# A Comparison of Student Achievement: Online and Face-to-Face Learning

## Introduction

With the state and national educational leadership concerned that increasing student achievement in math and science is needed to maintain global competitiveness, some see online classes as a necessary tool (Roblyer, 2009). This study will be a comparison between two learning groups. The learning gains of a traditional face-to-face group will be compared to the learning gains of an online group. The goal of the comparison is to identify possible differences and similarities in student achievement between the two learning environments. The study will investigate specific academic content learning gains in science. Using a statistical method, an analysis of available assessment data will be made to provide insight on the current status of specific content learning. Student achievement of both groups is assessed by the End of Course Test (EOCT) for physical science. Examination of this data will bring about more understanding of the impact that online learning has on the current education model. In the state of Georgia, a science course is a requirement for high school graduation. The data for this study will be a county wide collection from high schools.

## Introduction to Literature Review

Common online learning definitions: online learning, web based learning, Web based instruction, Web based training, Internet-based training, distributed learning, and off-site nomadic learning (Khan, 2005).

The National Center for Education Statistics reported in 2004-2005 that 506,950 public school students from both high school and middle school were enrolled in online

courses (Roblyer, 2009). Khan (2005) claimed that research evaluating instructional approaches for online learning was still limited.

This study examined current literature that compared student achievement between online and face-to-face courses. The reports were retrieved from database searches online. The databases included Eric from EBSCO Host, and ProQuest. Google searches retrieved studies from state and federal departments in US education and in US education foundations. The searches produced 50 studies that targeted the comparison topic, however only 15 studies were presented here. Reports were selected based on their common definition of online characteristics, curriculum content, and geographic significance. The data came from several US states, such as Pennsylvania, Indiana and Florida. An effort to include data from international sources was also made; two studies from Australia and one study from Romania were included in this review. Due to the global interest in online technology and science content, the majority of these selected studies were chosen based on their content on student achievement in specific content, science and math.

*Theory of Online Learning*

Online learning described education through participation and use of the Web, without face-to-face contact. In the education community *eLearning* was an adequate term used to define Web participation and use of Web based technology tools. These tools were also described as Web distributed and Web capable for the purpose of education. E-Learning may or may not be combined with face-to-face instruction. Depending on the college or university, the distinction between purely online and partly online was not consistent (Nichols, 2003).

Nichols (2003) stated that "technology is pedagogically neutral." The technology components were reported as important in the definitions of terms. It was also reported that pedagogy strategies built the framework that provided purposeful education; eLearning enabled unique individual learning that fits within the existing paradigm of face-to-face pedagogical practices. (Nichols, 2003 & Gregor, 2002).

Learning approaches using Information and Communication Technologies (ICT) provided many opportunities for constructivist teaching (Oliver, 2002). The ICT settings enabled learning to be related to context and practices unlike conventional lesson planning approaches (Oliver, 2002). Bodies of research indicated that constructivism theory is a suitable philosophy for online learning environments, ensuring the "learning among learners" (Koohang et el., 2009). Education based on cognitive theory and implemented using online tools allowed prior learning experiences to scaffold the learning experience further. Constructivism is regarded as a path to identify environmental relationships and variables that impact the means to build on student learning (Koohang et al., 2009). The constructive learning theory framed by Dewey, Piaget, and Vigotsky and further discussed by Hein (1991) referred to the idea that learners construct knowledge by themselves.

*Rationale for the Study*

The global need for highly skilled graduates with knowledge of science and math prompted some to support the union of online learning to the traditional education model. Research has not caught up to the expansion of eLearning, and research on specific content learning is very limited. The purpose of the literature review was to explore the two learning environments and student achievement. The literature was divided into four

sections titled performance results: similarities, positives for online, positives for face-to-face and related variables.

*Performance Results: Similarities*

Researchers examining psychology class assignments completed by 32 graduate students and 59 undergraduates found "no difference in quality of work between the online section and the face-to-face section" (Dell, 2010). These students, 14 graduate online, 13 undergraduate online, 18 graduates face-to-face and 46 undergraduate face-to face, were selected randomly. The selection process assigned random numbers for identification purposes. Using course assignments, researchers identified data by their assigned numbered format. The coded format was unknown by the instructor prior to the analysis. The assignments were measured for *knowledge of theories* and *constructs*; this data, along with an analysis of short stories, the description of journal articles and/or observations of the learning process were included as data. Answers to essay questions on final exams were also included in the statistical comparisons.

Franklin (2001) had similar research results when the researcher compared real dissection techniques with online dissections. The findings suggested little achievement differences between the two types of instructions. A required class, the lessons were based on the learning of organ structure and organ functions, and these lessons emphasized the use of live animal lab dissection practices. The lessons were known to have the highest disapproval rating because of the involvement of live and dead animals (Franklin, 2001).

The study measured the perceived effectiveness of "real" and "virtual" lab dissections in a first-year biology course. Students' exam results were compared, and the

findings offered support for online use as a *sensitive* alternative learning tool. The data was collected from 400 students; participants were randomly selected from a cohort of 800 first year biology students. A combination of qualitative and quantitative surveys and focus discussion groups were implemented during the introductory and final stages of the course (Franklin, 2001).

Brownstein, Brownstein, & Gerlowski (2008) stated in a comparative assessment, "no significant" differences were indicated in online learning and that of face to face. This sample of data originated from a required MBA course, which was instructed online and face to face by the same instructor. The performance of the 26 online students and 27 face to face students was identically assessed. Writing assignments and final exam grades were compared. The statistically evaluated MBA course work supported the use of the online environment (Brownstein et al., 2008)

Cavanaugh, Gillian, Kromrey, Hess, and Blomeyer (2001), using a meta-analysis, indicated that online learning was equal to academic achievement of traditional instruction for K-12 levels. These researchers stated that the US Department of Education should assume the leadership role and organize national online practices and recommendations. This comparison analysis looked at online participation between 1999 and 2004. The sample of web-delivered distance education programs were found to be favorable support for online learning. Researchers suggested that the leadership of education act at the national level. The researchers suggested that leadership organizations like the North American Council on Online Learning to be part of a leadership effort (Cavanaugh et al., 2001).

*Performance Results: More Positive for Online*

In Sydney, Australia, a study conducted to compare online learning and traditional learning examined student attitudes and performance. The findings indicated that the two learning environments were not equivalent (Suanpang, 2004). Online students had a "more positive attitude", a "greater ability" for problem solving, and a greater sense for the course subject's worth, while the students in traditional classes viewed the course as "more difficult." Two sample groups were pooled, 101 participants formed the online group, and there were 109 traditional face to face participants in the second group (Suanpang, 2004).

The statistical analysis used measurements of sub-scales for measuring positive and negative feelings concerning the course subject. *Cognitive competence* was indicated by measuring content knowledge and skills. Scores also measured *relevance* and subject worth. A score for *easiness* indicated how difficult the class was perceived. The survey responses were evaluated and converted to a percentage scale (Suanpang, 2004).

Research to address the effectiveness of online learning versus face-to-face was revisited after a decade of data collected that reflected K12 learners (Mean, 2009). The results of the comparison of online and traditional instruction indicated better performance "on average" of online students. The overall results of this meta-analysis originated from nearly 1000 systematically researched studies that confirmed some claims that online learning is more "acceptable" by learners than that of face to face (Mean, 2009).

A state university study in Minnesota during the fall of 2009 compared "outcomes achieved" in an online *marketing principles* class to "outcomes achieved" in a face-to-face environment (Smith & Stephens, 2010). The results of this statistical analysis of

grades from three classes, two traditional with 67 students and one online class with 24 students, indicated some differences in the results. The mean score for final class exams was 61.43 for the face-to-face students, and the mean score was 73.92 for the online students. These researchers concluded that demographics may provide a clue as to why the online students performed better in this study and that further research was needed (Smith & Stephens, 2010).

*Performance Results: More Positive for Face-to-Face*

This study addressed this research question: Is there a difference in student academic indicators between face-to-face and distance education (Urtel, 2009)? The research indicated that there were differences in student academic performances. Between the two groups, face-to-face and distance education, the findings favored face-to-face. The face-to-face students earned a grade of 3.16/4.00 and the distance education students earned a grade of 2.28/4.00 (Urtel, 2009).

Employing a statistical analysis, Urtel (2009), assessed the course work from 269 university students enrolled in a distance education section and 116 enrolled in the face-to-face section. The results indicated a statistically significant difference in final grades. The most notable trend was the disproportionate rate of students classified as freshmen. 65% of first year students earned grades of *D*, *F*, and *W* when taking an online class. The sample collection methods for this data analysis were identical for both face-to-face and distance education. This research analysis weighted course grades and the end of semester course evaluations. The grade point averages were computed on a 4.0 scale but a grade of *W* (student did not complete class) for grades were not factored into the evaluations and had no impact on computations (Urtel, 2009).

*Performance Results: Environmental Impact and Variables:*

Tutunea, Rus, and Toader (2009) implemented a study at Babeş-Bolyai University of Cluj-Napoca and composed a correlative statistical analysis. The Romanian study had several key objectives: to support an increase use of Internet services, promote development a knowledge-based economy, promote research and innovations, and accelerate the development of an information society. The results indicated that students with better basic computer and Internet skills preferred online learning methods, and concluded that the younger distance learning students have more information technology abilities. 45% of participants were characterized as *high-Internet skilled* users, 39% were labeled with medium-Internet skills, and 16% were categorized with low-Internet skills. The study also concluded that 55% of the participants would prefer a mix of both environments, a combination of online and face-to-face (Tutunea et al., 2009).

This data also suggested that students with previous instructional technology (IT) experience prefer online learning methods. The majority of the distance learning students did not have previous experiences in online learning. Students that manifested the highest reticence at the beginning of the online classes were also the most active persons on the platform. They communicated more questions and launched discussions. The researchers concluded that this initial attitude of reticence was considered an “attitude as being normal” and supported a need for traditional instruction. These students needed additional “explanations” and a mixture of online with traditional instructional help was required for a better learning experience. The researchers further concluded that it may be necessary to consider other methods that are beyond a comparison of exam grades in order to determine the advantages of online learning (Tutunea, et al., 2009).

Daymont and Blau (2008) performed a meta-analysis of a state university population in the eastern area of the US. This analysis compared final grades, and the average final grade for online students was 2.76, and the average final grade for traditional students was a score of 2.51. The grades were derived from course quizzes and discussion forums of business major students, and non-business majors, enrolled in a required undergraduate management course. Two classes were online and five classes were traditional (Daymont et al., 2008). This research also showed that the average quiz score for online students was 80.4 and for traditional students the average quiz score was 77.45. The sample population was 59% female. Researchers concluded that online students were not likely freshman and that online participants had higher cumulative GPA's (Daymont et al., 2008).

A synthesis of five Meta-analyses on K12 online learning education presented variances in research factors, such as student and teaching characteristics, course design, teacher preparation, technology, and administrative services (NACOL, 2007). This research was an effort to determine whether K12 distance education fostered a comparative learning experience similar to that of traditional classroom learning. Technology approaches that provided simulations and tutoring feedback indicated an increase in online student performance and that online students valued frequent and timely responses to their questions, with teacher feedback the most valued aspect of online courses (NACOL, 2007).

The analysis indicated that the better teaching practices provided collaborative communication tools for groups and one-on-one discussions. The report claimed that teachers with professional development for online facilitation had a positive effect in

online and classroom-based instructions. Elements such as administrative and technical support services for mentoring and on-site support staff may have also contributed to positive outcomes in the online learning process (NACOL, 2007).

*Summary*

The review of research here indicated that online learning had an accepted role in education. There were concerns that a national concerted effort was needed to better direct online pedagogy practices, and that the growth of K12 online programs need to be better supported. Online learning did not appear to be a major concern in the general community and therefore not at the attention of policy makers. The research was not conclusive on whether or not online learning experiences are equal to traditional face-to-face learning experiences.

It is evident that additional technological training is needed for teachers and student populations, and that the virtual classroom is participated in at most grade levels. Additional research-based data is needed to address situational implications such as demographics and content practices. Online learning credibility may be further enhanced with research that uses methodology that accounts for diverse learning factors. Comparisons in this review of literature mostly used course grades to reflect on university student achievement; K12 research was limited.

Beyond the scope of this review, additional concerns presented included: the need for technology in under-developed and under-funded educational systems, cheating, authenticity of online participation, and the role of the online facilitator. Language

barriers and instructional strategies related to content learning are recommended for future K12 research.

## Purpose of the Study:

The purpose of this comparison study will be to identify K12 student achievement differences and similarities of face-to-face and online learning environments. The study will examine student achievement in the four content domains of physical science. The four domains are Chemistry: *Atomic and Nuclear Theory, and Periodic Table*, Chemistry: *Chemical Reactions and Properties of Matter*, Physics: *Energy, Force, and Motion*, Physics: *Waves, Electricity, and Magnetism*. Research between face-to-face and online learning for K12 is limited, and consequently limits the advancement of online pedagogy.

## Research Questions:

The following research questions will be addressed:

- Will the findings of this study indicate online students achieve higher test scores than face-to-face students?
- Are there differences in achievement among the physical science content domains?

The Physical Science course content domains:

Chemistry: Atomic and Nuclear Theory, and Periodic Table

Chemistry: Chemical Reactions, and Properties of Matter

Physics: Energy, Force, and Motion

Lisa Fern Mozer
8000 Applied Field Research

Physics: Waves, Electricity, and Magnetism

## Importance of the Study

This investigation of student achievement in the online environment and the comparison to that of student achievement in the traditional face-to-face environment is necessary for the purpose of bringing more understanding of online student achievement in science. Online learning is now a part of the public school model, and research on K12 student achievement online is limited. The growth of K12 online learning is rapid and more adequate support of its effectiveness is warranted. There are claims that limitations in academia availability could be resolved by access to online programs. Advocators of online programs claim that online programs bring content curriculum not available in less fortunate and economically disadvantaged communities. Additional research that assesses online learning is needed to support the decisions of policy makers attempting to solidify standards for online pedagogy and online curricula. Face-to-face traditional classes are not being totally replaced by online classes; however school systems in need of content experts in math and science see online learning as a means to provide more students with expert teachers. Knowing what hindrances and impact/advantages are associated with the online environment will be of value for the education community and society at large.

The online learning environment is now part of the education model. Web tools have enabled an exchange of information and communication in a virtual place and time. Web tools such as chat rooms, discussion boards and email are providing both synchronous and asynchronous communication and information making the online classroom possible (Watkins, Leigh, & Triner, 2003).

## Definition of terms

eLearning – course content using the Internet, network, or a stand-alone computer, and has electronic delivery methods such as internet-based learning delivery packages, CD-ROM, online video conferencing, websites or email/messaging (Nichols, 2003).

ECOT – An End Of Course Test is a standards-based assessment, this test measures how well students are mastering specific skills as defined by the state of Georgia.

Face-to-face – Instructions provided by teachers to learners, together in the same physical space and moment in time are referred to as face-to-face (Khan, 2006).

Internet – The Internet is a global network that connects millions of computers and Exchanges transmitted digital data.

Online – An online connection to the Internet, and/or a computer connected to a network is referred to as online.

Virtual classroom – The virtual classroom is a learning environment that exists solely in the form of digital content that is stored, accessed, and exchanged through networked computers and information systems (Watkins, 2003).

Web site - A site of pages located on the World Wide Web is called a Web site. Each site contains a homepage that is the first page of many pages linked together.

Web page – A Web page is an digital document on the World Wide Web, commonly called a page, and is identified by a unique URL (Uniform Resource Locator).

Web tools – Web tools are communication methods such as: chat rooms, discussion boards and email messages. These tools provide synchronous and asynchronous communication (Watkins, Leigh, & Triner, 2003).

## Methodology:

### *Research Design*

The study, a quantitative analysis, will compare student academic achievement in physical science, in two learning environments. The End of Course Test scores (EOCT) for physical science will serve as the unit of measurement for student achievement. A statistical comparison of two participant groups will be made using EOCT scores. The study will compare the EOCT physical science scores of the students that participated online to the scores of the students that participated face-to-face. In additional to the overall tests, the subject domains scores of physical science will also be compared.

### *Participants*

Participant data will be collected from schools in a county wide program. Students, a total of 1,112, from 9 high schools will form the two student groups. The two groups, based on participation in physical science (a required core course) either online (a group of 42 students) or face-to-face (a group of 1082 students) include all student enrolled in physical science. In addition to the data being reflective of students that completed a physical science course, participant data shows that all students completed physical science and scored on the physical science EOCT.

*Data Sources and Collection*

The data for this study will be requested from a school district office, that oversees a county wide online program. The online participant poplation will determine the online sample size of the first group. The face-to-face participants will make up the second group.

*Reliability, of Instrument*

The available EOCT scores on file were collected after completion of the physical science class. The test score are averaged into the class grade as a weight at 15% of the final course grade. According to a district Web site, the EOCT tests provided scores that reflected student achievement levels and were based on internal consistency measures; using Kuder-Richardson 20 (KR-20). The KR-20 has a high reliability range of .08 to low .90 ranges. The state of Georgia considers this instrument reliable for measuring student achievement levels in the four domains of physical science content.

*Validity, of Instruction*

According to the Georgia Department of Education (www.doe.k12.ga.us) the EOCT is aligned with the Georgia curriculum standards and is an assessment of specific content knowledge. The assessment is used to identify student strengths and weaknesses in subject content areas, and indicates effectiveness of classroom instruction at the school and county levels.

*Data Analysis*

Student achievement, as interpreted by the EOCT (End of Course Test) scores, will be analyzed by using independent-samples t-Tests to determine significant differences in mean EOCT scores. The EOCT scaled scores are defined: below 400 - "Does Not Meet Expectations;" 400 to 449 - "Meets Expectations;" and scores at/or above 450 - "Exceeds Expectations." The Physical Science EOCT is composed of four domains and each has a raw score value: Chemistry: Atomic and Nuclear Theory, and Periodic Table, has a raw score of 15, Chemistry: Chemical Reactions, and Properties of Matter, raw score of 12, Physics: Energy, Force, and Motion, has a raw score of 13, and Physics: Waves, Electricity, and Magnetism, has a raw score of 10. Significant differences in achievement between students taught on-line and students taught face-to-face were indicated at a $p<.05$ level of significance.

## Findings

### *Quantitative Data Analysis*

This quantitative analysis will compare student achievement in a Physical Science course between the two learning groups. The comparison will be made by t-Test used to compare mean EOCT scores. The results will provide a statistical description of students achievement by the two groups.

### *Discussion and Implications*

It is important to know of statistical relationships between educational technology and academic achievement. Several actors, such as grade levels and ages difstrain may be influencing student learning and we need to uncover these relationships.  The concerns

regarding the effectiveness of online learning must be addressed in K12 research. Students participate in online learning for a number of reasons, such as schedule convenience and course offerings, and more understanding about the virtual learning experience is needed.

## Conclusion

The findings from this study should answer the research questions regarding how online learning compares to face-to-face learning in science content. Results from this statistical comparisons and may be descriptive of difficulties or differences in content learning. Research on K12 student achievement in online learning environment will lead to improvements in virtual content pedagogy and support higher student performance.

References

Brownstein, B., Brownstein, D. & Gerlowski, D. A., (2008). Web-based versus Face to Face MBS Classes: A Comparative Assessment Study, *Journal of College Teaching & Learning* 5(11).

Cavanaugh, C. Gillian, K.J, Kromrey, J, Hess, M, Blomeyer, R., (2001). The Effects of distance Education on K12 Student Outcomes: a Meta Analysis, University of North Florida.

Daymont, T, & Blau, G., (2008). Student Performance in Online and Traditional Sections of an Undergraduate Management Course, Temple University.

Dell, C. A., Low, C., & Wilker, J. F., (2010). Comparing Student Achievement in Online and Face-to-Face Class Formats, MERLOT *Journal of Online Learning and Teaching. 6 (1).*

Franklin, S., Peat, M., & Lewis, A., (2001). Virtual vs. traditional dissections in enhancing learning: a student perspective. School of Biological Sciences, University of Sydney, Australia.

Gregor, S., (2002). Design theory in information systems. *Australian Journal of Information Systems*, 9, 14-22.

Hein, H., (1991). The Museum and Needs of People, Lesley College, Massachusetts.

Khan, B., (2005). Managing e-learning: Design, delivery, implementation and evaluation. Hershey, PA: *Information Science Publishing.*

Koohang, A., Riley, L., & Smith, T. (2009), E-Learning and Constructivism: From Theory to Application, Interdisciplinary *Journal of E-Learning and Learning*

*Objects,* Macon State College.

Means, B., (2009). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies, US Department of Education Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service.

NACOL, (2007). Effectiveness of K12 Online Learning, Research Committee. Retrieved from: http://www.inacol.org/research/docs/VSresearch-summary.pdf

Nichols, M., (2003), A theory for elearning, Educational technology & Society. 6(2), 1-10.

Oliver, R. (2002). The Role of ICT in higher education for the 21st century: ICT as a Change agent for education, Edith Cowan University, Australia.

Roblyer, M. D, Porter, M., Bielefeldt, T., & Donaldson, M. B., (2009). "Teaching Online Made Me a Better Teacher": Studying the Impact of Virtual Course Experiences On Teachers' Face-to-Face Practice, Journal of Computing in Teacher Education 25(4).

Smith, D.F., & Stephens, B.K., (2010). Marketing Education: Online Vs Traditional, Demidji State University.

Suanpang, P, Petocz, P, & Kalceff, W., (2004). Traditional Methods Student Attitudes to Learning Business Statistics Online Vs Traditional Methods. Faculty of Science, University of Technology Sydney, Australia.

Tutunea, M, Rus, R.V, & Toader, V., ( 2009). Traditional education vs. E-learning in the vision of Romanian business students. *International Journal of Educational and*

*Information Technologies.* 1(3).

Urtel, M. G., (2008). Assessing academic performance between traditional and distance education course formats, *Educational Technology & Science* .Indiana University Purdue University.