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A Comparison Study Between Writing On Handheld Computers And Pencil -Paper In The Elementary Classroom

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Ho, J. F., & Ko, L. C. (2003). Three events that have influenced the distance education. *4th International Conference on Development and Utilization of the Internet,* 199-204.

Research Projects and Grants

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A Dissertation

Presented to

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In Partial Fulfillment

of the Requirements for the Degree

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by

Ling-Chin Ko

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DOCTORAL DISSERTATION

This is to certify that the Doctoral Dissertation of

Ling-Chin Ko

entitled

A Comparison Study between Writing on Handheld Computers and Pencil-Paper in the Elementary Classroom

has been approved by the Examining Committee for the dissertation requirement for the

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ABSTRACT

The purpose of this study was to compare the difference in writing effort associated with two methods, pencil and paper and handheld computers in the third grade classroom. The methods were compared in terms of the quality of the stories written, and the length of the stories in number of words, and time on task during writing of the stories. Three hypotheses were defined to identify the effect of writing efforts associated with the two methods, two classes and the effect on the interaction between the methods and the class. All three hypotheses were analyzed with a two-way MANOVA test.

Two third grade classes with 40 students in Terre Haute, Indiana were selected to participate in this study during two data collection periods. Each student had to complete two written stories individually with pencil-paper and on a handheld computer. A two-way multivariate analysis of variance (MANOVA) test revealed the finding in the first main effect for writing efforts associated with the first methods-pencil-paper was shown to be significantly different [Wilks' Lambda Λ=.333, $F(3,66)$=44.109, p<.001, multivariate η^2=.667] from the second method-handheld computer affect in the combined DV of the score in the quality of the written stories, the length of the stories in number of words, and time on-task during writing of the stories in two classes. A follow-up univariate ANOVA results indicated that the effect of writing effort associated with the first method (pencil-paper) differed significantly from the second method (handheld computers) in the length of story in number of words [$F(1,68)$=4.251, p=004, η^2=.059]

and the time on task [$F(1,68)=72.869$, $p=.000$, $\eta^2=.517$] but not in the score on the quality of story written in two classes. The second main effect for writing efforts associated with the two classes was shown to be significantly different [Wilks' Lambda $\Lambda=.744$, $F(3,66)=7.582$, $p<.001$, multivariate $\eta^2=.256$] on the combined DV of the quality of the stories written, the length of the stories in number words, and the time on-task during writing of the stories in two methods. A follow-up univariate ANOVA indicated that the effect of writing effort associated with Class One significantly different from Class Two on the time on task [$F(1,68)=16.318$, $p=.000$, $\eta^2=.194$] but not the length of story in number of words [$F(1,68)=.003$, $p=.959$, $\eta^2=.000$] and the quality of story written [$F(1,68)=.136$, $p=.713$, $\eta^2=.002$] between the two methods.

DEDICATION

For my mother, Tsai Chiao Ko

And my father, Shih-Tung Ko

And to my husband, Jui-Feng Ho, who makes all things possible

And to my sons, Christopher Yu-Hsiu Ho and Andrew Han-Ju Ho

And to my American family in Utah, the Dumas family members

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Chapter 1

INTRODUCTION

The field of educational technology has passed through a number of innovations over the past century. New delivery systems, such as handheld computers, have stimulated the development and use of technological applications for teaching and learning (Ely, 2002; Satterlee, 2002). Handheld computers are now finding their way in to the K-12 environment (Ray, 2002) and numerous vendors are working with educators on the integration of handheld devices across the curriculum (Satterlee). Molebash and Fisher (2003) indicated that the handheld computers will be one of the greatest promises in affecting positive change in literacy instruction. Pownell and Bailey (2001) have predicted that handheld computers will be "the next machines that will change the face of our everyday lives" (p. 1).

Handheld computers are small computing device with a screen and stylus that can connect to the Internet. Pownell and Bailey (2001) stated that with the ability to connect to the Internet, the handheld computer increases it functionality and potential benefits in education. One of the irresistible advantages for teachers and students is the convenience of portability. Soloway (2001) and Pfeifer and Robb (2001) described some examples of handheld computer's educational advantages, such as low cost, mobility, wireless, small

size, increased collaboration and sharing between students, encouragement of students to work together and share information, and the simplicity of use. But, Trotter (2002) pointed out that administrators have banned handheld computers because students can use them to cheat on test, play games, e-mail friends or access inappropriate Web sites. Just (2004) stated that technical problems will occur even with handheld devices too.

Handheld computers also are being used in many innovative ways and bring important benefits to schools by assisting the administration or administrators and supporting classroom management. Walery (2000) reported that nearly 1,700 high school students and 65 teachers are participating in the largest educational deployment of handheld computers in the United States. Located 25 miles southwest of Chicago, Consolidated High School District 230 serves nearly 9,000 students at three comprehensive high schools: Victor J. Andrew High School in Tinley Park; Carl Sandburg High School in Orland Park; and Amos Alonzo Stagg High School in Palos Hills. They are implementing classroom projects utilizing handheld computers in their fitness & nutrition, biology, English and science courses. Another research project based on handheld computers was carried out in a grade 9 language class at Ballard High School in Seattle, Washington (Brown, 2001). The Handspring Visor Deluxe handheld devices were used in this project. The aim in this project was to help students to develop stronger organizational skills for access to curriculum materials on the school web site. Wake Forest University developed Class In Hand and Data in Hand for the handheld computer. The Class In Hand turns a handheld equipped with a wireless card into a web server, a presentation controller, and a quizzing tool for a classroom instructor. This program will allow students to collect data into surveys and forms that were created on a

PC and then transferred to a handheld (Bishop, Dinkins & Dominick, 2003). In England, 30 assorted schools have been given a selection of devices to evaluate the use of PDAs (personal digital assists) in schools for managing teacher's work and supporting teaching and learning (Perry, 2003).

Using PDAs with word processing software to write is becoming an affordable and portable writing tool in elementary classrooms. Just (2004) reported his experience in how 5th grade classes use PDAs to write essays, note ideas, directions and lessons in the classroom and stated that "PDA improve students performance" (p. 23) in the Wayne School District in Indianapolis, Indiana. Vincent (2003), a fifth grader teacher, observed meaningful writing experiences through handheld technology in his class and reported that handheld computers have helped motivate his students with writing. Students are actually excited to take out their handheld computers and keyboards to compose. Tyre (2002) reported fully 91% of teachers who had their students use the Palm handhelds for writing assignments felt it can improve the quality of the activity.

Although handheld computers have been available for several years and making their presence known in many schools across the U. S., whether handheld computer impacted student performance is considered to be new and untried when compared with desktop or laptop computers. More specifically, using handheld computers as a writing tool for teaching and learning in the educational environment is still a relatively new area needed to be explored before trying these devices for classroom activities and being heavily adopted for use in the classroom.

Statement of the Problem

Past researchers have found obvious benefits of integrating computer technology

into writing classrooms (Duling, 1985; Rohman, 1965). Kahn (1988) found that elementary students enjoyed writing more when writing with a word processing program. Similar results indicate that middle school and secondary students develop better attitudes toward writing through computer-based technology (Baer, 1988; Rosenbluth & Reed, 1992). Several studies have found positive relationships among the following: computer assisted instruction (CAI), computer based instruction (CBI), writing attitude, and motivation (Curey & Cross, 1984; Din, 1996; Kulik & Kulik, 1991; Kurth, 1987). However, few studies exist that investigate and evaluate the effectiveness of the handheld device as a writing tool in the classroom.

The goal of this study is to compare the process of writing task difference between two methods of writing a story in a third grade classroom. The first method is writing through a handheld computer, and the second method is writing through pencil-and-paper. More specifically, the purpose of the study is to investigate if differences exist between writing through a handheld computer and a pencil-and-paper as determined by: (1) the quality of story written, (2) the length of the stories in number of words, and (3) the time on task during the writing of the stories.

Specifically, three questions are examined:

1. Are there differences in two methods of story writing with regards to the quality of the stories written, the length of the stories in number of words, and the time on task during writing of the stories between two classes?
2. Is there a difference in two classes of story writing with regards to the quality of the stories written, the length of the stories in number of words, and the time on task between two methods?

3. Is there a difference interaction between the methods of writing a story and the classes on the process of writing tasks?

Significance of the Study

The results of this study will contribute to the understanding of the difference between employing handheld computers and pencil-and-paper in the English composition classroom. With the innovation of handheld technology moving into classrooms, it is expected the increasing indications of the development of a pedagogy which includes such devices can be incorporated into various subject activities in the near future.

The results of this study are needed for teachers or individuals who are engaged in K-12 education, community colleges and universities, business and industry as handheld device and wireless technology move into classrooms as fast as one can imagine. These research results will provide information for administrators or teachers who may consider the purchase of handheld computers as a way to maximize limited technology. Finally, handheld computers represent not just a useful tool but also a new way of interacting with information (Clyde, 2004).

Definition of Terms

The following terms are defined for use in this study:

1. *Personal Digit Assistants (PDAs):* a specific type of handheld device that fit into the palm of the hand and are designed for mobile computing; applications may include calendars, address books, notepads, calculators and other useful tools.
2. *Handheld computers:* a more popular term for PDAs.
3. *Word To Go (Premium Edition version 5):* a handheld application software under Documents to Go package created by DataViz, Inc. It is a complete word

processing program for handheld devices which includes basic word processing features and advanced features such as auto-capitalization, spell checking and word count.

4. *Time on task:* the amount of time a student is actually engaged in writing a story from beginning of writing until end of writing period.
5. *Indiana Statewide Testing for Educational Progress (ISTEP) rubric:* the ISTEP 6 points writing applications rubric (grades 3-5) came from the Indiana Department of Education (2002). Each score level is assessed in-depth on the ideas, content, the organization, and style in a composition.
6. *Quality of writing:* the quality of students' story will be graded by evaluators based on the Indiana Statewide Testing for Educational Progress (ISTEP) rubric.
7. *The length of writing in number of words:* total number of text in each story.

Limitations

The following limitations are established for the study:

1. Students are selected from two third grade classes in Terre Haute, Indiana.
2. Students in Class One have used handheld computers for six months. The students in Class Two have used handheld computers for three months. They are fairly familiar with using the handheld computers and have basic keyboarding skills.
3. The handheld computers used in this study included 10 color Palm Zires and 10 Palm Tungsten Ts handheld computer and twenty wireless full-sized keyboards. Those Palms are free to use and kept in one of the third grade classrooms and not shared with other students.

Assumptions

The following assumptions are established for this study:

1. Students worked individually during the writing procedure and were not allowed to talk except to instructors.
2. Students had basic keyboarding skills and knowledge to complete a writing task on a handheld computer.
3. There was no time limit for students to complete their story during a regular composition section. But, each classroom teacher had set up a 45 minute composition section. However, they allowed students to extend their writing task if students needed more time to complete their story.
4. The measures of time on task were appropriate measures of student engagement during the writing effort.
5. The measures of the quality of written story and length of story in number of words are appropriate measures of a complete written task.

Chapter 2

LITERATURE REVIEW

Computers are transforming the way many of us read, write and think. As computers turn out to be increasingly common at elementary school, many young writers now draft their first sentences using word processors. Recently, a new computer device, called a handheld computer has moved to the elementary composition classroom. Review of literature directly related to the effects of handheld computers in the elementary composition classroom is a new and untested research area. The primary reason is that handheld computers are still a novelty for many of the 14.5 million U. S. college students (Fallon, 2002) ten years after the introduction of the first handheld device, let alone for the elementary school population. Second, since the majority of schools are equipped with computer-based laboratories or laptops, the handheld computer is lacking an experimental environment to explore the pedagogical application (Jones, Johnson, & Bentley, 2004). The third problem is training teachers to ultimately integrate technology into the classroom. Staudt (2000) suggests encouraging teachers to use handheld applications that match their existing course objectives.

This section presents reviews of the previous and current studies that address five issues: a history of contemporary analyses of media comparison studies; a review of

previous studies on the effect of integrated computer technology to affect student's writing attitudes and motivation; a definition of the role of learning tasks presented via the computer-assisted instruction; an examination of current handheld device applications in the classroom; and a ratio of computer access at school.

Contemporary Analyses of Media Comparison Studies

What are Media Comparison Studies?

Studies of the influence of media on learning have leaded to so called "media selection" schemes or models (Reiser & Gagné, 1982). These models examine the different points of view about the impact of media and attributes of media on learning, motivation and efficiency gains from instruction. The purpose of media research is to obtain knowledge about the educational or instructional effectiveness of a specific medium; to increase understanding of how media and technology function and what psychological effects they have on a learner; and to improve the practice of education through the provision and evaluation of better materials, media, procedures and technologies (Salomon & Clark, 1974).

When studies compare the effect of two different forms of media, many researchers have argued that media as a delivery device has differential economic benefits but no differential learning benefits. For example, Lumsdaine (1963) disputed whether the use of educational technology has resulted in effective learning outcomes. Other researchers stand on the other side and suggest computer-based technology can have a positive effect on student learning under certain circumstances and when used for certain purposes (White, Ringstaff & Kelley, 2002).

A chronological collection of hundreds of media experiments found "no significant"

differences (Russell, 1997). This database serves as a reminder to researchers that the questions about the comparative impacts of the technologies remain of paramount importance.

Media and Method Debate

The debate regarding the effects of media has stimulated many instructional designers and educational technology researchers to define an appropriate methodology to assess learning effects relating learning from media. Clark (1983) reviewed meta-analyses of media research and stated that there was

> consistent evidence found that there are no learning benefits to be gained from employing any specific medium to deliver instruction. Research showing performance on time saving gains from one or another medium is shown to be vulnerable to compelling rival hypothesis concerning the uncontrolled effects of instructional method and novelty. (p. 445)

The "no learning benefit" statement left the door open to a media versus method comparison debate and spurred debate within the field of instructional technology (Clark, 1994b; Kozma, 1991; Morrison, 1994; Reiser, 1994; Shrock, 1994; Tennyson, 1994).

Clark (1983) cited evidence to supporting his hypothesis that instructional methods had been confounded with media, i.e., the attribution to influence learning is methods, not media. Clark (1983, 1994a) maintained this thought and argued that it is instructional method that influences learning, not the delivery medium. He said that "media comparison studies that find causal connections between media and achievement are confounded" (1983, p. 447). He explained the possible sources of confounding in media comparison research are "uncontrolled novelty effects with newer media and

instructional methods or content difference between treatments groups" (1983, p. 445).

In 1994, Clark updated his analogy and compared the various methods of pharmaceutical delivery methods (pills, suppositories, IV, and injections) with their effectiveness. Clark pointed out that the delivery method does not increase the patients' health; rather, improvement is the result of the active chemical ingredients (1994a). Clark believes that media cannot be separated from instructional design, and does not influence learning improvement (Tennyson, 1994). Furthermore, Clark stated that media alone does not affect learning. Media can reduce the costs and increase the efficiency of learning, but the use of an adequate teaching method alone will ultimately influence learning (Clark, 1994b). Moreover, Clark (1994a) indicated that there is no single media attribute that can not be replicated by other similar media attributes. He viewed media comparison studies as a replaceability test: "if a treatment can be replaced by another treatment with similar results, the cause of the results is in some shared (and uncontrolled) properties of both treatments" (1994a, p. 21).

There are alternative views regarding the influence of media on learning. Kozma (1991) responded to Clark's challenge for "...researchers (to) refrain from producing additional studies exploring the relationship between media and learning unless a novel theory is suggested" (1983, p. 457). Kozma proposed that

> the capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the ways learners represent and process information and may result in more or different learning when one medium is compared to another for certain learns and tasks. (p. 179)

Learning with media is a complementary process within which representations are

constructed and procedures performed, sometimes by the learner and sometimes by the medium (Kozma, 1991). The same ideas are supported by Reiser (1994) who indicates that media have attributes that can influence learning in certain situations.

Kozma (1991) believes that media and method can be treated as an independent variable that can be shown to improve learning over traditional teaching methods. The methods are integrated and connected within the environment and learning situation media. Kozma concedes that there is no past research evidence for a causal connection between media and learning. However, he believes a relationship will exist between media and learning. Kozma indicates that learning occurs because of a unique mix of methods, technologies, and initiatives taken by the learner in a learning environment. Kozma reframed the media comparison debate question "Will media influence learning?" and posted a new approach "In what ways can we use the capabilities of media to influence learning for particular students, tasks, and situations?" He suggested that in order to understand the role of media in learning, we must "ground a theory of media in the cognitive and social processes by which knowledge is constructed" (p. 8). He explained that, learning is viewed as an active, constructive process whereby the learner strategically manages the available cognitive resources to create new knowledge by extracting information from the environment and integrating it with information stored in memory (Kozma, 1991).

Recent Findings in Media Research Studies

There are consistent and recurring errors for the failure of media comparison studies to measure the impact of technology on student achievement in empirical educational technologies research (Lockee, Burton, & Cross, 1999). The primary error

reported in the media comparison research is a lack of control over the comparison groups. Another problem of validity is a lack of randomization in the sample selection election. Similar results also found bias when the study participants are not equal between groups (Shadish, Cook, & Campbell, 2002).The third problem is the assumption that grades actually measure student achievement. Lockee et al. explain that establishing no significant difference in the achievement of the two groups does *not* mean that the two methods of instruction are equally effective but rather badly flawed, such as lack of control over the comparison groups, lack of randomization in the sample selection. The fourth impact is the novelty effect which may be another internal threat not taken into account in past studies (Bryant & Hunton, 2000; Clark & Sugrue, 1990; Colorado, 1988). Clark and Sugrue reported that increased attention leads to an increased effort which inflates achievement gains. Finally, the confounding of the instructional design and teacher effect are also threats to the validity of media comparison studies (Clark & Sugrue; Lockee et al.).

Evaluative comparison studies can be particularly useful if they collect other information beyond student achievement. Clark (2001) suggested that media comparison research "should focus on necessary characteristics of instructional methods and other variables, such as learner's task, learner aptitude, and attributions" (p. 151).

Fleming and Raptis (2000) report that many experimental and quasi-experimental media comparison research studies conducted in the 1980s were behaviorist in approach where the learner made a behavioral response and the studies lacked adequate research controls. Methodology errors, novelty effects, and the confounding of the maturation variable were among the reasons that media effect was shown to be significantly effective

or have no significant difference. Furthermore, when they analyzed media comparison research from 1990 to 1999, only 25 % of the studies controlled for extraneous variables. Jones and Paolucci (1997) estimate that 95% of published studies on the effectiveness of technology in learning outcomes from 1993 to 1997 either had flawed designs and methodologies, or lacked appropriate quantitative measures for learning outcomes.

What is next in the media and methods debate? Clark (2001) recommended the following conditions are necessary to investigate media; 1) find a way to conceptualize and measure the cognitive demand of instruction and learning task; 2) carefully analyze the context where the learning is occurring and a commitment to the measurement of the amount of time it takes; 3) provide a solution that disputes about the measurement of "cognitive processes" during learning; and finally, 4) frame a theory to guide our question on media and learning.

Computer Technology to Facilitate Student Learning of the Writing Process

Word Processing to Enhance Writing

Rohman (1965) identified that effective writers break the writing process down into three stages (1) prewriting, (2) drafting, and (3) revising. Computer-based writing has enabled the writing task to be much more efficient, especially in the revision and editing steps. In the 1980s, many experimental and quasi-experimental research studies compared the effect of word processing on the student's writing process, learning attitudes toward writing, motivation to write in a computer-based setting and the traditional classroom in the 1980s. Owston and Wideman (1997) conducted a quasi-experimental design that integrated a collection of quantitative and qualitative data in a three-year study to discuss third grade students writing products and processes. An

analysis of the student writing results showed there was a greater improvement in writing quality with the high-access site (HAS) group than the low-access site (LAS) group during the three years of the study. Similar results were also found by Cheever (1987) who conducted a quasi-experimental study that examined the effects of using a word processor on the acquisition of composition skills in seven classes of fourth grade students. Pre-test and post-test pencil and paper writing samples were collected from all students, as well as post-test word processor samples from the experimental group. Observations were made to identify the number and type of revisions each group made while writing. Students' attitudes toward writing and teachers' perceptions of word processing were assessed through separate surveys. Significant findings occurred in the experimental group in all measures for the quantity and quality of writing.

Another study by Green (1991) investigated the effects of word processing and a process approach to writing on reading and writing achievement, attitudes toward writing, and development of revision and editing in Mexican American third graders. Analysis of the texts produced during treatment by the two experimental groups found that: (1) the word processing group produced longer texts and had fewer errors in both first and final drafts and (2) the group which did not do word processing produced more texts and made more mature revisions. Neither group did significantly better at editing their errors.

The Revision Effect of Word Processing

Beesley (1986) investigated the effects of word processing in a sixth grade composition classroom. This study compared: (1) a group of students writing and revising strategies when utilizing word processors and pen; (2) the length, errors, and quality of the students' written products when using word processors and pen; and (3) the

students' attitudes toward writing and revising with word processors and pen. As a result, more students preferred writing with computer, although after each session, one or two more were converting to a preference for pen. An equal number of students preferred revising with pen as compared to a word processor. Duling (1985) examined word processors and student writing as it impacted revision, fluency, and quality of writing (composition) in a ninth grade English class for a year. He found that there was no difference in the judgment about the quality of writing of the student papers whether hand or computer revised. Quality of student writing was not affected by the move to word processors.

Studies on revising effect of word processing are not only found in K-12 but also in higher education. Ellis (1997) investigated Montana State University's population of developmental writers and whether deep revision improved on drafts produced by hand as measured against drafts produced using the word processor. A systematic method for obtaining information concerning whether there exists a significant difference with regard to deep revision skills in final scores between drafts produced by hand and drafts produced using the word processor was tested. The result showed students who handwrote their work scored significantly lower than students who word processed their work; the use of a word processor positively affected the quality of deep revision.

Keyboards

Keyboards are versatile, portable systems that motivate students to edit and improve their writing in all area. Siegel (1998) explained how effective portable keyboards can be in the curriculum and to encourage students to write. Morrow (1989) examined a random selection of sixth, seventh and eighth graders at a local elementary

school who were chosen for instruction in keyboarding. Results concerning the effect on composition quality, length and revisions suggest that familiarity with the word processing program and writing abilities are more important factors than keyboarding skill. Interaction analysis seems to suggest that keyboarding instruction benefits the low ability writing students. Attitudes toward computers and writing were not affected by keyboarding instruction.

Motivation and Attitude

Song and Keller (2001) conducted a study to examine the effects of a prototype of motivationally-adaptive computer-assisted instruction. The basic motivational theory was provided by Keller's (1987) ARCS model (an acronym formed from attention, relevance, confidence, and satisfaction). Results indicated that motivationally adaptive computer-assisted instruction was supported by the data in terms of its motivation, effectiveness, overall motivation and efficiency. Fitch (1985) examined the effect of word processing on student's attitudes toward writing in 60 seventh-grade students. The experimental group used a word processor and the control group used pen and paper. He concluded that the effect of word processing did not affect student's attitudes toward writing but it did help students revise more and at a higher level. In another study, the effect of word processing on writing, conducted by Curey and Cross (1984) measured the dimensions of attitude (pre-and post anxiety, pre and post-readiness, and reaction), performance (organization, idea development, grammar usage, sentence structure, and grade); and process (brainstorming, outlining, rough drafting, and working on revisions); and computer resource costs. Results indicated the teacher and class had positive changes in writing behavior. Kurth (1987) indicated that the use of word processing improved

students' attitudes and motivation towards writing. Another study on the use of computers for writing found that there were significant performance differences between students who used word processors and those who wrote by hand (Robinson-Staveley & Cooper, 1990).

In Rockman's study of laptop computing (2004), he surveyed 3000 students and 175 teachers in Indianapolis and Crawfordsville, Indiana. Teachers reported that students have greater engagement in their assigned work. Of the students who were showing improvements in the area of writing and student's attitudes toward writing, 76% enjoyed writing more on laptops than on paper; 80% indicated the laptops made it easier to rewrite and revise their writing; and 73% said they earned better grades for laptop work. Weymer (2002) conducted a study to examine the relationships between cognitive style, verbal ability, quantitative ability, prior knowledge, motivation and achievement in sixth grade modular technology education. These results showed a statistically significant relationship between achievement and cognitive style, verbal ability, quantitative ability, prior knowledge and motivation.

Learning Task Study

Time on Task and Learning

The concept of time on task refers to the amount of time a student is actually engaged in a learning activity (Feldman, 2003). At school, most learning tasks are time limited. Teachers keep students very engaged throughout a whole lesson and encourage students to contribute their ideas and insights as a means of enhancing their own and other students' learning. Black (2003) addresses a review of the research on student motivation and student disengagement. The review addresses research on student

disengagement in the upper grades and the characteristics of teachers who are adept at engaging students in learning. In a recent study, Black (2004) presents a project to show students who are mentally engaged in all activities and assignments; permit students to initiate and adapt learning activities and projects; and form instructional groups that work to achieve learning objectives. In recent years, some educational researchers who study motivation have been expanding their focus to consider the broader contexts of motivated activity (Hickey, 2003). Hickey applied a sociocultural view of engagement that knowledge resides in contexts of its use to the study of achievement motivation. Lee, Kelly and Nyre (1999) conducted a study to examine the relationship between the percentage of on-task behavior and completion of school work. The preliminary results point to a significant relationship between the percentage of on-task behavior and academic seatwork completion.

Effective classrooms are influenced by the amount of time students devoted to a subject. Walberg (1988) reviewed current psychological research on the effects of time and learning, discuss practical implications and proposed that "productive time" (p. 76) should be a new focus of educational renewal. Walberg said:

> We can help students learn by increasing time-on-task, but we can achieve more learning if we except 'productive time', where students engage in lessons adjusted to their differences in learning rate and background knowledge. (p. 76)

Walberg collected and synthesized 2,575 studies on productivity theory related to time and learning (Walberg 1984a, 1984b, 1988) and suggested nine educational productivity factors that influence school-related cognitive, affective, and behavioral learning. The nine educational productivity factors are:

1. Ability, or prior achievement
2. Development as indexed by age
3. Motivation or self-concept or student's willingness to intensive on learning task
4. The amount of time students engage in learning
5. The quality of the instructional experience
6. The curriculum
7. The morale of classroom social group in psychological environments
8. The peer group outside school
9. Minimum leisure-time television viewing

It can be seen that time is a central element among the alterable factors in learning for each of the fist five factors which is necessary for learning in school. In an extensive review on time effects in school, Frederick and Walberg (1980) concluded "time devoted to school learning appears to be a modest predictor of school achievement "(p. 193).

With research on both objective measurement and subjective observation of students, as Louis and Miles (1990) indicated, the main factor to influence effective classroom is time on task. Students are apt to more likely be on-task when they are interactive with teachers or peers, than just listening to the lecture (Good, Reys, Grouws, & Mulryan, 1989; Stallings, 1980). The time on task observations are emphasized not only during class periods but also the times while students are actually working on their own. Croll and Moses (1988) found that greater amounts of whole class instruction were associated with higher levels of student time-on-task when investigated the relationship

between teaching approaches and student engagement rates in 32 elementary ("junior") classes in the British school system.

Time on Task and Computer Assisted Instruction

Much of our past media comparison research on learning may not have explored and measured the time it takes their subjects to finish learning tasks (Clark, 2001). Clark recommends that researchers "need a commitment to measurement of the amount of time it takes similar learners to achieve a specific learning criterion in instructional studies" (p. 315). When evaluating a class for "time on task", the researcher is asked to observe students' behavior in the classroom, note and record individual student behavior at regular time intervals (Bonine, 1999).

Newhouse (2001) compared the perceptions of students and teachers towards the use of portable computers at a secondary school in a 1999 and 1995 study carried out by the researcher at the same school. The data were collected from 102 twelfth grade and 104 eighth grade students and 40 teachers. The results indicated for younger students that computers appeared to be used more often and for a greater range of tasks. Some studies indicate that the time for instruction is compressed when technology is used (Kulik & Kulik, 1991). Computer based instruction (CBI) took approximately two-thirds of the time required for traditional courses in 32 post-secondary classrooms (Kulik & Kulik). Din (1996) observed two tenth grade classes for seven weeks to investigate whether student's time-off task rate during computer assisted instruction (CAI) was different from that in seatwork. The result was that students' time off-task duration during CAI was lower than that during seatwork and their achievement in computer assignments was found to be significantly better than that in seatwork assignments. The results were also a

reduction in student disruption and other forms of off-task behavior. Indeed, positive findings in the literature proved that students' time on-task increased during CAI (MacArthur, Haynes, & Malouf, 1986; MacArthur, Haynes, Malouf, Harris, & Owings, 1990).

Handheld Devices in the Classroom

A handheld computer functions not just as a computer, but also as a textbook, calculator, calendar, notepad and "pencil" (Yuen & Yuen, 2003). Liu et al. (2003) classified currently available educational applications of PDAs into two main types of use; one is when the PDA serves as an interface to a "main" desktop program to extend the use of the desktop application for specific scenarios, the other is when the PDA serves as a stand alone application tool with or without connection to a central desktop application. Handheld computers have an advantage over traditional computers due to their ability to transmit data from one device to another; and ability to be accessed at any time and anywhere (Hudgins, 2001; Hennessy, 2000). This tremendous flexibility has significant advantages for students as well as teachers. As handheld computing devices are being introduced into the school, many research projects are successfully testing, developing and implementing core applications and supporting the curriculum; such as in reading, writing and arithmetic (Soloway et al., 2001). Jipping, Krikke, Dieter and Sandro (2001) conducted the Classroom Application Rapid Deployment System (CARDS) project to enhance collaboration, participation, and experimentation through the use of handheld platforms. They stated "we believe that handheld computers can be used in 'traditional' methods of classroom teaching and that they represent new platforms for bold and unique teaching methods" (p. 169). The study results leverage the advantages of handheld

computing by developing application tools. Lang (1999) also found instead of composing on paper and rewriting on computers, handheld computers are ready when students are. She pointed out that "students who have trouble organizing their thoughts have an easier time editing their work with PDA's delete, cut and copy and paste functions" (p. 70-71).

Ray (2002) indicated that use of handheld computers can assist students in the writing process. Luchini, Quintana and Soloway (2003) applied handheld computers synthesizing characteristic and designed a research project to compare the impact on students' work processes and products between handheld and desktop tools. A learner-centered concept mapping tool for handheld Pocket PCs, the Pocket PicoMap, is applied to explore the benefits and challenges of using handheld computers to support learners in creating concept maps. The study's results suggest that students can complete complex learning activities using handheld tools, and have the potential to enhance classroom activities.

Hennessy (2000) conducted a study on the impact on learning and attitudes to the use of portable computers on graphing investigation technology. The issues of the project were to evaluate use of a palmtop computer in a weather project. A total of 48 students aged 13 to 14 worked in groups over 3 weeks to collect and graph temperature date. The result of his project showed that the use of palms contributed to positive gains in motivation and improved attitudes to the use of a new technology. Hennessy's study confirmed that "those of previous studies of students' attitudes which tend to converge on the conclusions that portable computers are more popular than desktop machines and that their use improves attitudes to computers" (p. 225). O'Donovan (1999) discussed how the latest portable computers offer more power and affordability than ever and reported

several beneficial results, including increased student motivation and encouragement of a more child-centered education when teachers act as facilitators and help students learn.

Hudgins (2001) reported that students are enthusiastic about using handheld devices to take quizzes and desire to perform at a higher level when they were involved as a part of a national pilot program for the first handheld device specifically designed for use in ongoing classroom testing. Many researchers have reported that handheld computers effectively support how teachers organize their work in the classroom and record their classroom observations (Kahng & Iwata, 1998; Pownell & Bailey, 2000; Saudargas & Bunn, 1989; Soloway, 2000).

Sharples, Corlett, and Westmancott (2002) built a causal model to analyze the complex interactions between people and mobile learning. The finding from this study was that mobile learning is more strongly mediated by its context than classroom construction. Context involves the learners' learning goals, motivation, co-learners and the surrounding resources. Liu et al. (2003) built an experimental study to examine the effect of teaching and learning activity in a Wireless Technology Enhanced Classroom (WiTEC) at three six grade classes in Taiwan. The WiTEC classroom was equipped with wireless LAN, wireless mobile leaning devices, and electronic whiteboard and an interactive classroom server. The results indicated the WiTEC enabled the teachers and students to be on task during teaching and learning activity. Pinkwart, Hoppe, Milrad, and Perez (2003) employed PDAs into educational scenarios to orchestrate classrooms. Three approaches for supporting synchronous cooperation are described; one is an annotation tool, the second one replicates a modeling system on the PDA, and the third one makes use of a wireless optical reader in addition to the PDA. The findings showed the

extensions for handheld applications were at hand without binding the attention of the learner.

Computer Access at School

The ratio of students to computers

Over the past decade, the number of computers in American elementary and secondary schools and classrooms has been steadily increasing. The ratio of students to computers has dropped dramatically from 125:1 in 1983 to 9:1 in 1995, 6:1 in 1998, and 4:1 in 2002 (Education Week, 2003; Market Data Retrieval, 1999).

Believing that increased access to computers in schools will lead to increased use of computers, educational leaders have gradually reduced student to computer ratios targets. Becker (2000) used data from the *Teaching, Learning, and Computing: 1998* (TLC-1998) project and defined eight benchmarks related to the density of various computer technologies. He reported that fewer than 20% of the schools had at least one computer for every four students enrolled and 70% of the teachers allowed their students to access computers at school zero or two times a week. Similar low frequency computer use rates at schools has found approximately 45% of teachers reported their students use a computer less than 15 minutes a week (Soloway, et al., 2001). In a recent study, a Tech-Know-Build project in Indianapolis and Crawfordsville, Indiana, conducted by Rockman (2004) shows that "teaching and learning change in consistent and reliable ways when laptops are introduced into the school environment" (p. 36). In his survey, students' attitudes toward writing showed that 76 % of students enjoy writing more on laptops than on paper; 80 % indicated the laptops make it easier to rewrite and revise their writing. Marx et al. (2004) found that in-class availability of computers is strongly

associated with gains in student learning. Soloway et al. argue that a "handheld device can be the PC of choice for K-12" (p. 17) in order to increase classroom availability.

Computer Access Ratio

The explanation for the slow increase in computer use focuses on challenges in the way in which computers are distributed within a school setting. Despite relatively low student computer ratios, in many middle and high schools computers are located in labs and the library media center, which make access during class time difficult. In contrast, elementary schools often place computers directly in the classroom, but at a ratio that requires teachers to rotate students on and off computers in order to provide all students with access (Russell, Bebell, & Higgins, 2004). Russell, Bebell, and Cowan (2003) conducted a study to examine how teaching and learning change when three fourth-grade classrooms were equipped with one AlphaSmart (portable keyboard) for each student. The findings were based on observations, student and teacher interviews, and on students' depictions of themselves working in the classroom. The results indicated that several aspects of teaching and learning did change when the ratio of students to AlphaSmart increased from 3:1 to one student per AlphaSmart. Later, Russell et al. (2004) compared teaching and learning activities in 4th and 5th grade classrooms to examine those rooms that were permanently equipped with one laptop for each student and classrooms that shared a cart of laptops that created a 1:1 computing environment on a temporary basis. The findings summarized in this article provide evidence of several differences in teaching and learning activities between the two settings. Classrooms that were fully equipped with 1:1 laptops showed more technology use across the curriculum, more use of technology at home for academic purposes, less large group instruction, and nearly

universal use of technology for writing.

Owston and Wideman (2001) examined the assumption that "optimal learning occurs in classrooms where every child has access to their own computer" (p. 433). Their results showed that almost twice as much time was spent disciplining students in the four to one computer ratio classes than the one to one and two to one classes.

Conclusion

Media comparison studies are comparing the learning outcomes of an experimental group receiving instructional content via one medium against the outcomes of a control group receiving the same content through a different medium (Clark, 1994b). Media comparison studies have stimulated and encouraged researchers to argue and analyze the debate about the learning benefits of new media. As an educational technology researcher, finding the effect and efficiency teaching methods associated with newest educational technology to help teachers improve classroom skills and students to learn better is an important task.

Learning with media on a classroom work affects students' task learning behavior and time on task. When students accomplish a learning task associated with a technology, they achieve success when they use their own initiative to explore learning beyond their limits. Thus, student learning behavior is encouraged by the media and a student is stimulated to engage more time in a learning task and can accomplish student objectives more successfully.

It is reasonable to expect if the ratio of computers to student remains above 1:1; we are not going to see a positive impact on using computing technologies in learning and teaching. Teachers and students will use computing technologies more efficiently and

effectively only when they are as available as pencils.

Handheld computing devices are changing the way technology is being used at elementary schools. Trotter (2002) indicated that "more and more school officials believe the devices, which are relatively inexpensive compared with laptops or personal computers, are the best way to get technology into the hands of every child" (p. 9) Handheld computers serve as affordable new tools associated with new instructional methods could provide ongoing assessment data to effectively monitor student's learning progress in school.

Chapter 3

METHODOLOGY

This chapter is divided into five sections. The first section describes the information related to the participants in the study. The second section explains the research questions, types of variables used in the study, hypotheses, reliability and validity of instruments used for the purposes of data collection. The third section discusses the experimental procedures of the research study. The fourth section discusses the data collection process. The fifth and final section describes the data analysis used in this research study.

The purpose of the study is to compare the writing efforts associated with two methods of writing a story in a third grade classroom. The first method is writing with pencil and paper. Students had papers on which to write their drafts and to rewrite their final stories. The second method was writing on a handheld computer. Students wrote, revised and saved their stories directly to a handheld computer. Each student was given a Palm Zire or Palm Tungsten T handheld computer with a full-sized keyboard. A handheld application software Word-to-Go was used in the study. The software is a word processing program which allows the students to write, edit and save their documents on a handheld computer. The writing efforts associated with the two methods were compared

using the quality of the stories written, the length of the stories in number of words, and the time on task during writing of the stories.

Participants

Students

The participants in this study were two classes of third grade students from Fuqua Elementary School in Terre Haute, Indiana. The student body is predominantly white and students selected for the study represent the norm of the student body of the school. The two classes under study were mixed gender, with 19 boys and 21 girls. Students and classes were selected based upon their teacher's decision to participate in this study. Data collection took place only for students who agreed to share their stories. All participant data were kept confidential.

In order to equalize students' keyboard skills and reduce keyboard knowledge and experience that could affect the measurement of the time on task; the third grade classes were chosen due to the participants previous keyboarding lessons in the beginning of the semester and their achievement of a basic level of keyboarding skill. The students had participated in a research project related to handheld computer use in the classroom in a previous semester. Therefore, the students had also already learned how to use handheld computers and several pieces of applications software, including the selected word processing program. The students currently were able to work on the handheld computers individually without teacher help and were allowed to use handheld computers freely, but were not allowed to take the handheld computers home.

Teachers

Two third grade teachers in the Fuqua Elementary School were selected based upon their agreement to participate in this study. Both teachers were female (European-American). The teachers used the Indiana Statewide Testing for Education Progress (ISTEP) writing rubric to grade student composition.

Instructor

The researcher served as a classroom teacher to instruct students during the writing task and to help students solve technical problems while they were using the handheld computers. At the end of each class, the researcher uploaded student files from the handheld computers to a desktop computer in the school computer laboratory and printed their files out.

Raters

Two evaluators who were native English speakers with Indiana Teaching Licenses from the local school corporation volunteered to grade the stories. Both evaluators were female. The two evaluators were trained in the use of a story rubric. A one hour training session took place in lecture and discussion format with both evaluators. The first part of training section introduced the content of the story rubric. The second part of training section discussed an interrater agreement procedure. The evaluators practiced using the story rubric to assess five sample student stories.

Observer

A volunteer doctoral student who has participated in classroom observations for Indiana State University and also has several years of teaching experience recorded the students' time on task during the experimental period.

Materials

Two writing prompts were chosen by classroom teachers and the researcher as writing materials. Students can read the information and then do the writing activities. The two writing prompts came out of the Vigo County School Corporation Elementary Language Arts Curricula Guide from 2000 and were developed by a committee of teachers. The first writing prompt's topic is "Life as a Ladybug" with a picture showing a ladybug and her friends. Students were asked to write a real or make-believe story about the way their life would change if they have been transformed into a ladybug according to the following prompts: 1) think about the places you will travel to and what you would see, 2) think about the friends you would meet, 3) think about the many activities you might do and 4) be sure your story has a beginning, middle, and an end. The second writing prompt's topic is "The Mysterious Egg" with a picture showing that Pam has just found a mysterious egg under a tree and she will wondering what will hatch from an egg so big. Students were asked to write a real or make-believe story about the mysterious egg according to the following prompts: 1) think about where Pam found the egg, 2) think about what hatch from the egg, 3) think about what Pam is feeling, 4) think about what Pam will do and 5) be sure your story has a beginning, middle, and an end.

Instruments

Variables

The primary independent variable in the study was the method of writing the story. However, to increase the number of participants and to eliminate the time period of story writing as a confounding variable, two classes were used. Therefore, a second independent variable was class. The dependent variables were the quality of the stories

written, the length of the stories in number of words, and the time on task during the writing of the stories. The quality of the written stories was evaluated using a story rubric. The time on task during writing of the stories was measured by observation during the writing of the stories.

Research Questions

1. Are there significant mean differences in the combined dependent variable (DV) of the quality of the stories written, the length of the stories in number of words, and the time on task for the writing efforts associated with the first method-using pencil-and-paper and the second method-using handheld computers in two classes?
2. Are there significant mean differences in the combine dependent variable (DV) of the quality of the stories written, the length of the stories in number of words, and the time on task for the writing efforts associated with the Class One and Class Two in two methods?
3. Is there a significant interaction between the writing efforts associated with the methods and classes on the combined (DV) of the quality of the stories written, the length of the stories in number of words, and the time on task?

Hypotheses

For the purposes of this study, the following null hypotheses are formed:

1. The first hypothesis stated that the writing efforts associated with the first method pencil and paper will not differ from the second method- handheld computers significantly affect the combined DV of the quality of the stories written, the length of the stories in number of words, and the time on task during writing of the stories in two classes.

2. The second hypothesis stated that the main effect of writing efforts associated with the two third-grade classes, Class One and Class Two, will not significantly affected the combined DV in the quality of the stories written, the length of the stories in number of words, and the time on task during writing of the stories in two methods.
3. The third hypothesis stated that the writing effort associated with methods and classes will not interact in the effect on the combined DV of the quality of written story, the length of the stories in number of words, and the on-task time.

Reliability and Validity

The stories were graded by two raters. To estimate the reliability of the story quality scores, an interrater agreement procedure was used. The stories were assigned a number from one to eighty. One rater graded stories numbered one to fifty. The other rater graded from thirty to eighty. The stories thirty to fifty, therefore, were graded twice by two different evaluators. A correlation coefficient was calculated using these two sets of scores to determine the level of interrater agreement.

The observation to collect data related to time on task was a low-inference observation procedure. It was designed to ensure the reliability of the time-on-task measure. In addition, because the variable itself was a straightforward behavioral variable, the interval coding procedure ensured validity of the measure.

Procedures

The study took place over two weeks. The researcher sent an invitation letter which explained the purpose of the study (see Appendix A) to the principal and had an initial meeting with the teachers and the principal to briefly introduce the purpose of the study and invite the teachers to participate in this research study. The teachers and the

principal showed high support and interest in the study. A written permission letter with Principal's signature from the Fuqua Elementary School showed support for this study (see Appendix A).

In order to ensure students were familiar with handheld computers and to eliminate the "novelty effect" (Clark, 1983) of a new media, the researcher involved students in regular handheld computers practices and helped their classroom teachers respond to technical problem before the data collection period. By doing this, the researcher retained interaction with students and knew the students keyboard knowledge and the expertise level with using handheld computers.

The following time line (see Table 3.1) shows the progression for the study:

Table 3.1

Timeline for Progress Schedule

Date of Week	Task
March, 2005	School visiting/Meeting with teachers and principal
	A written permission letter from principal
April 4-15, 2005	Classroom visiting
April 19, 2005	Data collection:
	1. Class One: writing on handheld computers.
	2. Class Two: writing with a pencil-and-paper.
April 26, 2005	Data collection:
	1. Class One: writing with a pencil-and-paper.
	2. Class Two: writing on handheld computers.

Experimental Procedures

The data collection in this study took place over a two week period in April, 2005. Although the assumption in this study was that there would be no time limit to complete the story for each study, classroom teachers had set up 45 minutes for students to complete a writing task although also allowed students to work on their task for either shorter or longer periods if desired. The two classrooms were organized in the same pattern. Students were arranged in five rows with four seats. Each student was given a number sticker to place on his/her table to represent each student name for two weeks.

The student writing process was similar to a regular classroom writing procedure. The students were given the instructions to complete their writing task. First, there was no time limit to complete their stories. Second, they had to turn in their completed story on papers or on a handheld computer to the researcher when done with their writing task. Third, students were told to write the number on their story instead of name. Fourth, each student wrote a story in reaction to a story prompt read aloud by the researcher. The researcher explained a story prompt and answered students' questions before students started to write their stories. At the same time, the observer was in the classroom to observe and record on-task/off-task data in reaction to the students' time on task during classroom period. Each student's completed time was recorded when he/she turned his/her completed story to the researcher. The researcher was available during all data collection sessions to solve technical problems and concerns of students' questions but without class wide interruptions.

During the classroom observation to collect time on task data, the observer observed each student sequentially in a predetermined order for approximately five

seconds to decide whether the students were on the writing task or not. If the student was obviously engaged in using the handheld computer or the pencil and paper, a "+" was marked beside the student's name for the observation. If the student was obviously not engaged in writing, a "-"was recorded on the observation sheet. If the observer was not able to determine in that five-second period whether the student was engaged in writing, the space for that observation was left blank. After completing the full cycle for all students in the class, the observer began the next cycle by returning to the first student and observing for five seconds. The observations continued with each student being observed in the predetermined order. When an individual student finished writing his/her story and took the handheld computer or paper to the researcher, the observer marked a line through the remaining observation sheet cells in the row for that student and recorded a complete time for each student.

The same procedures were used again during the second week, but the students in Class One used pencils and paper for their stories and the students in Class Two used handheld computers.

Data Collection

The Quality of Written Stories

The students' written stories with pencil-and paper were copied and collected after class. Students' written stories on handheld computer were saved on the handheld computers after the class. The researcher uploaded the document files to a desktop computer and printed them out. No student's name appeared on the stories. Both copies of the handwritten stories and printed stories were sent to two trained evaluators to grade. All data will be stored for three years and then destroyed.

The quality of each story written during the study was assessed using the story rubric which was adopted from the Indiana Statewide Testing for Educational Progress (ISTEP) test. Two trained raters assessed students' stories.

Time on Task Observation

The time on task of each student was measured by observation using five-second sampling interval coding during the writing of the stories. Students were observed and recorded by their seat number. Students were judged to be on-task or doing nothing. The observer selected one of these descriptions of the student's behavior and recorded either a letter + (on-task), or - (nothing). At the end of the observation session, the data were tallied and a percent time-on-task score was obtained. Observational data collection was completed when the individual student complete his/her stories. There was no time limit for students to complete their stories. Each student's on-task time was measured by a percent of time-on-task score compared to the completed time.

The Length of the Stories

The length of the stories in number words was counted by the researcher. All copied written stories were manually counted by the researcher, and all printed written stories were counted by the Word Processing software. The standard of measure for the number of words in the two methods was the same.

Data Analysis

All three hypotheses were analyzed with a two-way multivariate analysis of variance (MANOVA) that investigated the writing effort associated with the method and class differences in the quality of written stories, the length of story in number of words and time on task between two groups of students.

The independent variables were method and class. The dependent variables were the quality of the stories written, the length of the stories in number words, and the time on task during writing of the stories. The significance of the two main effects and one interaction effect was assessed at the .01 alpha level.

If a significant multivariate effect was found, the MANOVA was followed by univariate ANOVA analyses for individual dependent variables.

Chapter 4

RESULTS

This chapter provides results of the study as it relates to each of the three hypotheses. The purpose of this study was to compare the writing efforts associated with the two methods in a third grade classroom. One is the traditional pencil-and-paper method, and the other involves the use of a handheld computer. Three hypotheses were 1) the writing efforts associated with the two methods- pencil-and-paper or handheld computers will not differ significantly with the combined of DV of the quality of the stories written, the length of the stories in number words, and the time on task during writing of the stories; 2) the writing efforts associated with the two third-grade classes will not differ significantly with the combined DV of the quality of the stories written, the length of the stories in number words, and the time on task during writing of the stories; and 3) the writing efforts associated with methods and classes will not interact in the effect on the quality of the stories written, the length of the stories in number words, and the time on task during writing of the stories.

Demographic Data

The participants under this study were 40 third grade students in two classes. The student body included 9 boys and 11 girls in Class One with one Hispanic-American, 19

European-American; and 10 boys and 10 girls in Class Two with one African-American, one Hispanic, one multiracial and 17 European-American. In the first data collection week, both classes had perfect attendance. The valid returned written stories in Class One were 18 due to one student did not want to share his/her story with the researcher and another student who did not save his/her completed story as a given number on the Palm. In the second data collection week, two students were absent in Class Two, whereas Class One had perfect attendance. As a result, there were 18 valid participants in both classes during the two data collection weeks.

Test for MANOVA Assumptions

This study used a two-way multivariate analysis of variance (MANOVA) to evaluate the differences in writing efforts associated with two methods as the first independent variable and two classes as the second independent variable, the quality of the stories written, the length of the stories in number words, and the time on task during writing of the stories as the combined dependent variable (DV).

For multivariate analysis of variance, these assumptions are:

1. The observations with each sample must be randomly sampled and must be independent of each other.
2. The observations on all dependent variables must follow a multivariate normal distribution in each group.
3. The homogeneity of covariance for the dependent variables in each group must be equal.
4. The relationships among all pairs of dependent variables for each cell in the data must be linear.

To test the homogeneity assumption for MANOVA, the homogeneity of variance-covariance (Box's Test) should be evaluated. The Box's Test revealed that equal variances could be assumed, $F(18,16340.025)=1.314$, $p=.167$; therefore, Wilks' Lambda will be used as the test statistic. Linearity of the three dependant variables was tested by creating a scatter plot and calculating the Pearson correlation coefficient. Results indicated a linear relationship. The last assumption homogeneity of variance-covariance was tested with MANOVA.

Pearson Correlation

In order to ensure reliability of raters judgment score on the quality of story written, a Pearson correlation coefficient was examined to determine the level of interrater agreement. The valid returned written stories were seventy-two. One rater graded stories numbered one to fifty. The other rater graded from twenty-two to seventy-two. These two sets of scores twenty-two to fifty were used to conduct a correlation coefficient value. The result showed that Pearson correlation coefficient value was ($r=.93$). The high percentage of agreement provided an indication of reliability.

Results for Hypothesis One

The first hypothesis stated that the writing efforts associated with the first method, pencil and paper will not differ from the second methods-handheld computer significantly affect the combined DV of the quality of the stories written, the length of the stories in number of words, and the time on task during writing of the stories in two classes.

The MANOVA results (see Table 4.1) indicated that the main effect of writing efforts associated with the first methods pencil-and-paper [Wilks' Lambda $\Lambda=.333$, $F(3,66)=44.109$, $p<.001$, multivariate $\eta^2=.667$] was significantly different from the

second method, i.e., handheld computers affect the combined DV of the quality of written stories, the length of the stories in number of words, and time on task during writing of the stories in two classes. Therefore, null hypothesis one was rejected.

Table 4.1

MANOVA Results Effects of Methods and Classes

Effect		Value	F	df	Error df	P	η^2
Intercept	Pillai's Trace	.948	403.933	3	66	.000	.948
	Wilks's Lambda	.052	403.933	3	66	.000	.948
	Hotelling's Trace	18.361	403.933	3	66	.000	.948
	Roy's Largest Root	18.361	403.933	3	66	.000	.948
Methods	Pillai's Trace	.667	44.109	3	66	.000	.667
	Wilks's Lambda	.333	44.109	3	66	.000	.667
	Hotelling's Trace	2.005	44.109	3	66	.000	.667
	Roy's Largest Root	2.005	44.109	3	66	.000	.667
Classes	Pillai's Trace	.256	7.582	3	66	.000	.256
	Wilks's Lambda	.744	7.582	3	66	.000	.256
	Hotelling's Trace	.345	7.582	3	66	.000	.256
	Roy's Largest Root	.345	7.582	3	66	.000	.256
Method*Class	Pillai's Trace	.144	3.693	3	66	.016	.144
	Wilks's Lambda	.856	3.693	3	66	.016	.144
	Hotelling's Trace	.168	3.693	3	66	.016	.144
	Roy's Largest Root	.168	3.693	3	66	.016	.144

Note. Computed using alpha=.01

Table 4.2 presents the group means and standard deviations for the first method (pencil-paper) and second method (handheld computers) on score in the quality of the written stories, the length of story written in number of words, and time on task during writing of the stories in Class One and Class Two.

Table 4.2

Means and Standard Deviations for the combined DV by Methods between Classes

	Pencil-Paper (n=36)		Handheld Computer (n=36)	
	Class One	Class Two	Class One	Class Two
Written Score				
M	4.00	3.78	3.33	3.33
SD	1.19	1.35	1.28	1.28
Number of Words				
M	106.78	108.28	82.00	79.17
SD	52.69	53.28	65.07	49.28
On-Task Time				
M	21.2	19.3	45.72	31.17
SD	9.03	5.43	11.58	8.53

Note. The combined DV represented the written score, number of words, on-task time.

Follow-up univariate ANOVAs were conducted to examine differences in each of the dependable variables. Univariate ANOVA results (see Table 4.3) indicated that the writing effort associated with the first method (pencil-paper) was significantly different from the second method (handheld computers) on the length of story in number of words [$F(1,68)=4.251$, $p=004$, $\eta^2=.059$] and the time on task [$F(1,68)=72.869$, $p=.000$, $\eta^2=.517$] but not the quality of story written between two classes.

Results for Hypothesis Two

The second hypothesis stated that the main effect of writing efforts associated with the two third-grade classes, Class One and Class Two, will not significantly affect the combined DV in the quality of the stories written, the length of the stories in number of words, and the time on task during writing of the stories in two methods.

MANOVA results (see Table 4.1) indicated that the main effect of writing efforts associated with the Class One [Wilks' Lambda $\Lambda=.744$, $F(3,66)=7.582$, $p<.001$,

multivariate η^2=.256] was significantly different from Class Two, i.e. the effect of the combined DV of the quality of the stories written, the length of the stories in number of words, and the time on-task during writing of the stories in two methods. Therefore, null hypothesis two was rejected.

A follow-up univariate ANOVA results (see Table 4.3) indicated that the writing effort associated with the Class One was significantly different from Class Two for time on task [F(1,68)=16.318, p=.000, η^2=.194] but not the length of story in number of words [F(1,68)=.003, p=.959, η^2=.000] and the quality of story written [F(1,68)=.136, p=.713, η^2=.002] for the two methods.

Table 4.3

Univariate ANOVA table

Source	Depend Variable	SS	df	MS	F	p
Method	Number of Word	13068.056	1	13068.056	4.251	.043
	Written Score	5.556	1	5.556	3.400	.070
	Task	5793.364	1	5793.364	72.869	.000
Class	Number of Word	8.000	1	8.000	.003	.959
	Written Score	.222	1	.222	.136	.713
	Task	1297.357	1	1297.357	16.318	.000
Method*class	Number of Word	84.500	1	84.500	.027	.869
	Written Score	.222	1	.222	.136	.713
	Task	663.026	1	663.026	83.340	.005
Error	Number of Word	209053.222	68	3074.312		
	Written Score	111.111	68	1.634		
	Task	5406.278	68	79.504		
Total	Number of Word	859158.000	72			
	Written Score	1056.000	72			
	Task	75723.072	72			

*p<.05

Results for Hypothesis Three

The third hypothesis stated that the writing effort associated with methods and classes will not interact in the effect on the combined DV of the quality of written story, the length of the stories in number words, and the on-task time. The MANOVA results indicated that [Wilks' Lambda Λ=.856, $F(3,66)$=3.693, p>.001, multivariate η^2=.144] the writing efforts associated with methods and class interaction was not significantly effecting the combined DV of the quality of written story, the length of stories in number of words, and the on-task time. Therefore, the null hypothesis was assumed.

Summary of On-Task Frequency and Completed Time

The observation to collect data on time on task is a straightforward behavioral variable. However, in order to analyze individual students' degree of engaged time on a writing task in two methods, each students' on-task frequency and completed time should be identified. Table 4.4 summarizes individual participant on-task frequency associated with his/her completed writing time by two methods-pencil-paper and handheld computer in each class.

Table 4.4

Individual participants' On-task frequency and Completed Time

	Class One					Class Two			
	Pencil-Paper		Handheld Computer			Pencil-Paper		Handheld Computer	
Stu-ID	On-Task	Time	On-Task	Time	Stu-ID	On-Task	Time	On-Task	Time
1	100.00%	18	100.00%	45	22	100.00%	29	100.00%	45
2	100.00%	40	96.55%	56	23	100.00%	19	100.00%	38
3	100.00%	14	100.00%	35	24	94.12%	27	100.00%	40
4	100.00%	12	100.00%	52	25	100.00%	19	88.24%	30
5	100.00%	25	91.30%	44	26	100.00%	20	88.24%	30
6	100.00%	16	80.95%	40	27	80.00%	15	86.67%	27
7	86.67%	37	83.33%	35	28	85.71%	22	95.65%	30
8	100.00%	20	96.88%	65	29	100.00%	12	100.00%	25
9	83.33%	15	91.67%	50	30	85.71%	24	95.65%	40
10	90.00%	17	90.48%	42	31	70.00%	13	85.71%	25
11	100.00%	35	94.12%	69	32	100.00%	24	100.00%	22
12	100.00%	36	100.00%	50	33	94.12%	27	94.74%	35
13	100.00%	19	96.43%	54	34	93.33%	21	88.24%	30
14	100.00%	20	95.24%	40	35	81.82%	26	100.00%	22
15	100.00%	25	73.53%	80	36	100.00%	21	100.00%	38
16	100.00%	15	96.55%	55	37	100.00%	15	100.00%	30
17	90.00%	29	96.15%	50	38	46.67%	26	96.55%	52
18	100.00%	10	64.71%	36	39	88.89%	27	88.24%	30

Chapter 5

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to compare the effect of different writing efforts associated with two methods, pencil-paper and handheld computers, in two third grade classes. The comparisons were guided by three research questions. First, are there significant mean differences in the combined dependent variable (DV) of the quality of the stories written, the length of the stories in number of words, and the time on task during writing the stories for the first method (pencil-and-paper) and the second method (handheld computers) in two classes? Second, are there significant mean differences in the combine dependent variable (DV) of the quality of the stories written, the length of the stories in number of words, and the time on task during writing the stories for Class One and Class Two in two methods? Third, is there a significant interaction between the effect of writing efforts associated with the methods and classes on the combined DV of the quality of the stories written, the length of the stories in number of words, and the time on task?

The sample selected in this study was 40 third grade students in a local elementary school. Each student was given two similar story prompts and asked to complete two written stories individually with pencil-paper and on a handheld computer

in two data collection periods. A two-way MANOVA revealed significant differences for the two main effects and no significant different effects in the interaction between the two methods and two classes. Based on the data presented and on the analysis, the following conclusions were drawn from the findings of the study

Different Effects of Writing Efforts Associated with Two Methods

A multivariate analysis of variance (MANOVA) test revealed the finding in this study that the first main effect for writing efforts associated with the first method (pencil-paper) was shown to be significantly different [Wilks' Lambda Λ=.333, $F(3,66)=44.109$, $p<.001$, multivariate $\eta^2=.667$] from the second method of the handheld computer affect in the combined DV of the score in the quality of the written stories, the length of the stories in number of words, and time on-task during writing of the stories in two classes. Follow-up univariate ANOVA results indicated that the effect of writing effort associated with the first method of pencil-paper significantly differed from the second method-handheld computers in the length of story in number of words [$F(1,68)=4.251$, $p=004$, $\eta^2=.059$] and the time on task [$F(1,68)=72.869$, $p=.000$, $\eta^2=.517$] but not in the score on the quality of story written in two classes.

The first finding in this study revealed that the effect of students' writing effort associated with the first method of pencil-paper differed from the second method of handheld computers in the longer length of story in number of words and shorter on-task time on the first method than on the second method, but not significantly different in the score on the quality of story written in two classes.

No differences in students' written scores on the quality of story written in Class

One and Class Two in two methods were found. This finding is consistent with previous research reporting "no learning benefits" statement by Clark (1983) and Duling (1985) examined on no difference in the judgment about the quality of writing with pencil-paper or computer writing revision.

The second finding in shorter length of story in number words while writing on handheld computers differ from writing on pencil-paper can be supported by Beesley's (1986) investigation in comparing the revision effect of word processing when utilizing word processors and pen. Also, these results indicated that, at least for this sample third grade students' level of keyboarding skills can impact students' composition production on writing a long length of stories comparing with writing on pencil-paper.

The third finding in longer on-task time while writing on handheld computer than on pencil-paper is supported by a Lee et al. (1999) study that examined the relationship between the percentage of on-task behavior and completion of school work, Newhouse (2001) reported on a follow-up study of students attitudes while using portable computers. The result appeared that for the younger students the portable computers appeared to be used for a greater range of tasks. This finding confirmed the notion by Clark (2001) that past media comparison research on learning lacked an exploration of measured time on task. This finding makes intuitive sense because writing on handheld computers will generate an inevitably more difficult writing tasks compared with writing with pencil-paper because students have to overcome technical problems before they begin to construct their composition.

Difference Effects of Writing Efforts in Two Classes

The second main effect for writing efforts associated with the two classes was

shown to significantly [Wilks' Lambda Λ=.744, $F(3,66)$=7.582, p<.001, multivariate η^2=.256] affect the combined DV of the quality of the stories written, the length of the stories in number words, and the time on-task during writing of the stories in two methods. Follow-up univariate ANOVA results indicated that the effect of writing effort associated with Class One significantly differed from Class Two on the time on task [$F(1,68)$=16.318, p=.000, η^2=.194] but not the length of story in number of words [$F(1,68)$=.003, p=.959, η^2=.000] and the quality of story written [$F(1,68)$=.136, p=.713, η^2=.002] between the two methods.

This finding might be associated with the limitation in this study due to students' experience and exercise on using handheld computers in Class One are longer than Class Two. More technical questions, such as, how to change the color of texts, how to enter slashes, colons on a portable keyboard were asked by students in Class One compared with none in Class Two. The result also can be viewed as a reasonable explanation that students in Class One were spending more time on task to edit and revise their compositions than students in Class Two. Also, the differences in the two classes' time on task behavior can be affected by the classroom teachers' perception of using computing technology in the classroom. While the classroom teacher in Class One is expert in using handheld computers and the other teacher is more afraid to use them in Class Two.

On-Task Behavior Observation in Classrooms

Most unique to this study is adding the qualitative methods in experiment during the classroom observation to collect time on task data. Hence, it is important to present additional findings as to how students' reactions and behavior changed in the classrooms

during writing of the stories in two methods.

Difference in Classroom Activity

Overall, the two classes of students worked on their own task quietly and without asking questions while writing with pencil and paper in a shorter on-task completed time while compared with a little more noise and longer on-task completed time while writing on handheld computers. The classroom noise began with students' volunteering to spread out handheld computers and keyboards to everyone. After students had a handheld computer, they became very excited to turn on the machine and wanted to type words on it. Even while students were writing their individual composition, many of them tried to peak at others' work or attempted to help with other students' problems.

Only a few technical problems were reported while students worked on handheld computers; however, many students asked the researcher several questions on how to spell specific vocabulary compared to no students who asked for help while working with pencil-paper.

Individual On-Task Engagement Improvement

By analysis with individual student's completed on-task time in Class One with the two methods, most of the students had a longer on-task time while writing on a handheld computer than with pencil-paper. In other words, students were apt to spend more time as well as more engagement on their writing task while writing on a handheld computer. More specifically, the lowest student's engagement on-task time frequency (83.33%) in writing with pencil-paper increased to on-task frequency (91.67%) in writing with a handheld computer. Similar results were also found in Class Two with the lowest student's engagement on-task time frequency (46.67%) writing with pencil-paper had

increased to on-task frequency (96.55%) while writing on a handheld computer.

Recommendations for Future Research

The results in this study have implications for future research. First, more research is needed to confirm the findings in the change on students' on-task time observation as students' level of keyboarding skills increased in the future. Second, during classroom observation, students tended to compete with others work while writing on handheld computers. This finding leads to the tentative hypothesis that a collaborative learning exercise could affect student learning motivation compared to an individual work exercise while using a mobile device in the classroom. Further evidence for this hypothesis could be tested. Third, integrating mobile computing applications into different subject matter to stimulate students' engagement on-task learning in the elementary classroom could be another track for future research.

Conclusions

The goal in this study was to explore how the processes of student's writing efforts differ when using handheld computers and pencil-paper in the elementary classroom and gain a better understanding of how the different factors of these methods may impact student's on-task learning processes. Both quantitative and qualitative methods were used to support more complete address of the research on testing the nature of the contributions of the effect of utilizing handheld computer in the elementary classroom. The results in this study revealed the processes of students' writing efforts differed in the two methods existed. By utilizing handheld computers as a writing tool in the elementary classroom, it should be emphasized that importance of handheld computers impacted the process of writing effort on time on task and attitudes changed in

learning behaviors.

As Hennessy (2000) mentioned for young students, using handheld computing increased students' attitudes to enjoyment of working with computers. Those enjoyment experiences will help students learn by increasing time-on-task (Walberg, 1988) and gain a meaningful writing experience through handheld computers (Vincent, 2003). Clark (1994) claimed "media and their attributes have important influences on the cost or speed of learning but only the use of adequate instructional methods will influence learning" (p. 27). It is necessary to carefully develop effective instruction with mobile computing devices and assess the results when using them for educational purposes. Gay, Stefanone, Grace-Martin, and Hembrooke (2001) pointed out "not every teaching activity or learning community can or should successfully integrate mobile computing applications" (p. 273).

Although Soloway et al. (2000) proposed a skeptical question as to whether a handheld device can be the PC of choice for K-12 in the future, these portable technologies provide a low cost computing writing tool with the possibility to be accessed at anytime and anywhere in the field of K-12 and higher education. As Pfeifer and Robb (2001) indicated, handheld computing has changed the rules of technology usage in the classroom activity. They save space for computer labs and are easy to install in the classroom. As handheld computing devices become an educational power tool and reduce student to computer ratios to 1: 1, all students can learn more easily and effectively in the classroom.

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APPENDIX A

An Invitation Letter and A Written Permission Letter

An Invitation Letter from the Researcher

Ling-Chin Ko
Room 1010, College of Education
Indiana State University
Terre Haute, IN 47809
March 8, 2005

Fuqua Elementary School
1111 E. Wheeler Ave.
Terre Haute, IN 47802

Dear Mrs. Mary Beth Harris,

My name is Ling-Chin (Allison) KO. I am a doctoral student in the Indiana State University, Department of Curriculum, Instruction and Media Technology.

I would like to invite two third grade teachers and third grade classes to participate in my research study on application of handheld computers in the elementary classroom. Dr. Melissa Nail is one of my doctoral dissertation committee. She highly recommends that your students are the best qualified for this study.

The goal of this study is to compare the difference between two methods of writing a story in the third grade classroom. The first method is writing through a handheld computer, and the second method is writing through pencil-and-paper. More specifically, the purpose of the study is to investigate if differences exist between writing through a handheld computer and a pencil-and-paper as determined by: (1) the length of the stories in number of words, (2) the quality of story written, and (3) the time on task during the writing of the stories

I will be responsible for instructing students in how to use handheld computers, providing two story prompts and recording students' time on task observed during the writing process. Two evaluators who are native English speakers with Indiana Teaching Licenses from the local school corporation have volunteered to grade the stories. I will collect the data/student's stories at the end of each class.

This study will help students learn more about handheld computers, it will also teach me important ways to help other children in the future. Again, I am glade to invite you and your students to participate in this study. If you have any question, please send me an e-mail. lko@mymail.indstate.edu or call me at 237-7454.

Sincerely

Ling-Chin (Allison) Ko