Final Team Project

LT 785 Research Methods in Educational Technology

Don Wiken

Submitted by Max Hodgen and Darren Swenson

Dec. 18th, 2009

I - Statement of the Research Question

How has or will technology improve integration and learning in math and science in the K-12 schools?

II - Summary of the Literature

Technology plays an integral role in the lives of millions of U.S. students every day. Their use of communication devices, gaming systems, ipods, social networking groups, and ability to navigate the internet and design multimedia works of art are just a few activities that typical American students participate in daily. However, extensive amounts of research conducted to investigate teachers' experiences about the amount of technology in their instruction suggest that the majority of teachers do not feel well prepared to integrate technology into their teaching because of the time that to learn, plan, and implement educational technology is too long, especially for computers (Turkmen, 2006). A majority of teachers blame time as the greatest barrier to their successful integration of computers; this was evident not only in their lack of computer preparation, but the usage as well (Cummings, 1998).

It is time to more fully integrate technology into the educational setting since skillful use of technology supports the development of process skills such as higher order skills, adaptability, critical thinking, problem solving, and collaboration that are essential to succeed in our rapidly changing information age (Turkmen, 2006). Technology integration into the math and science curriculums applied with a constructivist teaching philosophy could better prepare U.S. students to complete in an ever changing global economy. The Third International Mathematics and Science Study (TIMSS) reported disturbing finding about the performance of U.S. secondary school students in science and mathematics, ranking them well below the international average (Blume, 2001).

In a meta-analysis conducted by Sule Bayraktar, of 42 studies yielding 108 effect sizes, found that a typical student moved from the 50^{th} percentile to the 62^{nd} percentile in science when computer assisted instruction (CAI) was used (2002). The analysis compared CAI to traditional teaching methods with respect to eight different variables. The most promising results for supporting the integration of technology resulted in the mode of CAI and the subject matter (Bayraktar, 2002).

In the above mentioned meta-analysis, the results also revealed which science courses benefited the most from CAI. The largest mean effect was found for physics (ES =0.555), suggesting that CAI is most effective in physics, and the lowest mean effect for Earth science (Bayraktar, 2002). These results appear to logically coincide with the best modes of CAI for increasing achievement, which are simulations and tutorials. Learning physics is an active process that requires students to analyze, synthesize, and problem solve.

The present analysis revealed that computers are more effective when used in simulation or tutorial modes (Bayraktar, 2002). Simulations in both math and science allow the student to actively interact with the process; manipulating variables while leaving others constant to quickly analyze different outcomes. Simulations provide students with access to real-world situations that they would otherwise find difficult to experience in a classroom setting.

Science and mathematics can be considered as two separate subjects. In reality, they go hand-in-hand. Science uses mathematics to solve problems, gather data and to create quantitative models. In the past, methods of gathering data included using analog equipment, graph paper and mechanical tools to synthesize the information. With today's technology explosion, the methods of using mathematics in science have changed. Graphing programs, graphing calculators and probeware make data collection easier, faster and more real-world (Lukens, J. and Feinstein, S. 2000).

In a study by Lukens, J. and Feinstein, S. (2000), students that enrolled in an integrated Advanced Placement Biology/Calculus block course scored 43.5% higher on the Advanced Placement Biology Exam compared to students enrolled in a traditional Advanced Placement Biology course. Of the students in the integrated course, 85% passed the AP Biology exam, scoring a 3 or higher (scale of 1-5) in comparison to the students of the traditional AP Biology course with 38% passing.

With the use of these modern tools, the integration of mathematics and science has never been easier and more productive. In a report by Rye, Priselac & Bardwell (1999), graphing calculators can be used to generate descriptive statistics of data, which in turn, can be analyzed to develop understandings of variables, correlation and linear regression. Students will have immediate feedback when collecting data, be able to simulate situations based on collected variables, and make the real-world connection between mathematics and science.

Computers and computer software can be a valuable tool in integrating math and science. Cummings (1998), states that spreadsheets are an invaluable tool for students charting data. Once the data has been entered, students can create visual displays in the form of graphs to visually analyze the data. Spreadsheets can also be used for keeping student records, such as grades and financial information. As valuable as the commercial software can be, some research has concluded that experimental/teacher developed software was relatively more effective than commercial software (Bayraktar, 2002).

One obstacle to fully integrating technology into the math and science curriculums is the professional development required to train educators. A survey conducted by Hezel Associates, of PBS TeacherLine, a federally funded online professional development initiative for K-12 educators, found that seventy-three percent of teachers pay in full or in part for taking online courses/modules (2006). Although the lack of funding is discouraging, research does suggest some positive effects of professional development. In a self-efficacy survey of 377 participants conducted by Overbaugh and Lu, participants revealed increased confidence and competence in technology integration (2008). The pair sample t-test of the self-efficacy survey (pre, post, and follow-up) revealed there were statistically significant differences in the means. On surprise came from the mean of the follow-up survey, which revealed higher than expected self-efficacy reports (Overbaugh, 2008). In short, teachers continued to feel confident about their ability to integrate technology.

One would tend to think that significant gains were being made with the training of pre-service teachers with regards to educating them with more effect methods of technology integration, but the research suggests otherwise. In a survey conducted on new teachers in Silicon Valley, Ca, only one third of the male respondents and one quarter of the female respondents said that "technology was important" in their pre-service program, so it was not surprising to see that a combined 65.5 percent of males and 68.2 percent of females either disagreed or strongly disagreed with the statement "My pre-service teacher training program included teaching with technology methodologies that were beneficial to me." (Hernandez-Ramos, 2005).

III - Summary and Conclusions

Technology or computer assisted instruction can improve learning under some particular conditions. Research is showing that a learning environment with a low student to computer ratio that uses modes such as simulations, tutorials, graphing calculators and hand held sensors are more effective than traditional methods of instruction (Bayraktar, 2002).

To fully realize the benefits of integrating technology into math and science a paradigm shift in teaching philosophy within the educational community will be necessary; a philosophy of constructivism that more closely relates to "21st century skills. The large majority of schools (and school systems) have a long way to go before it can be said that they have structured their activities around the possibilities offered by new technology and newer pedagogies, to the same degree that industries such as banking or travel (for example) have been fundamentally transformed over the last 10 to 20 years (Hernandez-Ramos, 2005).

If one of the goals of math and science education is to prepare students to compete in a rapidly changing global market then educators must equip students with the skills necessary to compete. To be successful in the workplace of the 21st century, individuals must not only have an extensive store of knowledge, but also must know how to keep that knowledge current, apply it to solve novel problems, and function as a member of a team (Artino, 2008).

IV - Application of the Research in a Typical School/Classroom

If technology is to be used as a tool to help integrate math and science, school districts in this nation are going to need to make committed changes. School districts will need to dedicate time for educator training. This training will need to include how to utilize the new technology as well as implementing the technology into the curriculum. Without this time, educators will be reluctant to implement the use of technology into their math and science curriculums.

School districts will also need to make a monetary commitment to purchase the required technology, whether it is graphing calculators, computers, software, or probes. Complete laboratory sets will be required in the classrooms for the integration of math and science with technology to have a chance of becoming successful. A single set of probes, graphing calculators without probeware, software that cannot be utilized on all student machines or computers that are out of date will hamper efforts of educators in the implementation the integration process.

Finally, teachers need to take more of a constructivist philosophy to education; structuring their lesson around student-centered activities and problem based learning. Thematic units in which real-world situations are analyzed by teams of students will need to be implemented if true integration of math and science is to occur. Math and science teachers will also need to work in cadres for this integration to become a success. Team-teaching with block scheduling would greatly improve the chances of a successful integration program.

V - List of References

References

Artino, A. (2008). A Brief Analysis of Research on Problem-Based Learning. (ERIC Document Reproduction Service No. ED501593)

Bayraktar, S. (2002). A Meta-Analysis of the Effectiveness of Computer-Assisted Instruction in Science Education. *Journal of Research on Technology in Education*, *34*(2), 173-188. Retrieved December 1, 2009, from Research Library. (Document ID: 113176812).

Blume, J., Garcia, K., Mullinax, K., & Vogel, K. (2001, May 1). Integrating Math and Science with Technology. (ERIC Document Reproduction Service No. ED 454088)

Cummings, C. (1998). Teacher Attitudes and Effective Computer Integration. (ERIC Document Reproduction Service No. ED 419512)

Hernandez-Ramos, P. (2005). If Not Here, Where? Understanding Teachers' Use of Technology in Silicon Valley Schools. *Journal of Research on Technology in Education*, *38*(1), 39-64. (ERIC Document Reproduction Service No. EJ 719937)

Hezel Associates., S. (2007). PBS TeacherLine National Survey of Teacher Professional Development, 2005-2006. *Hezel Associates,* (ERIC Document Reproduction Service No. ED499124)

Lankard, B., & ERIC Clearinghouse on Adult, C. (1993). *Integrating Science and Math in Vocational Education.* (ERIC Document Reproduction Service No. ED 355456)

Lukens, J., & Feinstein, S. (2000). Graphing Calculators' Impact on AP Biology. (ERIC Document Reproduction Service No. 446978)

Overbaugh, R., & Lu, R. (2008). The Impact of a NCLB-EETT Funded Professional Development Program on Teacher Self-Efficacy and Resultant Implementation. *Journal of Research on Technology in Education*, *41*(1), 43-61.

Rye, J., Priselac, N., & Bardwell, J. (1999). Connecting Science, Mathematics, and Human Health: Applications of the Graphing Calculator in Teacher Professional Development and Student Academic Enrichment. (ERIC Document Reproduction Service No. ED443681)

Appendix A - Analysis of Research

Article 1 Darren Swenson

Bibliographic Citation (APA Style)

Lukens, J., & Feinstein, S. (2000). Graphing Calculators' Impact on AP Biology. (ERIC Document Reproduction Service No. 446978)

Type of Research:

Type of Research:	___ Descriptive	___ Correlation
	___ Experimental	___ Causal-Comparative
	___ Historical	__xx_ Quasi-Experimental
	___ Meta-Analysis	___ Survey

Evidence from article you used to determine Type of Research

The study was done over a period of two school years (1997-1999). The researcher took test results from the Advanced Placement Biology Exam taken by students from two different classes: one entitled AP Biology taught traditionally; the other entitled AP Biology/Calculus taught in a two-period block. Also, grade point averages (GPA's) of the students in the two classes were compared. The researcher appears to be an instructor of one or both classes, making this more of a quasi-experimental study than a causal-comparative study.

Purpose of the Research

The purpose of the research was to determine if the use of graphing calculators would improve student achievement in upper level biology courses.

Instruments Used

The instrument used in this study is the Advanced Placement Biology Exam. Also, descriptive statistics of the students' grade point averages were used.

Validity and reliability of Instruments Used

The AP Biology Exam is a valid instrument to be used for purpose of this research. The AP Biology Exam provides content-related evidence of student achievement. The AP Biology Exam is also a reliable instrument based on the comparison of grade point averages between the classes.

Subjects

The subjects in this study are students in the same high school enrolled in AP Biology/Calculus block course (39 students) or traditional AP Biology (105) over a two year time period.

Results and Conclusions

The results of this study indicate that students that took AP Biology/Calculus block course, integrating the use of graphing calculators, achieved 43.5% higher on the AP Biology exam than students that took the traditional AP Biology course when the means of the two classes' AP Biology exam test scores are compared. Of those that took the AP Biology/Calculus block course, 85% passed the exam with a score of 3 or higher (on a scale of 1-5). Of those that took the AP Biology traditional course, 38% passed the exam. When the grade point averages were compared, there was a 7.4% higher GPA average for the AP Biology/Calculus block course.

Possible Influence of Extraneous Variables

There are multiple possible extraneous variables that need to be considered in this quasi-experiment. First and foremost is the time students spend in the classroom each day. The students in the AP Biology/Calculus block course were in class twice as much as those in the AP Biology traditional course. The second obvious extraneous variable is that the block course was taught by two instructors while the traditional course was taught by one.

Other extraneous variables may include course materials, time of day, class size, teaching methods, teacher personalities, and academic proficiency of the students.

Possible Threats to Internal and External Validity

Some possible threats to internal validity include subject characteristics (students were not randomly selected), loss of subjects (number of students that dropped out of the courses are unknown), data collector characteristics (how the instructors implemented the study), data collector bias (the researcher was the instructor), extraneous events (many of which happen in public schools), attitude of subjects(it is unknown if the students knew they were in a study), and implementation (which could be instructor related or personal bias of the students' choice of course).

This study was done in one school with two courses in a two-year period. The results do suggest that the integration of the graphing calculator into a biology course increases student achievement. However, the generalizability of the results to a larger population is in question, as stated by the author.

Generalizability of Results to Local Issues

Based on the lack of demographic information of the high school in which the study was conducted, it is difficult to generalize the results to certain areas of the country. However, AP requirements have been established nation-wide. Therefore, the results may be applicable to AP Biology courses nationwide.

Article 2 - Max Hodgen

Bibliographic Citation (APA Style)

Bayraktar, S. (2002). A Meta-Analysis of the Effectiveness of Computer-Assisted Instruction in Science Education. *Journal of Research on Technology in Education*, *34*(2), 173-188. Retrieved December 1, 2009, from Research Library. (Document ID: 113176812).

Type of Research:

___ Descriptive
___ Experimental
___ Historical
_X__ Meta-Analysis
___ Correlation
___ Causal-Comparative
___ Quasi-Experimental
___ Survey

Evidence from article you used to determine Type of Research

The type of research was clearly stated and a brief explanation of what meta-analysis research is was provided. The study reviewed and coded 42 studies and produced an effect size of 108.

Purpose of the Research

This meta-analysis investigated how effective computer assisted instruction (CIA) is on student achievement in secondary and college science education when compared to traditional instruction between 1970 and 1999.

Instruments Used

Studies used for the meta-analysis were located through electronic data bases and manual searches of professional journals. Studies for analysis were limited to experimental and quasi experimental research conducted in the United States. Studies that didn't use a comparison group in their design or those that didn't provide adequate statistic for transformation into effect size were not included.

A coding sheet was prepared for translating study information into coded form. Variables and effect size information was coded by three coders.

Validity and reliability of Instruments Used

A random sample of 5 of the 42 studies were duplicated and distributed among the coders. To assess inter-coder reliability, agreement rated (AR) or percent agreement index was used. An agreement rate of 0.88 was found; an AR greater than 0.85 should be considered sufficient.

Subjects

The meta-analysis compared the science achievement of students exposed to CAI to students taught with traditional methods. The following variables were used in the analysis to make relationships:

- Course Content
- Science Subject
- Instructor Effect
- Duration of Treatment
- Publication Date
- Software Design
- Student to Computer Ratio

Results and Conclusions

The mean of the 108 effect sizes was determined to be 0.273 standard deviations, indicating a small positive effect for CAI in science education when compared to traditional instruction. The average student exposed to CAI exceeded the performance of 62% of the students taught using traditional instruction methods.

Significant differences were found between the specific subjects within science and the methods of CAI. The most effective mode of CAI was simulations followed by tutorials, practice and drill methods had an overall negative effect. Subjects benefiting the most from CAI were physics and general science, where Earth science had overall negative effects. Teacher designed CAI had a larger mean effect than commercially designed software.

The results of the study also indicated that the length of the treatment was strongly related to CAI in science education. As the length of the CAI increased beyond four weeks the effectiveness began to decrease.

Finally, one surprising relationship between effect size and publication date exists. Results revealed that CAI was most effective between 1970 -1979 and least effective between 1990 - 1999.

Possible Influence of Extraneous Variables

Since the meta-analysis is an analysis of 42 separate studies, individual components of each study were not presented within the analysis. One argument about conducting a meta-analysis is that a poorly designed study counts as much as one that has been carefully designed.

Possible Threats to Internal and External Validity

The Hawthrone effect could be used to explain the results related to the length of treatment and the relationship of the publication date. The students are stimulated to greater efforts because of the novelty. As time progress, in either the case of the treatment or the publication date, it loses its attractiveness and becomes less effective.

The results of instructor effect showed that when different instructors taught the CAI group and traditional group the effectiveness of the CAI group was higher. All thought, further investigation of the data revealed that about 33% of the studies did not specify if same instructors or different instructors were used.

More explanation could have been provided within the analysis or in an appendix relative to the coding process used to synthesize the data of each study.

Generalizability of Results to Local Issues

As a math and science teacher the results are encouraging as they provide some direction and statistical research to support my own CAI. Simulations and tutorial are far more effective than drill and practice methods. CAI is far more effect when students use computers individually, which is the current teaching environment that I am involved with now. Finally, CAI is more beneficial when it is utilized as a supplement to traditional instruction than a substitute.

Appendix B – Shared Participation in Writing the Final Paper

<u>Max:</u>
5 Articles:

A Brief Analysis of Research on Problem-Based Learning

If Not Here, Where? Understanding Teachers' Use of Technology in Silicon Valley Schools

The Impact of a NCLB-EETT Funded Professional Development Program on Teacher Self-Efficacy and Resultant Implementation

A Meta-analysis of the Effectiveness of Computer-Assisted Instruction in Science Education

PBS TeacherLine National Survey of Teacher Professional Development

II-Summary of the Literature
III-Summary and Conclusions
V-List of References
Appendix A: Article #2 – Analysis of Two Research Articles

<u>Darren:</u>
5 Articles:

Connecting Science, Mathematics, and Human Health: Applications of the Graphing Calculator in Teacher Professional Development and Student Academic Enrichment

Graphing Calculators' Impact on AP Biology

Integrating Math and Science with Technology

Integrating Science and Math in Vocational Education

Teacher Attitudes and Effective Computer Integration

I – Statement of the Research Question/Problem
II-Summary of the Literature
IV – Application of the Research in a Typical School/Classroom
Appendix A: Article #1 – Analysis of Two Research Articles
Appendix B: Shared Participation in Writing the Final Paper

References

Artino, A. (2008). A Brief Analysis of Research on Problem-Based Learning. (ERIC Document Reproduction Service No. ED501593)

Bayraktar, S. (2002). A Meta-Analysis of the Effectiveness of Computer-Assisted Instruction in Science Education. *Journal of Research on Technology in Education*, *34*(2), 173-188. Retrieved December 1, 2009, from Research Library. (Document ID: 113176812).

Blume, J., Garcia, K., Mullinax, K., & Vogel, K. (2001, May 1). Integrating Math and Science with Technology. (ERIC Document Reproduction Service No. ED 454088)

Cummings, C. (1998). Teacher Attitudes and Effective Computer Integration. (ERIC Document Reproduction Service No. ED 419512)

Hezel Associates., S. (2007). PBS TeacherLine National Survey of Teacher Professional Development, 2005-2006. *Hezel Associates*, (ERIC Document Reproduction Service No. ED499124)

Lankard, B., & ERIC Clearinghouse on Adult, C. (1993). *Integrating Science and Math in Vocational Education.* (ERIC Document Reproduction Service No. ED 355456)

Lukens, J., & Feinstein, S. (2000). Graphing Calculators' Impact on AP Biology. (ERIC Document Reproduction Service No. 446978)

Overbaugh, R., & Lu, R. (2008). The Impact of a NCLB-EETT Funded Professional Development Program on Teacher Self-Efficacy and Resultant Implementation. *Journal of Research on Technology in Education*, *41*(1), 43-61.

Rye, J., Priselac, N., & Bardwell, J. (1999). Connecting Science, Mathematics, and Human Health: Applications of the Graphing Calculator in Teacher Professional Development and Student Academic Enrichment. (ERIC Document Reproduction Service No. ED443681)