Journal of Research on Computing in Education
Volume 33 Number 5 Summer 2001

Multimedia in the Classroom
Its Effect on Student Writing Ability

Huey-Ling Fan
Chung-Yu Junior College of Business Administration

Michael Orey
University of Georgia

Abstract
This article presents a study regarding the implementation of a constructivistic approach to using multimedia technology in two advanced language arts classrooms in a public middle school. Because the principal content consisted of written material, we examined pre- to posttest improvement in writing ability as measured by trained raters of essays. In the first experiment, we found significant improvement in student writing abilities after participation in the multimedia writing project. In the second experiment, we attempted to account for procedural variables present in our first experiment. As a result, data collected from the second experiment indicate that our initial finding of significant improvement was likely because of flaws in our study methodology. Though we still feel our approach is legitimate, looking for short-term gains in writing ability seems somewhat optimistic.

Since the introduction of the computer into composition instruction in the late 1970s, many writing researchers have been studying how the computer can be used effectively to teach composition. According to national educational surveys such as the 1983 “School Uses of Microcomputers” and the 1985 “Second National Survey of Instructional Uses of School Computers” (as cited in Becker, 1991), computers in the schools have been used primarily for drill and practice, educational games, and for teaching students about computers themselves. However, based on data from the 1989 IEA Computers in Education survey (as cited in Becker), there have been increasing efforts to use computers as productive intellectual tools, especially in middle and high schools. In light of how computer usage has evolved, Becker concludes that, in addition to software, teachers also need models, examples, and detailed instructions on how to help their students improve the quality of their written expression using computers.

Ambron and Hooper (1988) defined multimedia as “the innovation of mixing text, audio, and video with a computer” (p. 5). Technologically, multimedia, also known as hypermedia or hypertext, is the latest instructional innovation to be proclaimed as the solution to the problems that plague education in the United States. Such bold promises have been made before (Cuban, 1990), and certainly few can seriously think that interactive multimedia or digital technologies alone will save schools. Nevertheless, multimedia is a reality, and its potential in education must be thoroughly investigated.

One potential use of multimedia in the classroom involves engaging students in the construction of their own multimedia learning environments. This approach can be an integral part of a general transition from a transmissionist instructional system in which students are passive recipients of information to a constructivist one in which students actively and collaboratively synthesize knowledge and express it in extrinsic ways (Brown, Collins, & Duguid, 1989; Duffy & Jonassen, 1992). Several educational theorists believe that involving students in the construction of multimedia projects has considerable potential for improving their creativity, problem-solving abilities, and even their knowledge and skills in specific subjects such as reading, writing, and mathematics (cf., Nix, 1990; Schank & Jona, 1990; Soloway, 1993). Although little empirical evidence exists to support these claims, the anecdotal evidence reported is compelling. As Nix describes,

one can watch the children as they work on these projects … the students are involved with more of their personalities. They more directly own what they are doing, both in terms of the cognitive and the affective elements. It has in general been shown that the deeper the processing of information, and the wider the range of types of processing, and the greater the motivation and sense of ownership, the greater the impact. (p. 161)

The purpose of this study was to examine the constructivist use of multimedia technology to improve students’ writing performance in a language arts classroom in a public middle school. A review of the research on the use of multimedia in constructivist learning environments provides its context.

As computer technology matures, students are increasingly able to combine different multimedia objects such as video clips, still images, sound, graphics, and text to express their thoughts explicitly. Akin to the constructivist viewpoint, this trend has caused students to become knowledge composers, rather than knowledge consumers (Harel, 1991; Kafai, 1995; Pea, 1991).

Pea's (1991) study of eight adolescents in a boys' club indicates that it is possible to make multimedia composition accessible to middle school students. The participants not only learned the subject matter but also developed effective communication skills. Pea gives several reasons that various multimedia objects can play an important role in both developing student understanding and in conveying knowledge to others. Multimedia is less restrictive than written text and more similar to face-to-face communication. It can place abstract concepts in a specific context (for example, refraction in physics might be depicted in a file of lens and light behavior). It allows for individual differences as to which sensory channels are preferred for learning, and it enables the coordination of diverse external representations, with distinctive strengths, from different perspectives.

In an early print-based project, Woolsey (1991) originally intended for students to elaborate on existing print documents by adding multimedia elements. However, the end result was much more dramatic. In the Mystery of the Disappearing Ducks project, a group of high school students created multimedia products for their peers and learned quite a bit about ecology in the process. This led Woolsey and his colleagues to view the project as a model of how creating a multimedia product could be used to learn specific content. Moreover, they found that self-expression enhanced the students' learning experience. Woolsey concluded that "people find well-designed multimedia presentations engaging, imaginative, and useful, both as viewers and participants" (p. 38).

Kearsley (1988) states that hypermedia creators are required to think hard about the structure and organization of the information. This view is supported by Jonassen (1993), who found that those who learned the most from the instructional design process were the designers. Although their purpose was to present information explicitly to the learners, hypermedia designers came to develop a deeper understanding about the subject matter. Trollip and Lippert (1987) also observed that developers who were constructing expert systems gained more knowledge in the content areas. Such findings have inspired many researchers to place young students in the role of designers (Harel, 1991; Kafai, 1995; Pea, 1991; Woolsey, 1991) or knowledge engineers (Churcher, 1989; Farrow, 1993) and suggest that placing students in such roles creates a powerful learning experience (Jonassen & Reeves, 1996).

Farrow (1993) investigated the effects of constructing HyperCard (1987–1998) stacks based on students' cognitive skills. Problem-solving and critical-thinking abilities have been reported as the main features of knowledge-engineering (Starfield, Butala, England, & Smith, 1983; Trollip & Lippert, 1987). In Farrow's study, 32 college students were required to produce HyperCard stacks and tutorial presentations. Forty-eight percent of the students "thought about information differently, that is they linked, categorized, systematized, and organized information" (p. 11). The results indicate that HyperCard may prompt students to think and organize information more thoroughly.

Lehrer (1993) conducted a similar study, with the most striking finding being "the degree of student involvement and engagement" (p. 209). In the Lehrer study, 10 eighth-grade American history students were involved in creating multimedia projects about the Civil War using a hypermedia authoring system developed by Lehrer called HyperAuthor. One year later, these 10 student designers were found to outperform their peers in matters related to their Civil War coursework. This suggests that involvement in the creation of multimedia learning projects improved the participants' conceptualization and retention skills. Based on Papert's (1980) constructionist views and Perkins' (1986) knowledge as design pedagogy, Harel (1991) conducted an exemplar experiment to implement the Instructional Software Design Project and assess the cognitive processes of child designers. Seventeen fourth-grade students played the role of instructional designers by creating an instructional program using Logo to teach third-grade students about fractions. The student designers' performance on fractions and programming skills was significantly better than the two control groups in this study. Kafai (1995) conducted a study similar to Harel's, the only difference being that the fourth-grade student designers in Kafai's study created a game, rather than an instructional program, to teach fractions to the third graders. Although the game makers' performance on fractions and programming skills was lower than Harel's design group, they still scored higher than the other two control groups. Herman (1988) conducted a study to evaluate the effectiveness of the Apple Classroom of Tomorrow (ACOT) in which he observed "the improvement in both the quality and quantity of students' writing resulting from the ACOT experience" (p. 1). The results reported by Harel, Kafai, and Herman confirm the effects of learning through technologically based design activities.

An article in the *Multimedia Today* magazine in January–March 1995 suggests that "Multimedia [is] for [e]veryone" (Multimedia for Everyone, 1995). It reported a successful implementation of multimedia authoring across the curriculum at the Exeter-West Greenwich (EWG) Junior/Senior High School in Rhode Island. With a few weeks of training in an authoring language. students at EWG, ranging from 7th to 12th grade, started to create multimedia projects and then presented them to their classmates (Multimedia for everyone). The most dramatic finding from the multimedia authoring study was that the school dropout rate decreased to 4%—a 90% drop in less than three years. Teachers were amazed by what students had accomplished in a short period of time. They reported that "students really fly with the technology" and that "students not only learned research and presentation skills—they also learned how to work together as a group toward shared goals" (p. 56).

Recent research into brain hemisphericity suggests that left-mode thinking is associated with verbal and linear reasoning and right-mode thinking is related to imagistic and visual perception (Fortune, 1989). Edwards (1979) argues that schools only emphasize the left-hemispheric mode of thinking, and that "the right brain is lost in our school systems and goes largely untaught" (p. 37). Because students in the extremely verbal group in his study are blind to certain aspects of problem solving, Adams (1986) concludes that neglecting visualization in school has limited a student's problem-solving abilities. Fortune, therefore, stressed that "more needs to be done in developing ways to work [the right brain] explicitly into writing instruction for students at all grade levels" (p. 152) and that the computer is the best tool to achieve this goal because of its ability to blend both verbal and visual representations.

Integrating the computer into composition instruction has been demonstrated to have positive effects on both the quantity and quality of student writing (Glynn, Oaks, Mattocks, & Britton, 1989; Robinson-Staveley & Cooper, 1990; Williamson & Pence, 1989). Moreover, multimedia elements such as video, graphics, sound, and photographs are crucial components in motivating students to engage in active learning (Lehrer, 1993; Pea, 1991; Woolsey, 1991). As computer technology has advanced, constructivism offers a complementary model for integrating its use in more sophisticated ways. Wigginton (1985), the founder of the *Foxfire* project, reminds us of a crucial principle of education that has generally been ignored to date: "you don't learn basics by memorizing the basics, but by doing projects (or creating products) where the basics have to be utilized" (p. 208). From the constructivist viewpoint, knowledge is constructed actively and often collaboratively by individuals rather than transmitted by a teacher (Brown et al., 1989; Vygotsky, 1978).

Research regarding the creation of multimedia writing projects in collaborative learning environments needs to be further explored. Most studies, based on a learning-by-design approach, have required students to spend time learning programming skills with complex software languages such as Logo (Harel, 1991; Kafai, 1995), and programs, such as HyperCard (1987–1998; in Farrow, 1993), or HyperAuthor (Lehrer, 1993). This has certainly increased the difficulty of implementing projects in an already tight school curriculum. The authoring software used in this study was fairly easy to master, so students were better able to concentrate on expressing their knowledge and thoughts effectively. The research question explored in this study was "What effect does participation in a multimedia writing project have on a student's writing skill?"

Methodology

The first experiment reported in this article was performed without a control group. The second experiment replicated the original but also included a control group.

Experiment 1

Sample

The subjects for this study were 20 seventh-grade students randomly selected from two advanced language arts classes in a public middle school located in the southeastern United States. These students represented the top 41% of the entire seventh grade in the school. On the first day of the project, the students were asked to write down three choices of partners. After the class was dismissed, the teacher and the researcher paired the students based on the preferences they had submitted. The researcher then randomly selected five pairs per class (a total of 10 pairs) to participate in the multimedia writing project.

Research Site

The 10 multimedia groups shared the classroom with classmates who were not participating in the study. Students used four 486 MS-DOS desktop computers with 170 MB hard drives and 8 MB of RAM and one Power Macintosh 5200 LC computer with a 500 MB hard drive and 16 MB of RAM. ClarisWorks (now AppleWorks, 1991–1998) was installed on all four MS-DOS computers. Likewise, there were various other multimedia software and tools to convert analog video source to digital data, to convert video source to digital data, and to capture photographs.

Research Design

The quantitative approach for the original study was a one-group pretest and posttest design. The independent variable was the multimedia treatment. The dependent variable was achievement, as defined by the quality of students' written pre- and posttest essays. The research hypothesis was: the rating of the quality of the student's written essay between the pretests and posttests of those who participate in the multimedia writing project will not be significantly different.

Research Procedures

On the first day of this study, the multimedia writing project was introduced to the students. It was explained that the final projects would be pressed on a CD-ROM, uploaded to the Internet, and presented at an international conference. Student participants were paired into 10 groups, given an opportunity to select their topic, and then given a pretest. The pretest consisted of having the students write an essay discussing what each of them would like to learn from the multimedia writing project.

Each of the 10 multimedia pairs worked at one computer to create a multimedia writing project. They worked in 45-minute segments five days each week for one school grading period (six weeks). The researcher and teacher provided instruction, learning guidance, and materials to support student planning, development, and revision efforts during this same six-week period. On the last day of this study, all students were required to turn in their final writing project and write the posttest essay about what they had learned. The final products created by the multimedia groups were evaluated and included as a part of their language arts final grade. To get an idea of the kinds of projects produced by these students, go to http://lpsl1.coe.uga.edu/OreyPage/middle-school.html.

Data Collection

The quantitative data collected in this study included the grades on the pretest, posttest, and final multimedia projects. Two raters were invited to examine the pretest and posttest essays according to the five domain criteria used by the Test Scoring and Reporting Services of the Georgia State Department of Education. The final projects were also graded for organization, level of difficulty, creativity, visual appeal, and appropriate use of media and mechanics.

Data Analysis

A paired *t*-test was used as the statistical basis for measuring consistency between the two raters and the effect of the multimedia writing project on student performance. Pretest and posttest scores of the multimedia groups were used to try to reject the null hypotheses.

Rating Criteria and Scoring of Pretest and Posttest

Two experienced and certified raters from Test Scoring and Reporting Services rated the pretest and posttest essays according to the five domain criteria of the Rater Training Manual for Grade 8, Georgia Writing Assessment: content and organization, sentence formation, mechanics, usage, and style. The scores of the two raters were averaged to obtain the final score for each student's pretest and posttest. The correlation between their two ratings (each rater rated each student) was 0.91, an indication that the interrater reliability was outstanding. All essays were provided to the raters at the same time. They did their ratings of both the pretest and the posttest at the same time, but the essays had been coded and there was no way for the raters to know which essays were pretests and which were posttests.

Experiment 2

In experiment 1, we did not include a control group and also ran the experiment at the beginning of the school year (resulting in possibly inordinately low pretest scores). Therefore, the second experiment used methods that compensate for potential flaws in experiment 1.

Participants

There were a total of 47 participants for this experiment. They were taken from the two seventh-grade advanced language arts classes at a small city middle school in the southeastern United States. Their participation took place over a single six-week grading period. There were approximately 24 students in each of the two classes. There were six computers. We asked students to write the names of four people with whom they would be comfortable working. The teacher took this information and paired the participants into 12 work groups. Six of these pairs were randomly selected to participate in the multimedia project. The remaining six pairs spent their class time working on a Writing Workshop requiring them to complete two writing assignments by the end of the grading period. This process was repeated for the second class. It should be noted that this second experiment was conducted during the second grading period. One criticism of the first experiment was that the project took place during the first marking period and that the pretest was administered on one of the first days of school. Because the students had been away from class work for the summer, the pretest score may have been artificially low.

Materials

We used six computers in this experiment. They were all PC-compatible computers (486-25MHz). All had a video digitizing card installed, a CD-ROM drive, and a sound card. The software packages used were a video capture package that came with the capture card, an audio capture program, Windows 3.1 (1992), PaintBrush (a graphics package that comes with Windows), and Write (a word processing program that comes with Windows). Groups could choose to use either ClarisWorks (now AppleWorks, 1991–1998) or HyperStudio (1989–2000) to develop their project (five chose ClarisWorks and seven chose HyperStudio.) As it turns out, HyperStudio did not support Video for Windows so none of the HyperStudio projects had video. On the positive side, HyperStudio would allow the students to capture photographs and sounds to place directly into HyperStudio. Therefore, the groups who used HyperStudio only needed to learn HyperStudio. The groups who used ClarisWorks needed to learn the capture software to capture photographs, video, and sound as video (because ClarisWorks only supported Video for Windows and no other media format).

Besides the technology, we included a set of job aids that allowed the learners to easily integrate media into their ClarisWorks (now AppleWorks, 1991–1998) documents. We also would print the projects from previous marking periods so that later participants could benefit from the earlier experiences.

The experimental test was to write two essays: one before the project began (pretest) and another at the conclusion of the project (posttest).To control for the effect of the topic, we had the entire third-period class write an essay based on the question: "What do you think you will be doing with your life 25 years from now? Describe your life/lifestyle in the year 2021." The entire eighth-period class wrote an essay on the topic, "What if you found out that you had only one year to live? What would you do or accomplish with the time you had left?" The topics were switched for the posttest so that no child wrote on the same topic and so that half the people in each group got one topic as the pretest/posttest and the other half got the other.

As previously mentioned, the essays were reviewed by a pair of raters using five domains. Each domain was given a rating from one to four. To calculate the score, the rating for content and organization was multiplied by a factor of three, and the rating for style was multiplied by a factor of two. These numbers were added to the other ratings to come up with a final score for that child by that rater. The process was repeated for the other rater. The scores from the two raters were then averaged. For example, if rater 1 gave child 34 a rating of 3 for content and organization, 2 for style, 4 for sentence formation, 1 for usage, and 2 mechanics, and rater 2 gave child 34 a rating of 2 for content and organization, 2 for style, 3 for sentence formation, 2 for usage, and 2 mechanics, the score for child 34's essay would be 20 [(3 x 3) + (2 x 2) + 4 + 1 + 2 = 20] plus 19 [(3 x 3) + (2 x 2) + 3 + 1 + 2 = 19], or 19.5. The range of scores was from 8 (all 1's) to 32 (all 4's).

The two raters reviewed a total of 94 essays (two essays from each of the 47 student participants). Of these 94 essays, the raters had the same rating 29 times, differed by one 21 times, differed by two 22 times, differed by three 14 times, differed by four 4 times, differed by five 3 times, and differed by six 1 time. Eighty-eight of the 94 essays received scores that were deemed reliable (i.e., a difference in score from the raters of three or less).

Procedure

On the first day, the children were asked to spend one class period (50 minutes) writing their pretest essays. On the second day, the children were given their group assignments and told which groups would be participating in the multimedia writing project first. The 12 students initially selected to participate in the multimedia project went to a classroom across the hall where the six computers were set up. The students were told about ClarisWorks (now AppleWorks, 1991–1998) and HyperStudio (1989–2000). They were also told that they could not begin their projects until they had completed a plan for their projects and that this plan was essential in helping them work together as a pair. Students were given the opportunity to work on their projects on Mondays, Wednesdays, and Thursdays over a period of the next six weeks. The total amount of time spent on the project was 15 hours (three 50-minute periods per week for 6 weeks). A computer-literate graduate student or faculty member from the local university was available to assist the students throughout the entire project.

During the first week, students received instructions on how to use the project software they selected. Actual work on the projects did not begin until the start of the second week. Information about individual students and pairs was shared between researchers by e-mail following each visit. At the end of the six-week period, students were asked to write their posttest essays. These essays were then graded by the researchers and counted as approximately 20% of the final grade for that student over that six-week period in language arts.

Analysis

Because the basic model of this method was a true experimental design with a pretest and posttest, we did an unpaired *t*-test on the gain scores using an alpha level of 0.05.

Results and Discussion

The research design of the original study was a one-group pretest and posttest design. Twenty participants all received the pretest, treatment for six weeks, and posttest. Because the same subjects took both pretest and posttest, the paired data *t*-test was used as a statistical measure to examine the effectiveness of the multimedia writing projects, testing the hypothesis, "the rating of the quality of the students' written essays between the pretest and posttest for those who participated in the multimedia writing projects, will not be significantly different." This same *t*-test procedure was used to judge the reliability of the scores evaluated by the two raters. Results are reported in Table 1 and Figure 1.

Table 1. Test Results for Students Receiving the Multimedia Writing Project Treatment

	Pretest		Posttest			
	M	*SD*	*M*	*SD*	*t*	*p*
Content and organization	6.150	1.916	6.900	2.373	1.365	0.094
Style	4.150	1.312	4.900	1.692	2.319	0.016*
Sentence formation	2.500	0.847	2.825	0.675	2.041	0.028*
Usage	2.125	0.686	2.650	0.770	4.972	0.000**
Mechanics	2.125	0.607	2.500	0.679	3.470	0.001**
Final scores	17.050	4.483	19.775	5.512	2.845	0.005**

* p < *0.05.* ** p < *0.01.* df = *19.*

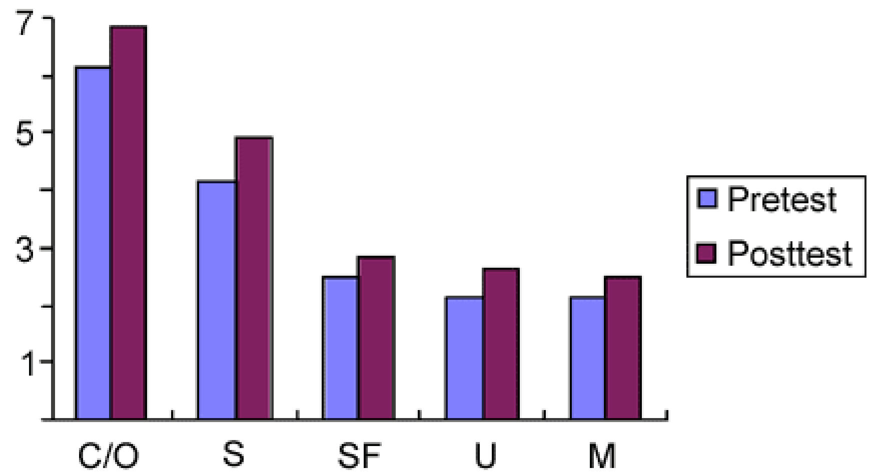

Figure 1. Pretest and posttest essay in five domains.

The means and standard deviations for each criteria category and total score are shown in Table 1. The mean of the posttest (= 19.725) was statistically significant, (*df* = 19, *t* = 2.845, *p* < 0.01) in relation to the mean of the pretest (= 17.050). To examine this result in detail, the means and the standard deviations among the five criteria domains used by the raters were also calculated. The results revealed that except for the content and organization category, all other categories were significantly different: style, *t* = 2.319, *p* < 0.01; sentence formation *t* = 2.041, *p* < 0.01; usage *t* = 4.972, *p* < 0.01; and mechanics *t* = 3.47, *p* < 0.01. All these results suggested that differences between the pretest and posttest were statistically significant.

The positive results revealed from the data are consistent with the following studies: Kuechle (1990) found that the writing performance of first-grade students of all ability levels in the computer group were far superior to those in the non-computer group. Herman’s (1988) evaluation research conducted in the Apple Classroom of Tomorrow showed that students’ writing improved both in quality and quantity.

However, given the complex nature of this multimedia writing project, many factors could have contributed to the significant results. First, the results may have been caused by the instructional method itself, as Clark and Craig (1992) claimed. For example, the planning activities or the feedback from the teacher about their writing might be the major factors that contributed to the significant difference in writing performance. Second, it could be the novelty of the computer technology which “helps sustain the interest and enthusiasm of youthful authors” (Kuechle, 1990, p. 39). Third, the students' writing skills may have declined during the summer vacation, as this study was conducted right after summer vacation. Whereas the pretest may have been measuring lapsed writing skills, the posttest may have measured the restoration of writing skills as students became accustomed to the academic environment six weeks later. Fourth, the results could simply be due to maturation over the six weeks of the study. Because there was no control group in this study, these alternative explanations could not be eliminated.

The topic of the pretest essay was "What do you expect to learn from your multimedia writing project?" and the topic of the posttest was "What did you learn from your multimedia writing project?" Because of the nature of the topic, one would assume that the latter would be easier because the participants had more knowledge about multimedia writing projects at the end of the project. Surprisingly, the data shown in Table 1 indicated that the content and organization was not significantly different. Instead, the other four domains (style, sentence formation, usage, and mechanics) were all significantly different from the pretest. This result eliminated the possible explanation that the topic of the posttest had an advantage over the topic of the pretest. One would expect the difference in the first category, not the last four. Herman (1988) used the same approach to assess students' writing performance by asking them to write about the effects of their ACOT experience, which as Herman stated "the writing assessment will be used not only to assess the quality of student writing but also to gather additional data on the nature of ACOT effects" (p. 4). In this study, the pretest and posttest essay also gave researchers the ability to examine what the students expected from the project and what they actually experienced.

Rater Reliability

The results shown in Table 2 and Figure 2 revealed that no significant difference was found between the two raters, *df*. = 19, $t = 1.528$, $p > 0.05$. This suggests that the scores issued by the two raters were consistent.

Table 2. Pretest and Posttest Scores Graded by Two Raters

	Rater A	Rater B	*t*	*p*
Pretest *M*	17.25	16.85	1.00	0.33
Posttest *M*	20.05	19.50	1.42	0.17
Sum scores	37.30	36.35	1.528	0.14

df = *19.*

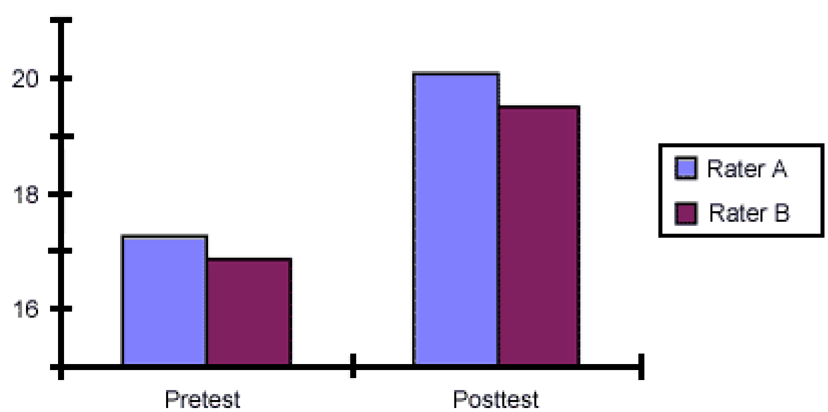

Figure 2. Pretest and posttest mean.

The validity of the quantitative data was considered high for the following reasons. Two experienced raters from Test Scoring and Reporting Services evaluated student performance according to criteria established by the Georgia State Department of Education and arrived at similar conclusions. Deviation from the normal language arts curricula was minimal. A pilot study of the experiment was conducted to ensure that the researcher could implement the multimedia writing projects effectively and efficiently. Finally, student participation was stretched out over a six-week period minimizing the possibility of aberrant short-term performance affecting the long-term outcome.

Experiment 2

The results of the second experiment showed no statistically significant differences between the control group and the experimental group, $F = 0.165$, $p = 0.686$. There were no statistically significant differences between pretest and posttest, $F = 0.324$, $p = 0.571$. Also, there was no statistically significant interaction, $F = 0.238$, $p = 0.627$. Table 3 shows descriptive statistics for this analysis.

Table 3. Descriptive Statistics for the Total Score on the Essay

	Count	*M*	*SD*
Pretest			
Control	22	23.2	4.66
Experimental	17	24.2	4.63
Posttest			
Control	22	23.1	5.29
Experimental	17	23.0	4.84

The meaning of this data suggests that either participating in multimedia projects has no effect on writing ability or our writing test is not valid. Though there is some reason to think that the latter explanation has some credence, we believe the former explanation is the more likely. After all, much of the work completed in the multimedia projects is in the form of graphics and audio, not text. The essays only measure one form of communication that is learned while participating in these projects.

Conclusions

This study implemented a constructivist approach to integrating multimedia technology in two seventh-grade language arts classes in a public middle school located in the southeastern United States. Though our first experiment suggested that there was an improvement in writing performance as the result of participating in a six-week, project-based approach to learning, the results of the second experiment suggests that this may be too optimistic.

In the first experiment, we had two major experimental problems. The first was that we ran the experiment in the first marking period of the school year. Therefore, the pretest essay was written after three months of not participating in formal schooling. The danger was that the pretest was artificially low. The improvement found in the first experiment could easily be explained by suggesting that the posttest was only the students returning to their previously attained writing level at the end of the sixth grade. To control for this, we ran the second experiment during the second marking period. Interestingly, the posttests in experiment one were rated approximately 20. The pretests in experiment two were rated approximately 23. Perhaps, the pretest topic for experiment two resulted in artificially high pretests.

The second experimental problem was that we did not have a control group. We corrected this in the second experiment. Unfortunately, the results indicated that there was no difference between groups. Combining this result with the previous result, we are left with a single logical conclusion: the participation for six weeks in a project-based learning environment does not improve writing performance on paper-and-pencil essays. We observed the project-based method as a valid approach, but its power may lay in its motivational effects rather than its effect on learning writing. In the future, we will examine the motivational aspects more systematically.

Contributors

Huey-Ling Fan (hfan@cc1.cyjcba.edu.tw) is an assistant professor at Chung-Yu Junior College of Business Administration in Taiwan.

Michael Orey (morey@coe.uga.edu) is an associate professor at the University of Georgia in the Department of Instructional Technology, 604 Aderhold Hall, Athens, GA 30602-7144, 706-542-4028.

References

Adams, J. (1986). *Conceptual blockbusting: A guide to better ideas* (3rd ed.). New York: Norton.

Ambron, S., & Hooper, K. (1988). *Interactive multimedia*. Redmond, WA: Microsoft Publishing.

AppleWorks [Computer software]. (1991–1998). Cupertino, CA: Apple.

Becker, H. J. (1991). How computers are used in United States schools: Basic data from the 1989 IEA Computers in Education Survey. *Journal of Educational Computing Research, 7*(4), 385–406.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Research, 18*(1), 32–42.

Churcher, P. (1989). A common knowledge presentation, cognitive models, learning and hypertext. *Hypermedia, 1*(3), 235–255.

Clark, R. E., & Craig, T. G. (1992). Research and theory on multimedia learning effects. In M. Giardina (Ed.), *Interactive multimedia learning environments: Human factors and technical considerations on design issues* (pp. 19–30). Heidelberg, Germany: Springer-Verlag.

Cuban, L. (1990). Reforming again, again, and again. *Educational Researcher, 19*(1), 3–13.

Duffy, T. M., & Jonassen, D. H. (1992). Constructivism: New implications for instructional technology. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 1–16). Hillsdale, NJ: Lawrence Erlbaum Associates.

Edwards, B. (1979). *Drawing on the right side of the brain: A course in enhancing creativity and artistic confidence*. Los Angeles: J. P. Tarcher.

Farrow, M. (1993). Knowledge-engineering using HyperCard: A learning strategy for tertiary education. *Journal of Computer-Based Instruction, 20*(1), 9–14.

Fortune, R. (1989). Visual and verbal thinking: Drawing and word-processing software in writing instruction. In G. E. Hawisher & C. L. Selfe (Eds.), *Critical perspectives on computers and composition instruction* (pp. 145–161). New York: Teachers College Press.

Glynn, S. M., Oaks, D. R., Mattocks, L. F., & Britton, B. K. (1989). Computer environments for managing writers' thinking processes. In B. K. Britton & S. M. Glynn (Eds.), *Computer writing environment: Theory, research, and design* (pp. 1–16). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Harel, I. (1991). *Children designers*. Norwood, NJ: Ablex Publishing Corporation.

Herman, J. L. (1988, April). *The faces of meaning: What do teachers, students and administrators think is happening in ACOT?* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

HyperCard [Computer software]. (1987–1998). Cupertino, CA: Apple.

HyperStudio [Computer software]. (1989–2000). Torrance, CA: Knowledge Adventure

Jonassen, D. H. (1993). Evaluating constructivistic learning. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 137–148). Hillsdale, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H., & Reeves, T. C. (1996). Learning with technology: Using computers as cognitive tools. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 693–719). New York: Macmillan.

Kafai, Y. B. (1995). *Minds in play: Computer game design as a context for children's learning*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Kearsley, G. (1988). Authoring considerations for hypertext. *Educational Technology, 28*(11), 21–24.

Kuechle, N. (1990). Computers and first grade writing: A learning center approach. *The Computing Teacher, 18*(1), 39–41.

Lehrer, R. (1993). Authors of knowledge: Patterns of hypermedia design. In S. P. Lajoie &. S. J. Derry (Eds.), *Computers as cognitive tools* (pp. 197–227). Hillsdale, NJ: Lawrence Erlbaum Associates.

Multimedia for everyone. (1995, January–March). *Multimedia today, 3*(1), 52–56.

Nix, D. (1990). Should computers know what you can do with them? In D. Nix & R. Spiro (Eds.), *Cognition, education, and multimedia: Exploring ideas in high technology* (pp. 115–141). Hillsdale, NJ: Lawrence Erlbaum.

Pea, R. D. (1991). Learning through multimedia. *IEEE Computer Graphics & Applications, 11*(4), 58–66.

Papert, S. (1980). *Mindstorms: Children, computers and powerful ideas*. New York: Basic Books.

Perkins, D. N. (1986). *Knowledge as design*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Robinson-Staveley, K., & Cooper, J. (1990). The use of computers for writing: Effects on an English composition class. *Journal of Educational Computing, 6*(1), 41–48.

Schank, R. C., & Jona, M. Y. (1990). *Empowering the student: New Perspectives on the design of teaching systems* (Tech. Rep. No. 4). Evanston, IL: The Institute for the Learning Sciences, Northwestern University.

Soloway, E. (1993). Technology in education: Introduction to a special issue. *Communications of the ACM, 36*(5), 28–30.

Starfield, A. M., Butala, K. L., England, M. M., & Smith, K. A. (1983). Mastering engineering concepts by building an expert system. *Engineering Education, 11*, 104–107.

Trollip, S., & Lippert, R. (1987). Constructing knowledge bases: A promising instructional tool. *Journal of Computer-Based Instruction, 14*(2), 44–48.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wigginton, E. (1985). *Sometimes a shining moment*. Garden City, NY: Anchor Press/Doubleday.

Williamson, M. M., & Pence, P. (1989). Word processing and student writers. In B. K. Britton & S. M. Glynn (Eds.), *Computer writing environments: Theory, research, & design* (pp. 93–127). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Windows 3.1 [Computer software]. (1992). Redmond, WA: Microsoft.

Woolsey, K. H. (1991). Multimedia scouting. *IEEE Computer Graphics & Applications, 11*(4), 26–38.