for her to know the other person and to build a trusting relationship with him or her before starting such a project. Micah agreed, saying that to have an online dialogue with living artists is fine, but he feels that high school students may not be able to carry on a sensible dialogue for long. Micah observed that students are often silent when guest artists visit the classroom; consequently he suspects that long-term collaboration with others would not work well. In thinking about Micah's point of view, it occurred to me that students who are usually silent in the classroom might feel more confident about asking questions of unfamiliar people on the Internet. Perhaps this is a direction worthy of further investigation.

In general, art teachers use computer technology in their teaching in different ways, but computers are most commonly used for art making and conducting research. There are also few cases of collaborative projects in which students work in small



groups for problem solving, or communicating with people outside the school community.

Teachers' teaching goals, and their personal beliefs in art, technology, teaching and learning, seem to influence their attitudes toward and use of computer technology. Eleven out of the twelve teachers feel that the use of computer technology does not change drastically their teaching styles and beliefs.

Implications

The study yields the following implications. First, there are inconsistencies between the educational literature and what I observed in current teaching praxis. The use of computer technology, for example, does not revolutionize the classroom situation, as some of the technology advocates have suggested. On the positive side, this means that the use of computer technology has not driven the curriculum. Teachers are still the ones in control of how they use computer technology. However, the fact that the new media does not change teachers' teaching goals or beliefs raises some questions. It is possible that some teachers only use computers to do what older media do. The use of computer technology does not challenge their assumptions about art, teaching, and learning, and they fail to recognize the unique qualities and full potentials of computer use. It is also reasonable to speculate that the revolutionary benefits of computer technology in teaching and learning may be over-stated in theories. A closer relationship between theory and practice needs to be established.

Second, although all twelve teachers agree that the computer is an important tool, not all agree that technology use is essential in art foundation courses. One teacher even argues that students should not use computers prior to 7th grade or after they have a solid foundation in traditional media. Issues raised about the use of computer technology in teaching art lead us to rethink the questions of basic in art education. Should the basics of art education include computer technology? And how and when should computer technology be included?

Third, gender is an issue that needs further investigation. A growing body of research studies indicates that gender differences exist in computer use (Freedman , 1997). The literature suggests that most boys and girls have positive attitudes toward computing, but the girls' attitudes are less positive than those of boys (Huber &

Schofield ◦ 1998). Boys have more access to computers at home and at school. Where computer programming is offered, more boys take the subject than girls (Scott ◦ Cole & Engel ◦ 1992).

A report of the American Association of University Women (AAUW) Educational Foundation in 1998 reviewed nearly 1000 studies, and confirmed that there is an alarming and deepening technological divide between girls and boys, although girls are catching up to boys in mathematics and science. The report showed that both inside and outside of school girls of all ages tend to have less exposure to computers and to say they feel less confident about using them, compared with boys (Viadero ◦ 1998). Weinman and Haag (1998) observe, "Girls are significantly more likely than boys to enroll in clerical and data-entry courses, the 1990s version of typing" (p. 44). Although the Internet is attracting more women, the users of more powerful areas of the Net are still 85 percent men (Tarlin ◦ 1997).

These troubling findings serve as a good reminder. Yet, to my surprise, the teachers that I talked to, except for Hilary, say that they do not think there are gender differences. The comment "Oh! Here is the gender biased question" was made when I asked one of the teachers if he observed any difference in terms of attitude and uses of the computer between male and female students. Several teachers, Micah, Cheryl, Ingrid and David, commented that male and female students face difference career choices in life. They all agree that there is gender inequity in life but not necessarily in computer use. Cheryl commented that the gender issue is a big one. Yet in their own classrooms, the teachers have not noticed any gender differences.

Ingrid describes herself as an advocate for girls, and is interested in reading studies that report gender inequalities in the computer use. Puzzled by the issue, Ingrid comments that "some boys are just as clueless" using computers, while some girls seem more confident and more efficient than boys do. One possible explanation for Ingrid is that "male students know how to hide it better." She recalls one incident where she required students to use a power saw. Female students were more vocal in expressing their uncertainty and unfamiliarity of the equipment while the boys pretended to be in control, although their facial expressions indicated otherwise.

Is the literature wrong or are teachers not sensitive enough to notice a subtle difference? I have mixed feelings. On the one hand, I noticed that one of the computer graphics classes had fourteen male students and one female while a data processing

class in the same school had dominantly female students. I also had several female students tell me that they are not interested in using computers.

On the other hand, some girls, as their teachers describe, are very interested and very proficient in computer use. When students were asked if there are gender differences, the response was no because some of their female friends or family members are interested in computers. If these observations are true, why does existing literature strongly suggest otherwise? Further research on the gender issue is clearly needed.

Limitations and Significance of the Study

The focus of this study was to begin the exploration of how K-12 art teachers in Ohio are really using computers in their teaching, to provide contextual information about that use, and to offer useful insights on specific strategies for the productive integration of computers into art teaching. This focus is in contrast to the body of literature that speculates upon how computers might be useful in teaching art. At this point in time, it seems premature to offer generalizations about when and how American art teachers are using computer technology. However, there are some teachers who are successfully integrating computers into their pedagogical strategies. It is possible to study such occurrences as one way to help the wider art teaching community begin to take advantage of the particular characteristics of computers in their teaching. By observing and understanding what is and is not working well, I hope to provide inspiration and support for art teachers to advance their educational purposes. With the rapidly changing nature of computer technology, studies that investigate the art teacher's computer use should also be continued and expanded beyond Ohio teachers.

Reference

- Adams, D. M. (1985). *Computers and teacher training: A practical guide*. New York, NY: The Haworth Press.
- Bromley, H. (1998). Introduction: Data-driven democracy? Social assessment of educational computing. In H. Bromley & M.W. Apple (Eds.), *Education/technology/power: Educational computing as a social practice*, 1-25. Albany, NY: State University of New York Press.
- Dede, K.(Ed.). (1998). *Learning with Technology: 1998 ASCD Yearbook*. ASCD.
- Dunn, P.C. (1996). More power: Integrated interactive technology and art education. *Art Education*, 49 (6), 6-11.
- Evans-Andris, M. (1996). *An apple for the teacher: Computers and work in elementary schools*. Thousand Oaks, CA: Sage Publication.
- Freedman, K. (1989). Microcomputers and the dynamics of image making and social life in three art classrooms. *Journal of Research on Computing in Education*, 21 (3), 290-298.
- Freedman, K., & Relan, A. (1992). Computer graphics, artistic production, and social process. *Studies in Art Education*, 33 (2), 98-109.
- Freedman, K. (1997). Visual Art/Virtual Art: Teaching technology for meaning. *Art Education*, 50 (4), 6-11.
- Gregory, D.C. (1995). Art education reform and interactive integrated media. *Art Education*, 58 (3), 6-16.
- Gregory, D. C. (1996). Art education reform: technology as savior. *Art Education*, 49 (6), 49-54.
- Gregory, D. C. (Ed.). (1997). *New technologies in art education: Implications for theory, research, and practice*. Reston, VA: National Art Education Association.
- Greh, D. (1986). Using computers in secondary art education. *Art Education*, 39 (6), 4-9.
- Greh, D. (1997). New technologies in the art classroom. In Gregory, D. C. (Ed.), *New technologies in art education: Implications for theory, research, and practice*, 13-22. Reston, VA: National Art Education Association.
- Guba, E.G., & Lincoln, Y.S. (1994). Competing paradigms in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research*, 105-117. Thousand Oaks, CA: Sage.



- Huber, B. R. & Schofield, J. W. (1998). "I like computers, but many girls don't": Gender and the sociocultural context of computing. In Bromley, H. & Apple, M. W. (Eds). *Education/Technology/Power*. Albany, NY: State University of New York Press.
- Jonassen, D., Peck, K.L., & Wilson, B.G. (1999). *Learning with technology: A constructive perspective*. Upper Saddle River, NJ: Prentice Hall.
- Koos, M., Smith-Shank, D.L. (1997). The world wide web: Alice meets cyberspace. *Art Education*, 29 (6), 19-24.
- Kozma, R. & Schank, P. (1998). Connecting with the 21st century. . In C. Dede (Eds.) *Learning with technology*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Lai, K.W. (1996). Living in the information age. In B. A. Collis et al. (Eds.), *Children and computers in school* 121-123. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
- Patton, M. (Ed.). (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage.
- Plomp, T. J. (1996). Future directions for IT in education. In B. A. Collis et al. (Eds.), *Children and computers in school* 124-130. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
- Sandholtz, J.H., Ringstaff, C. & Dwyer, D.C. (1997). *Teaching with technology: Creating student-centered classroom*. New York, NY: Teachers College Press.
- Scott, T., Cole, M., Engel, M. (1992). Computers and education: A cultural constructivist perspective. *Review of Research in Education*, 18, 191-251.
- Sewell. D. F. (1990). *New tools for new minds: A cognitive perspective on the use of computers with young children*. New York, NY: St. Martin's Press.
- Stake, R. (1994). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* 236-247. Thousand Oaks, CA: Sage.
- Stokrocki, M. (1997). How an art teacher instructed students with discovery-based electronic technology. In D. C. Gregory (Eds.), *New technologies in art education* 95-106. Reston, VA: The National Art Education Association.
- Tarlin, E. (1997). Computers in the classroom: Where are all the girls? *Harvard education letter focus series, technology and schools*, 3.

- Trotter, A. (1998). A question of effectiveness. *Technology Counts' 98: Putting School Technology to the Test. Educational Week, 18* (5), 6-9.
- Viadero, D. (1998). AAUW study finds girls making some progress, but gaps remain. *Education Week, October* (14), 9.
- Walker, S. (1997). Postmodern theory and classroom art criticism: Why bother? In J. Hutchens and M. Suggs (Eds.). *Art education: Content and practice in a postmodern era*. Reston, VA: National Art Education Association.
- Weinman, J. & Haag, P. (1998). Gender Equity in cyberspace. *Educational Leadership, 56* (5), 44-49.
- Williams, S. M., Burgees, K. L., Bray, M.H., Brandsford, J.D., Goldman, S. R. (1998). Technology and learning in schools for thought classrooms. In C. Dede (Ed.), *Learning with technology*. Alexandria, VA: Association for Supervision and Curriculum Development.