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# Technology Enhanced Learning Environments for Closing the Gap in Student Achievement Between Regions: Does it Work?

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The student achievement gap between urban and suburban regions is a major issue in U.S. schools. Technology enhanced learning environments that support the teaching and learning process may help to close this achievement gap. This article examines the impact of student and school factors on student achievement in a particular technology enhanced learning environment, the Cisco Networking Academy. The instructional model in the Cisco Networking Academy combines face-to-face instruction with online curriculum and instructional materials distributed over the Internet so that all instructors and students receive the same instructional materials and content tests. A total of 4,670 students from 386 high schools participated in this study. Considered together with gender, ability, and motivation factors, results showed that students located in urban, suburban, and rural geographic locations achieve equally well in the networking program. Thus the findings suggest that this combination of centralized materials and testing along with local face-to-face teaching may provide a strategy for reducing the achievement gap.

Achievement differences between schools located in urban, suburban, and rural regions have been a significant problem in educational systems worldwide (Fan & Chen, 1999; Kozol, 1991; Liddell, 1994; Young, 1998). When examined at the state level, students located in rural areas achieve less in standardized tests than their peers located in urban and suburban regions (Lee & McIntire, 2000). Although this situation has long been attributed to differences in socioeconomic status, recent research shows great variety in curricular activities, school resources, and instructional quality between urban and suburban regions (Brown, Anfara, & Roney, 2004; Lee & McIntire, 1999; Stern, 1994). Educational reforms and standards-based curriculum movements have promising potential to close this achievement gap by improving the instructional quality and curriculum differences in schools located in disadvantaged regions (Legters, Balfanz, & McPartland, 2002; Reys, Reys, Lapan, Holliday, & Wasman, 2003; Von Secker, 2002).

The National Council of Teachers of Mathematics (NCTM) defined standards-based curriculum as curriculum that emphasizes critical thinking, comprehension, integration, consistency with assessment activities and hands-on learning activities (NCTM, 2001). This type of curriculum provides in-depth coverage and more student engaging activities (Reys, Robinson, Sconiers, & Mark, 1999). A combination of computer and internet technologies has made it possible to extend high quality instructional materials and teaching environments to educationally disadvantaged regions. This study focuses on the impact of geographic location on student achievement in high schools in a technology enhanced standardized learning environment.

## LITERATURE REVIEW

Due to the differences in resources and curricular offerings between suburban and other regions, the geographic location of the schools is expected to have an impact on student achievement (Barker, 1985; Lee & McIntire, 1999). The educational inequalities between urban schools and other schools have been well-documented and achievement differences between these schools are attributed to curricular, instructional, and resource differences along with socioeconomic differences (Barker; Brown et al., 2004; Lee, 2001).

Developments in computer and communication technologies have impacted many areas, including education. Internet-based online learning has grown dramatically over the past decade to provide additional training and education for nontraditional students (Welsh, Wanberg, Brown, & Simmering, 2003). One form of technology enhanced learning environments, called blended learning, combines the Internet with traditional, face-to-face in-class instruction (Osguthorpe & Graham, 2003; Polin, 2004). Essentially, blended learning environments are a combination of online and in-class face-to-face instruction and, depending on the curriculum, can be implemented in a variety of ways. This study examines student achievement in one form of blended learning, the Cisco Networking Academy, which combines centralized curriculum and standards-based testing delivered over the Internet with local face-to-face teaching. The program exerts strong control over the content and teaching materials, but leaves the pedagogy of teaching to local instructors at each school.

The term blended learning environment as it is used in this article, refers to a technology enhanced learning environment where the curriculum, teaching materials, and tests are centrally developed, delivered online over the Internet, and implemented in a face-to-face learning environment with live teachers (Delialioglu & Yildirim, 2007). This blended learning approach allows teachers and students to use the same teaching and learning materials, regardless of region, minimizing the impact of curricular differences between regions. Previous research shows that this type of learning environment reduces the risks of achievement differences due to variation in teaching practices and teacher qualities in schools (Cakir, 2006).

A blended learning environment is based on the idea that the combination of face-to-face and online learning environments can bring the strengths of both learning environments into instruction and can increase student achievement and satisfaction, hence improving student learning. Face-to-face traditional learning environments offer several inherent instructional advantages to both students and instructors (Gage, 1978; Sinclair & Coulthard, 1975). For example, the immediate feedback available in face-to face interaction is a proven teaching method that is important in any learning environment. In classroom discourse and during the teaching and learning process, teachers have freedom to adjust the parameters of feedback, such as type of response, cuing, and timing of feedback, to maximize their students' learning. In-person teacher-student or student-student interactions can be conveyed not only with words but also with body language and expressions; therefore, classroom instruction provides an immense amount of feedback opportunity between students and teachers (Rosenshine & Stevens, 1986). On the other hand, preparing professional quality teaching materials, assuring the quality of instruction among teachers, and the lack of anytime access to teaching materials are generally accepted as major weaknesses of traditional classroom instruction. These weaknesses of face-to-face learning environments are considered the strengths of online learning environments. Using internet technologies to deliver the course content also gives opportunity for instructional designers and instructors to update the course materials and curriculum an excessive amount of time and resources (Bichelmeyer et al., 2006). Combining face-to-face and online learning environments, as a blended learning environment, offers the strengths of both learning environments to teachers and students.

An example of such a learning environment is the Cisco Certified Network Associate (CCNA) program. The CCNA program, a program offered by the Cisco Networking Academy, was established to provide computer networking education to students in high schools, colleges, universities, and nontraditional settings. This study focuses only on high schools. The curriculum, teaching materials, labs, simulations, and tests are developed centrally by Cisco Systems Inc. and the Cisco Learning Institute and are delivered over the Internet. The schools that adopt the curriculum then use it to teach their courses much as they would use a textbook from a regular publisher. Individual teachers implement the curriculum in the traditional classroom environment and adjust the teaching methods based on their students' needs.

The online environment also provides the means for an instructor support and quality control system. This quality control includes instructor training—instructors go through a one to two week training program for each course they teach. Additionally, instructors have access to a 24/7 online support system and online sharing of curriculum materials among instructors. Finally, the effectiveness of the instruction is monitored through the results of the online tests and student end-of-course ratings.

Studies show that nine main factors impact student achievement in tests, among which student socioeconomic status, motivation, and instruction have the greatest impact (Rowe & Hill, 1998; Young, Reynolds, & Walberg, 1996). Educational policies and resources can do very little to improve achievement differences due to socioeconomic differences among the regions. However, offering the same high quality curriculum and teaching materials by using blended learning environments may help educators close the achievement gap caused by the differences in curriculum and instructional resources among the geographic regions. The main question guiding this research study is: Can use of the Cisco blended learning environment in secondary education close the achievement gap among schools located in different geographic locations?

In addition to comparing performance across geographic locations, we also sought to compare the impact of differences in student gender, ability, and content knowledge. In examining differences in geographic location, we will use hierarchical linear modeling to control the effects of these student variables. Prior research has indicated that gender is an important factor in technical subjects with males having greater interest than females and usually showing higher levels of achievement (Crombie & Abarbanel, 2000). Thus we would expect that males will show greater gains in the blended learning curriculum.

Student academic ability refers to the student's general ability to learn new content. In this study we use student GPA as the index for ability. Students with higher GPAs are much more likely to have high achievement scores in the new courses they take (Gray & Jesson, 1990; Hakkinen, Kirjavainen, & Uusitalo, 2003). Another content specific ability indicator is prior knowledge and experience related to the content of the course that students take. In this study we used a survey instrument to assess the students' technical knowledge related to computers with the expectation that greater technical knowledge will lead to better performance in the blended curriculum.

## METHOD

### Context

The context for this research is the CCNA program, which is a worldwide computer network education program. The program is used at about 10,000 high schools, community colleges, universities, and nontraditional educational institutions in more than 150 countries. The program offers four courses taken in sequence. To examine the achievement differences between regions, high schools offering the CCNA1 course in the United States were included in this analysis.

As a blended learning environment, the CCNA program has four key components:

1. A centralized curriculum distributed over the Internet;
2. Standards-based testing distributed over the Internet;
3. Locally managed and designed instruction; and
4. A support system for ongoing training, support, and certification of instructors.

First, all curriculum materials are designed by Cisco and distributed over the Internet (traditional paper textbooks are also available, but not widely used). Instructors and students access materials from any computer with a web browser using a proprietary course management system. The curriculum includes online, interactive, learning materials, as well as a series of lab exercises intended to be conducted in a network lab.

Second, the standards-based tests, both interactive online exams and hands-on practicum tests, are developed by Cisco Systems. The tests are designed using advanced statistical techniques most commonly used for statewide or national exams rather than for classroom tests and provide immediate personalized feedback that highlights mistakes and directs students by way of links to sections of the curriculum in which they lack knowledge.

Third, instructors have complete freedom in deciding how their courses will be taught. Some instructors use traditional lectures, others use small group discussion, others use chapter tests to guide class discussion, and so on. This allows instructors to customize the course based on their students' levels and needs.

Finally, there is an extensive support system for schools and instructors. All instructors must pass certification exams for each CCNA course before they can teach it and be recertified every three years. Cisco also provides 24/7 technical support and an online community for all instructors, so they can share teaching tips, materials, and advice.

## Participants

The study examined the final exam performance of $11^{th}$ and $12^{th}$ grade U.S. high school students, who completed the survey. A total of 7,399 students at 1,549 high schools completed the survey administered at the beginning of the CCNA1 course, which yielded about a 17% return rate for the survey. Schools with four or fewer survey returns were eliminated from the final analysis; therefore the final student and school numbers included in the analysis were 4,670 high school students at 386 high schools.

## Data

There were three main data sources: (a) a survey to measure student self reported abilities and motivations to enroll in the program at the beginning of the CCNA1 class; (b) student gender and course achievement scores provided by the Networking Academy database, and (c) the National Center for Education Statistics (NCES) database which contains demographic data on the school location.

The data and measures were organized according to *student level* and *school level* for hierarchical analysis.

*Student level factors* include student demographics (gender), ability (self-reported GPA), computer knowledge, motivation, and achievement factors. Prior computer knowledge was measured using four 7-point likert scale items with .88 Cronbach's alpha. Student motivation was measured based on expectancy-value theory—asking questions about the value of the course to them and their expectations for success. Student motivation was measured with seven items using a 5-point likert scale (three focused on value and four on expectations), whose alpha was .86. We also asked a question about the main reason why students wanted to take the course, whether to enhance their career prospects, improve their education, or a host of other reasons (e.g., their friends were taking the course, someone advised them to take the course, or they thought it would be fun).,

*School level factors* include school location and class enrollment. Each school's location was classified by matching its ZIP code to the locale definition in the National Center for Education Statistics (NCES) database. Schools in ZIP codes were classified as urban, suburban, town, and rural. Number of students in a class implies the amount of attention a student gets from his/her instructor, hence impacting student achievement (Finn, Pannozzo, & Achilles, 2003). Therefore, class enrollment was included as an indicator of the size of Cisco classes offered in high schools.

The dependent variable in this study is student final examination scores in the CCNA1 course, which have a range of 0 to 100. The exam consisted of multiple choice items that asked students facts as well as presented trouble shooting scenarios. While students could retake the exam (alternative versions were presented) until a passing score was achieved, our data is based on the first exam. The instruction on exam administration is that it is a controlled, proctored exam, but we do not have data on the extent to which the protocol was followed.

### Analysis

The main aim of this study is to analyze the impact of school location on student achievement. Since individuals are nested within schools in the data, the Hierarchical Linear Modeling (HLM) method was used for the analysis. Traditional regression techniques were not well suited to data with a nested nature (Raundenbush & Bryk, 2002). With traditional regression, student and school effects on the dependent variable cannot be separated correctly, which results in omitting the impact of school level effects and can cause type 1 errors by inflating the significance. HLM is the appropriate analysis method to analyze this type of multi-level research design (Raundenbush & Bryk; Snijders & Bosker, 1999).

## RESULTS

Table 1 and Table 2 show descriptive statistics for the factors used in the analysis. The number of students is different for each factor due to missing data. Data from approximately 4,600 students and 386 schools were used in this analysis.

**Table 1**
Descriptive Statistics for School Level Factors

| Factor | | N | Percent | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Locale | | 386 | | | |
| | Urban | 114 | 29.5% | | |
| | Suburban | 198 | 48.7% | | |
| | Town | 20 | 5.2% | | |
| | Rural | 64 | 16.6% | | |
| Enrollment | | 386 | | 16.84 | 8.21 |

**Table 2**
Descriptive Statistics for Student Level Factors

| Factor | | N | Percent | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Final Exam Score | | 4,670 | | 62.55 | 18.76 |
| GPA | | 4,663 | | 3.16 | 0.63 |
| Technical Skills | | 4,669 | | 3.18 | 1.97 |
| Motivation | | 4,669 | | 4.19 | 0.68 |
| Gender | | 4,611 | | | |
| | Male | 4,047 | 87.8% | | |
| | Female | 564 | 12.2% | | |
| Reasons for Enrollment | | 4,664 | | | |
| | For career or education | 1,714 | 36.7% | | |
| | Other | 2,950 | 63.2% | | |
| Future Career Plans | | 4,631 | | | |
| | Computer related career | 2,448 | 52.4% | | |
| | Other | 2,183 | 46.7% | | |

The HLM analysis process using grand mean centering was followed. It includes building the level 1 model first and then the level 2 model. The analysis began with an unconditional model to determine whether sufficient variance exists between schools to be able to use HLM analysis. Analysis of the unconditional model indicated that HLM was a suitable approach to data analysis. Next, the level 1 model was built using only student ability and motivation factors (Table 3). Using only student factors explained 14.1% of the variance among students and 12.2% of the variance in achievement scores between the schools. Next, level 2 variables were added to the model; however, no level 2 factors were significant therefore, the final model explained 14.5% of the variance among students and 13.2% of the variance in the achievement scores among the schools.

**Table 3**
Results of Multilevel Analysis

| | Step 1: Student Factors | | Step 2: Student and School Factors | |
|---|---|---|---|---|
| | Beta | p | Beta | p |
| Student Factors | | | | |
| Gender (Female) | -3.56 | .000 | -3.55 | .000 |
| GPA | 6.62 | .000 | 6.62 | .000 |
| Technical skills | .83 | .000 | .82 | .000 |
| Motivation | 3.99 | .000 | 3.99 | .000 |
| Career goals | | | | |
| IT related careers | -.64 | ns | -.64 | ns |
| Other | Baseline | | Baseline | |
| Reasons to take course | | | | |
| Career and education | 1.04 | .038 | 1.05 | .037 |
| Other | Baseline | | Baseline | |
| School Factors | | | | |
| School location type | | | | |
| Urban | | | -.71 | ns |
| Suburban | | | Baseline | |
| Town | | | -5.06 | ns |
| Rural | | | 1.67 | ns |
| Class size | | | -.11 | ns |
| Level 1 R-Squared | .141 | | .145 | |
| Level 2 R-Squared | .122 | | .132 | |

As shown in Table 3, student gender, individual student ability factors (GPA, technical skills), and motivation are all significant at the $p<.001$ level. Students' career and education reasons for taking the CCNA1 course are significant at the $p<0.05$ level in comparison to other reasons for taking the course. None of the school level factors (school location and class enrollment) were significant.

Our results show that individual student factors which are important in traditional learning environments are also important in a blended learning environment supported with technology. Consistent with past research, our study found that males achieved higher than females in the CCNA program. In terms of ability, both students' self-reported cumulative GPA in high school and their technical skills significantly impacted their achievement—students with higher GPAs and good computer knowledge did better in the CCNA1 final exam in comparison to students with lower GPAs and poor computer knowledge. Finally, students' reasons for taking the course and their motivation in the course had an impact on student achievement—students who took the course because it is important to their future career or their educational goals achieved more than students who took the course for other reasons such as teacher's or friend's recommendation.

At the school level, the impact of school location and class size on student achievement were examined. Although past research on traditional learning environments concluded that students in urban and rural schools achieve less than their peers in suburban schools, our analysis shows that school location and class size do not make a difference on student achievement. Students from all four locations and from classes in different sizes achieved equally well in the CCNA1 course.

## Conclusion

Student achievement differences among different geographic locations in the United States are usually considered a result of differences in curricular activities and instructional resources among the schools in urban, suburban, and rural areas (Lee & McIntire, 1999). Technology enabled learning environments have the potential to close this instructional gap, and consequently, the achievement gap caused by differences in instructional resources. Combining strengths of face-to-face and online learning environments, technology enhanced blended learning environments hold the promise of providing better and equal educational opportunities for all students.

Using data from approximately 4,600 high school students and 386 high schools, the impact of school location on student achievement in the CCNA1 course was examined with a multilevel analysis approach. In contrast to the past research on traditional learning environments, our results show that school location, whether the school is located in urban or suburban areas, did not have any effect on student achievement. Student achievement was mainly affected by student level factors such as gender, prior academic ability, prior computer knowledge, and motivation. Therefore, the conclusion is that this technology enhanced blended learning environment provided equal educational opportunities regardless of geographic locale.

Blended learning environments offer new opportunities to improve teaching and learning. Future research for these types of learning environments can include examining different types of educational outcomes such as student engagement in schools, student future careers and educational aspirations. Other student level and school level factors should be investigated to enhance our understanding of student achievement in blended learning such as the socioeconomic status of students and the school type. Since technology enhanced blended learning environments have the potential to provide equal educational opportunities, other school subjects such as, mathematics and science can be designed and taught with this type of learning environment. The impact of these learning environments on student achievement can be examined with similar multilevel studies. Another important area of research is on the impact of blended learning environments on teaching practices.

As in any large scale educational study, this study has limitations such as, survey return rate and the use of self-reported student data. First, this was a large scale survey study with a significant portion of solicited students failing to return at least one of the surveys. Thus, we are unable to check the representativeness of the sample. However, using the Cisco database we were able to ascertain that the sample distribution of final exam performance and of gender were both representative of the full CCNA student population. Second, while the self-report data had acceptable reliability and validity, it is none-the-less self report data that could not be independently validated.

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