Cyberlearning and student achievement

By Leonardo Torres Pagan

The National Council of Teachers of Mathematics, NCTM, (2000), a group that encompasses math teachers, educators, and administrators, established that the use of a substantive number of technology and their applications are vital for high school mathematics instruction. According to Leung (2009), “the incorporation of information and communication technology (ICT) into mathematics education constitutes one of the most important themes in contemporary mathematics education” (p. 29). Dede (2007) established that there are certain aspects of mathematics that are directly affected by the use of technology in mathematics education learning. They include:

- The changing characteristics of student. According to Dede (2007), the characteristics of students are changing, as their usage of technology outside of academic settings shapes their learning styles. These students are able to relate more to what is learned and researched through the internet.
- Dede (2007) further establishes that the inception of information technology in education brings about interactive learning among the students and the teachers bring about maximum productivity in the education sector.
- Friedman (2005) suggests that the needs and expectations of the students by society in regard to education has greatly shifted. This is mainly attributed to the fact that there has been globalization and the emergence of a knowledge-based economy.

Based on the above findings, Dede (2007) suggests that educators should develop alternative models of education that use information and communication technologies to reinvent many aspects of teaching, and learning.

The use of information and communication technology (ICT) is a potential tool for collaborative learning that is can be used to support teacher enriching their teaching experience (Liaw, Chen & Huang, 2008). The collaborative learning process encourages students to explain and support their own points of view, and to incorporate discussion results in their knowledge to stimulate and improve learning (Cheng & Chen, 2008). With the rapid development of emerging technologies, the integration of information and communication technology has begun to attract the attention of educators and policy makers (Wang, 2008).

Not only has the internet made it easier for individuals to communicate, but also brought about a number of ways in which information can be collected and disseminated (Madhavan, Schroeder, and Xian (2009). Through the internet, learning has been extended outside the walls of learning institutions. Individuals can access information at any time at the comfort of their houses, restaurants, churches, and various social settings. Learning is a continuous process in the lives of human beings. Each and every day, a number of aspects in the human lifestyle keep changing. To this effect, it is important for the world’s population to try and keep up with this information for the betterment of the society. Education should be viewed as a continuous process contrary to the notion that education begins in school and ends once one leaves the gates of the educational facilities. Madhavan, Schroeder, and Xian (2009) further state that the current generation cannot survive a day without the internet.

It has been established that students prefer learning that includes ICT rather than the usual classroom setting (Leung, 2006). The National Science Foundation (2008) has established that, at this point (inception of cyber learning), it is possible to increase the payoffs that result from ICT learning. Cyber-learning plays great roles in ensuring students acquire the right knowledge when it comes to mathematics (Liaw, Chen & Huang, 2008;

Leung, 2009, NSF, 2008; Chandra & Lloyd, 2012; ISTE, 2010; Mioduser, Nachmias & Forkosh-Boruch, 2010). Virtual learning and the creation of social networks supports education by ensuring that almost all the students graduate successfully from math class because individual performance is enhanced. With specific regard to this study, the focus will be on the use of cyber-learning in low-performing schools and how contemporary education in such schools can be increased.

It is paramount for the educational and learning institutions to come up with clear and comprehensive mechanisms to ensure that technology is revamped on a real-time basis. The world has grown from being traditional to technological. ICT is now part and parcel of the world and its use in education has seen an increase in the number of students who complete school successfully (Richardson, 2011). Learning is now more interesting, interactive, and productive as compared to previous years. (Imel, 2003). In any setting, education is aimed at ensuring that the living standards of individuals and the society at large are greatly improved. It is through the efforts made by the scholars that the country's economy can experience double-digit growth. It is a view that is held by researchers and policy makers that high school students who pass mathematics with high scores are fundamental in the future of the country's economy (Chandra & Briskey, 2012; OECD, 2004; Slavin, Lake, & Groff, 2009; Wolfram, 2010).

It is common for some students not to directly exercise what they have learned in class in the real world. In a research carried out by El Nuevo Dia (2008), it was established that students from Puerto Rican high schools do not perform to the expectations set by the commonwealth. The Puerto Rican Tests for Academic Achievement, PPAA in Spanish (Puerto Rico Department of Education, PRDE, 2010) confirms this assessment. For more than 10 years, the Puerto Rican Department of Education has used PPAA to monitor the educational achievement of Puerto Rican students and the changes in that achievement across time. Results of the 2013 PPAA (Puerto Rican Education Department, 2004) shows that

> Most eleventh graders (90 percent) performed at Basic Level, rarely demonstrates knowledge of the subject or had limited knowledge of the conceptual and analytical comprehension of their grade (DEPR, 2013, p. 12).

In another study, the Mathematical Sciences Education Board (1989) established that American students do not possess adequate mathematical skills that are paramount in problem-solving situations in social environment such as the work place and at the college level. So far, the students have not attained contemporary educational achievement that is close to the expectations of the commonwealth (Department of Education, 2004). Based on these findings, it is paramount for the parents, teachers, students, policy makers, and stakeholders to come together and coordinate this kind of learning to ensure that the students are able to establish a link between what they are learning and the outside world. According to Chandra and Lloyd (2008), "web-based technologies offer exciting possibilities for expanding the capacity to provide access to instruction and knowledge world-wide" (p. 34). Contrary, Chandra, and Briskey (2012) assert that cyber-learning should be undertaken with extreme caution.

Mioduser, Nachmias, & Forkosh-Boruch (2010) have suggested that this method of learning (cyber learning) has gained international acclaim since its introduction. A good number of learning institutions within the education sector are striving to ensure that ICT is incorporated in mathematics learning and all other disciplines. This method of teaching has been viewed not only as a way of increasing knowledge amongst the learners, but also as a powerful technique for teaching and learning. Virtual learning is a new concept. Because of this, a number of literary works have emerged in support and against cyber learning. An insignificant amount of research work has been done on students who are aged 9-11 years old as compared to those who take mathematics in general regardless of age. In fact, Hodges (2008) established that much of the research work has focused on college-going students as compared to those in high school. Consequently, Moore (1990) seeks to explain that little attention has been given to the effectiveness and efficiency of the use of information technology in mathematics learning with specific interest on low performing Puerto Rican schools.

The integration of cyber-learning within the normal education system is advantageous in mathematics learning, especially in high school. Through this (cyber learning), a country's education undergoes complete transformation because there exist diverse methodologies in the teaching of a substantive number of topics in the educational curriculum. Also, the sector experiences customized interaction between the use of information technology, students, and teachers (NSF, 2008).

According to London (2011), a great deal of money, time and efforts have been spent on technology infrastructure in recent years (London, 2011). Such an initiative requires careful planning and implementation to deliver the best service to the students. This is important because a good implementation program will result in a number of benefits as far as the schools in the district, community, and their students are concerned. The National Science Foundation (2008) has established that, with the revamping and continuous growth in technology, cyber-learning will lead to increased understanding among the students involved and provide for a widespread demand for solutions to a number of educational concerns. Compared to the technological infrastructure that has been in place within the last decade, it is clear to say that the applications have undergone significant transformation. New approaches to research and design have evolved as compared to prior techniques. The recent technology is more responsive to the real-world requirements and learning environments (The National Science Foundation, 2008; National Council of Teachers of Mathematics 2000, 2010).

With the implementation of cyber-learning in a number of schools, information dissemination reaches a larger scope of students regardless of distance. According to the International Society for Technology Education (ISTE, 2000), this form of learning has shifted the paradigm of education from classroom-centered to learner-centered learning. Suddenly, the traditional and contextual thinking of learning within the physical space and confines of a classroom takes on an amorphous identity in the virtual space of online learning. The fact that such a program exists calls for an increase in the number of students who subscribe to it. Elasticity and flexibility are some of the core characteristics of virtual learning; a significant population amongst the students views this as the best method of learning, hence results into the retention of current students. Certain schools have taken upon themselves to use this education platform in the building of sustainable cyber domains and distance education curricula (ISTE, 2008; Madhavan, Schroeder & Xian, 2009; NCTM, 2010).

Background and Context

It is paramount for educational institutions to come up with clear and comprehensive mechanisms to ensure that technology is revamped on a real-time basis. The world has grown from being traditional to technological. ICT is now part and parcel of the world, and its use in education has created an increase in the number of students who complete school successfully (Richardson, 2011). Learning is now more interesting, interactive, and productive compared to previous years (Imel, 2003). In any setting, education is aimed at ensuring that the living standards of individuals and society at large are greatly improved. It is through the efforts made by scholars that the country's economy can experience double-digit growth. Researchers and policy makers believe that high school students who pass mathematics with high scores are fundamental to the future of the country's economy

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Theoretical Framework

For many decades now, high school math curriculum has been under constant development and redefining in an attempt to incorporate ICT in learning (Hill, Song, & West, 2009; Wang, 2008). According to Wang (2008), "social learning approaches have received attention as viable or even desirable frames for research and practice related to teaching and learning, particularly in cyberlearning environments" (p. 7). This section discusses social constructivism and the situated learning theory as the main theoretical framework for this study.

Social Constructivism

The main theoretical basis of this study is social constructivism. Vygotsky (1978) argued that "social interaction plays a key role in the development of cognitive function, and higher-order thinking results from relationships between individuals" (p. 17). From a social learning approach, Henning (2004) argues that "knowledge is constructed while individuals are engaging in activities, receiving feedback, and participating in other forms of human interaction in social contexts" (p. 18). This kind of constructivism describes learning as a collaborative process that is divided into two levels. Distinguishing between these levels as actual development and potential development resulted in Vygotsky's identification of the "zone of proximal development" (p. 85). The zone of proximal development is the potential level of cognitive development a learner has if he or she is provided with the appropriate support (Vygotsky, 1978).

For Brown and Green (2006), scaffolding is "the process that supports individual efforts through the structuring of interactions and the breakdown of instruction into steps that are manageable by the student in response to his or her level of performance" (p. 18). Because cognition is not considered an individual process, learning is shaped by the kinds of interactions a student has with others and the context within which these interactions occur (Brown & Green, 2006).

Situated Learning

According to Lave and Wenger (1991), there is a close correlation between situated learning and social constructivism, though the latter is more recent and more defined. The combined efforts of these researchers between the late 1980s and early 1990s led to their releasing a book that discusses the concept of situated learning. In their discussion, they establish that learning can be distinguished from the activities related to the learning process to become a way of living of the said group of people (culture) that is contrary to what students learn in school. Lave and Wenger established that effective and efficient learning occurs when activities are carried out in social settings (communities of practice) rather than in the usual classroom setting. S. Brown, Collins, and Duguid (1989) established that maximum productivity, as far as learning is concerned, highly depends on the context (setting) in which the activity takes place.

Neo (2007) argued it is only through an environment that has a direct link to the subject matter that enables students to gain cognitive development because they are able to relate what they learn from class directly to the social environment. A comprehensive technique must be incorporated for the learning process to be much more authentic; in this case, there is a need for the use of IT. Virtual learning has proven to be much more productive than normal learning because most students have been immersed in technology, notably social networking. A number of special interest groups have been created on the Internet with relation to specific subject matter. This makes it easier for students to peruse the Internet and find the information they need (Willett, 2007). Such an initiative ensures that information is disseminated to a wide scope of people who consequently bring about shared knowledge through such methods of collaborative learning.

According to the NCTM (2000, 2010), through collective learning, enhanced mathematics performance is achieved. Teachers assign authentic tasks to a group of students while they themselves play a supervisory role by providing scaffolding, guidance, and feedback. Neo (2007) also argued in support of this kind of situated learning. He established the students are able to grow in a number of dimensions that are key in day-to-day life. The information shared among these students and the help of their teachers and the social environment enable them to develop certain perspectives toward social problems. Through collaboration, many of the objectives that are set out in the learning manifesto can be achieved. Social networking has extended the learning process beyond school. Through the established social groups, students are guided by a common goal that may lead them to utilize technology in research and in the creation of a number of software programs. Within the comfort of their homes or other social settings, students can further the discussions and findings that were made in class through different platforms that may include online chat, social networking sites, wikis, and a number of fundamental technology-based tools.

Methodology

This research was designed to provide understanding of the problem that might lead to solutions, suggestions, and information that will be of great benefit to a number of concerned parties: administrators, educators, education policy makers, and the students. Also, the information that will be enacted in this paper will play a great deal in encouraging low-performing schools to try and use information technology in the learning process to enhance student performance in accordance with societal expectations, e.g., the commonwealth organization expectations.

The study utilized both dependent and independent variables. The independent variable for this study was the cyberlearning program designed to target schools that are performing below state achievement standards. These schools have continuously failed to meet the state targeted standard for two consecutive years and as such are mandated to institute reforms where all students receive the necessary instruction and assistance to help them achieve proficiency (DEPR, 2010). The math academic achievement scores, as assessed by the College Board Math Achievement Test developed by the Puerto Rico and Latin America Office of the College Board (2013b), was used as the dependent variable for the study.

This quantitative research study was a nonequivalent control group design, one of the most commonly used quasi-experimental designs (Creswell, 2012; Gall et al., 2006; Salkind, 2006). According to Creswell (2012), in the nonequivalent control group design, the researcher does not control the assignment of the participants to groups through the mechanism of random assignment. Students in the experimental group were encouraged to complete the math course with cyberlearning support, whereas the control group completed an identical course in a regular classroom environment.

In order to conduct this study, participants completed a pretest at the beginning of the school year. At the completion of the school year, participant completed a posttest to assess their math achievement. The use of a real school setting provided a more stringent test of the successful implementation of the intervention than would a study in a tightly controlled laboratory setting in which research results cannot be easily transferred to the context within the classroom.

The pretest of the participants was conducted using the College Board Math Achievement Test. A test answer form was distributed to both the comparison and treatment groups to collect their demographic information during the pretest. After collecting the pretest and demographic information, the data were screened for missing values, potential code violations, and outliers. The researcher assumed the pretest and demographic data would produce analogous characteristics of both the comparison and treatment groups and that any variation during the posttest of the two groups would be attributable to the intervention (Polit & Beck, 2008).

The examination was designed to measure skills and knowledge roughly equivalent to those gained during a one-semester college algebra course. A panel of college and university faculty members, augmented by College Board test specialists, agreed on subject matter boundaries and then developed, reviewed, and field tested a large number of initial test items, less than half of which were ultimately used. The panel then reviewed the final test. The time taken and the procedures followed in constructing the test offer assurance that the knowledge and abilities tested are those the test claims to measure.

The test consists of 50 five-response multiple-choice items that should be answered in 50 minutes. The authors provided permission for this researcher to utilize the College Board Mathematics Achievement Test, including administration instructions, test booklets, and answer sheets. Researchers are always welcome to share their findings and data from their studies with the College Board.

The participants in both groups answered a pretest before the treatment at the beginning of the school year (DEPR, 2013a). After the pretest, the experimental group completed the math course using cyberlearning support; the control group completed the math course without cyberlearning support. The pretest took into account students' prior knowledge related to targeted math skills. The posttest, with identical problems, was administered at the end of the treatment as part of the study

Results

The results suggest that cyberlearning had a measurable impact on student achievement when comparing the posttest scores for the treatment and control groups; however, there was no impact in the subgroups. The ANCOVA allowed the researcher to assess the effect of the treatment on math achievement, while eliminating students' preexisting differences, thus eliminating these differences as a potential confounding variable (Field, 2009).

RQ1: Does cyberlearning improve math student achievement significantly in Puerto Rican low-performing high schools?

Ho_1: There is no statistically significant difference in math achievement between students who receive cyberlearning support and students who receive traditional education.

Ha_1: There is a statistically significant difference in math achievement between students who receive cyberlearning support and students who receive traditional education.

The investigator conducted an ANCOVA to determine if there was a significant difference in posttest math achievement scores between the treatment students and control students after statistically controlling for their pretest math scores. There was a statistically significant difference in math achievement between groups, $F(1,121) = 44.45$, $p = 000$. Therefore, the null hypothesis was rejected for RQ1.

RQ2: Does cyberlearning improve special education math student achievement significantly in low-performing high schools in Puerto Rico?

Ho_2: There is no statistically significant difference in math achievement between special education students who receive cyberlearning support and students who receive traditional education.

Ha_2: There is a statistically significant difference in math achievement between special education students who receive cyberlearning support and students who receive traditional education.

The researcher examined differences in academic achievement between special education students who received cyberlearning support and those who received traditional education. There was no statistically significant difference in learning condition regarding special education status, $F(1,121) = 0.323$, $p = .571$. Therefore, the null hypothesis failed to be rejected.

RQ3: Does cyberlearning improve non-Puerto Rican math student achievement significantly in low-performing high schools in Puerto Rico?

Ho_3: There is no statistically significant difference in math achievement between non-Puerto Rican students who receive cyberlearning and students who receive traditional education.

Ha_3: There is a statistically significant difference in math achievement between non-Puerto Rican students who receive cyberlearning and students who receive traditional education.

The investigator conducted an ANCOVA to determine if there was a statistically significant difference in math achievement between Puerto Rican and non-Puerto Rican students. There was no statistically significant difference in learning condition between Puerto Rican and non-Puerto Rican students, $F(1,121) = 2.66$, $p = .607$. Therefore, the null hypothesis failed to be rejected.

RQ4: Is there a statistically significant difference in math achievement between boys and girls who participated in the cyberlearning program?

Ho_4: There is a significant difference in math achievement between boys and females who participated in the cyberlearning program.

Ha_4: There is no significant difference in math achievement between boys and girls who participated in the cyberlearning program.

The investigator conducted an ANCOVA to determine if there was a statistically significant difference in academic achievement by gender. There was no statistically significant difference in academic achievement between boys and girls, $F(1,121) = 464$, $p = .497$. Based on the results, the researcher found that, generally, male and female students who receive cyberlearning support can learn just as much information as male and female students who learn in a traditional classroom. Therefore, the null hypothesis was rejected.

Discussion of the Results

The analysis generated a thorough overview of how two groups of students—a treatment group that received cyberlearning support and a control group that was exposed to traditional learning conditions—compared to each other after 10 months. A one-way ANCOVA was conducted to determine if there were significant differences in posttest math scores between the treatment students and control students. The statistical analysis was also able to eliminate the students' preexisting differences, hence eliminating these differences as potential confounding variables in the statistical model.

The College Board Math Achievement Test was administered to all of the research participants ($N = 130$) by the researcher. The results indicate the treatment group had a higher mean pretest score ($M = 477.11$, $SD = 75.369$) than the control group ($M = 466.86$, $SD = 93.58$). Moreover, the treatment group had a higher mean posttest score ($M = 587.60$, $SD = 84.21$) than the control group ($M = 478.49$, $SD = 94.60$). The increase in the posttest scores demonstrated the students were able to increase their math performance. Each research group demonstrated gains on the posttest in comparison to the pretest scores regardless of type of instruction. However, posttest scores from the cyberlearning classroom showed significantly higher gains ($p = .000$) than scores from the traditional face-to-face group.

An ANCOVA was also run to test RQ4 regarding differences between boys and girls. From this analysis, the researcher determined there was no significant difference between genders. Therefore, the null hypothesis was rejected.

This study revealed that cyberlearning was as effective as traditional learning when looking at the all of the students in the study. In addition, when comparing genders, female online students had comparable results to male students in traditional and online classrooms. This means there is no significant difference between genders when students learn online. However, the study did not reveal any differences between special education and non-special education students or between Puerto Rican and non-Puerto Rican students.

Discussion of the Results in Relation to the Literature

The results from the ANCOVA are consistent with current research. For example, several meta-analyses suggested there was no significant difference between online and traditional learning (Allen et al., 2002; Cavanaugh et al., 2004). The positive trend of student achievement associated with cyberlearning support rather than the face-to-face setting has been ascertained by more researchers (Cavanaugh, 2001; Machtmes & Asher, 2000; Zhao, Lei, Yan, Lai, Tan, 2005). These researchers suggested a statistically significant and educationally important difference between the achievement of students who use cyberlearning and those who use a traditional face-to-face approach. These results are similar to other comparable studies. Allen et al. (2002) and Bernard, Abrami, et al. (2004) argued that online students perform academically as well as traditional students.

In addition, the findings of this study in relation to gender were consistent with current research. According to several investigators, both boys and girls do well with cyberlearning (Cheung & Kan, 2002; Gammie, Paver, Gammie, & Duncan, 2003; Rovai & Barnum, 2007). This is in accordance with the results of this study.

As confirmed in this study, as much as cyberlearning provides more alternative education, it does not help special education or minority populations. Results from a meta-analysis of studies examining the academic achievement of special education or minority students from several K–12 cyberlearning programs revealed there was no significant difference between the academic performance of special education or minority students using cyberlearning support and those using a traditional face-to-face approach (Bernard, Lou, et al., 2004; Cavanaugh et al., 2004; Machtmes & Asher, 2000). In this sense, additional studies of the impact of cyberlearning in these populations are needed.

Limitations

Several limitations apply to this study. First, the statistical analysis depended on the information provided by the students themselves as well as on their willingness to participate in the study with honesty and integrity, particularly since the posttest was administered at the end of the school year, after final exams at both schools. Another limitation was that tabulated findings pertained to low-performing schools relative only to math student achievement. Other subgroups, such as talented or high-performing students, were not included. The possible addition of other subgroups, such as gifted, White, or Spanish-limited students, could strengthen the outcomes.

Implication of the Results for Practice

The literature indicated that a great deal of money, time, and effort has been spent on technology infrastructure in recent years (London, 2011). Therefore, it is important to determine the best practices in designing and delivering learning experiences to students so that school districts, communities, and students reap the most benefit from the investments they make. According to the NSF (2008), “cyberlearning has tremendous potential right now because we have powerful new technologies, increased understanding of learning and instruction, and widespread demand for solutions to educational problems” (p. 12). Moreover, “the implementation of new technologies and our understanding of how students learn have evolved, while new approaches to research make the development and testing of technologies more responsive to real-world requirements and learning environments” (NSF, 2008, p. 23).

Cyberlearning opportunities provide a challenge to schools to redesign not only the delivery but also the pedagogy behind distance learning (London, 2011). The use of the

Internet in schools places learning in a new paradigm that moves from classroom-centered learning to learner-centered learning (ISTE, 2007). Suddenly, the traditional and contextual thinking of learning within the physical space and confines of a classroom takes on an amorphous identity in the virtual space of online learning. Elasticity and flexibility are two of the core characteristics of cyberlearning; a significant population among the students viewed this approach as the best method of learning and hence results in the retention of current students. In addition, several school leaders have taken upon themselves to use this education platform in the building of sustainable cyber domains and distance education curricula (ISTE, 2007; Madhavan et al., 2009; NCTM, 2010).

In addition, cyberlearning offers exciting possibilities for expanding the capacity to provide access to knowledge worldwide (Chandra & Lloyd, 2008). Chandra and Briskey (2012) asserted that "viewing these technological advancements in a more dynamic context, forces educators and researchers to rethink the fundamental processes of teaching and learning" (p. 56). Since its inception, ICT has been accompanied by attempts to integrate it into education, in pursuit of teaching and learning goals (Nachmias et al., 2010). The thorough combination of multimedia delivery capabilities, intuitive visual interfaces, support for efficient search and retrieval of information, and embedded allowance for synchronous and asynchronous interactions, along with the expansion of cyberspace into a huge hyperlinked repository of data, is perceived as a new powerful resource for teaching and learning purposes (ISTE, 2007; Khan, 1997; Nachmias et al., 2010; NCTM, 2000).

The findings of the present study will benefit educators, administrators, teachers, education policy makers, and, ultimately, students. Teachers will gain a better understanding of the nature of pedagogically sound cyberlearning support and will understand its role and benefits for student learning. In addition, the findings presented in this research could help policy makers, administrators, and teachers in developing and implementing new initiatives that encourage cyberlearning support in low-performing schools, and ultimately increase student performance and academic success.

The results of this study will be useful in identifying possible areas in need of improvement in curriculum/instruction, emerging instructional delivery formats, and educational planning/research for low-performing schools in Puerto Rico. Moreover, the results of the study may be used to design future studies in order to guide low-performing high schools in their decisions regarding the development of strategies to reduce the achievement gap in schools with high populations of Hispanic students. In addition, the study may provide teachers and students with valuable information and awareness of how Internet and web-based technologies can affect the classroom environment and the quality of student work. Moreover, teachers may learn how to effectively integrate technology into the curriculum in ways that present positive results for student achievement.

The results from the study can be beneficial in the field of math education and the approach educators take in establishing the challenging standards brought forth with the implementation of the Puerto Rico Common Core Standards. The results of this study revealed the importance of reforming the curriculum in the high school setting to include cyberlearning as a means of increasing student achievement. The results of the study showed the learning environment, whether cyberlearning or traditional, does not have an effect on student performance despite the students' ethnicity or gender.

Recommendations for Further Research

Cyberlearning, with specific regard to mathematics learning, has not been researched extensively (London, 2011). For instance, further studies are needed to provide for an in-depth analysis of the K–12 learning group as opposed to higher education, including junior colleges and universities. In addition, future studies should give descriptive details with respect to the interactions that were highlighted in the present study. This is because these interactions play a significant role in determining the future of mathematics learning in general (NCTM, 2000). For instance, a future study could focus on the requirements for successful mathematics learning. In addition, diverse interactions should also be analyzed in order to ascertain the impacts they have on these students. In relation to this study, it is paramount to establish whether learners in the lower levels of education require more interactions in order to excel.

For precision and accuracy of the results, successive studies should be executed for other schools. A substantive number of suggestions for future literary works were brought forth as a result of this study. Following are other topics that should be encompassed for further research:

- A future study should use a different subject aside from mathematics. This will enable the information users to determine whether other subjects can be taught online. For instance, are the chances of success higher among students who receive online math learning as opposed to those who use technology in learning a foreign language? Carrying out diverse research on a number of subjects offered at the high school level will aid in determining the impact of online learning in education.

- There is a need for research to determine the significance of online education with respect to gender and the implications. Does this instruction method allow for equity among students? This will be an important tool for policy makers and education facilitators regarding the decision on whether to adopt online learning in their schools.

- A future study should be characterized by diverse age groups or education levels. Age and maturity with relation to cyberlearning will provide for analysis of the effectiveness of online learning. There is a possibility that young students may find it difficult to adapt to this method of learning. Having a comparative study enables researchers determine the effectiveness of using such a framework within the education system.

- A future study should use multiple school settings. The present study focused on a low-performing public high school. Involving other schools, including magnet schools, will provide for conclusive results with respect to cyberlearning.

- There is need for further research to be carried out to that the program is all-inclusive in the following dimensions: time distribution between online and face-to-face time, the support relationships with adults, effective and academic supports, family support (Cavanaugh et al., 2009; Keeler, Richter, Anderson-Inman, Horney, & Ditson, 2007), and the contribution of expanded learning time (Gabrieli, 2011).

- There is need for research to determine the significance of online education with respect to exceptional students, minorities, and its implications. Does this methodology allow for equity among students? This will be an important tool for policy makers and education facilitators regarding the decision on whether to adopt online learning in their schools. With regard to minority students, more research needs to be conducted on how to support these students in successful completion of their academic courses. According to Repetto, Cavanaugh, Wayer, and Liu (2010); Repetto, Webb, Neubert, and Curran (2006); and Rhim and Kowal (2008), data in relation to disability cases should be effectively disseminated. There has been little conclusive information relating to online

> learning among students with disabilities (Repetto et al., 2010). This issue is a great hindrance among educational professionals regarding the need to determine adequate mechanisms to deal with these students. Research studies are limited because of the lack of disability-specific data collected by online schools. Lacking these data hinders in-depth disability-specific research that could help professionals to better serve students with disabilities in virtual settings (Repetto et al., 2010). Research is needed to compare student performance according to disability type, as students may perform differently in virtual courses depending on their disability.

Conclusions

Academic achievement is a concern in schools across the nation. However, not all students learn in the same ways. Alternative learning methods may be needed to increase student achievement. Cyberlearning has been shown to be an alternative way students can achieve. Students can learn just as much in online classes as they can in traditional classrooms. Online learning offers students the chance to learn anywhere and anytime. In addition, online learning offers students the chance to work at their own pace and take classes that might not otherwise be offered to them. Cyberlearning allows students the opportunity to gain academic achievement when a more traditional setting may have left them behind. Given the many benefits of cyberlearning for students, it is imperative the educational community continues to research and improve online education. However, for cyberlearning to be successful, a mechanism should be put in place to ensure the students interact with the environment.

As time progresses, IT advancements also improve. For this reason, distance learning will employ techniques that are pertinent and imperative to the students and consequently improve classroom learning, regardless of time constraints and place. As Crook et al. (2010) stated,

> ICT makes possible new forms of overarching classroom practice. This is apparent in three particular respects: [a] the reconfiguration of space such that new patterns of mobility, flexible working, and activity management can occur, [b] new ways in which class activities can be triggered, orchestrated and monitored, [c] new experiences associated with the virtualization of established and routine practices—such as using multiple documents in parallel, or manipulating spatial representations. (p. 4)

Cyberlearning is flexible because it provides a continuous learning process regardless of venue. As opposed to traditional learning, cyberlearning is a great tool in enhancing student performance (Cavanaugh, 2009a, 2009b). Education policy makers should strive to ensure that more research is carried out in order to improve this learning framework.

Educators and policy makers should continue to research cyberlearning in order to improve its effectiveness. Evaluation, assessment, and research must be considered as a tool to support public policy and inform decision making (Means & Haertel, 2004). It is no longer enough to ask whether cyberlearning is effective; educators, policy makers, and parents need to understand why it is effective (Cavanaugh et al., 2004). According to Means and Haertel (2004), investigators need to determine which factors contribute most to cyberlearning effectiveness, and in what contexts the factors interact. However, acquiring this knowledge requires a general consensus on a definition of *effectiveness* that goes beyond standardized tests, a system for identifying and measuring factors that influence effectiveness, and sophisticated statistical analyses. As Means and Haertel stressed, "many studies of the effects of technology-supported innovations are hindered by a lack of measures of student learning commensurate with the initiative's goals" (p. 99).

Educators are striving to ensure that students get through secondary school successfully and acquire all the pertinent skills they will need in life, especially since the advent of the NCLB and Race to the Top. It is the aim of public school educators in Puerto Rico to come up with a different view of teaching and enhance student academic performance. These are done through programs such as understanding by design, a new focus on Common Core learning standards, and differentiated instruction. It is not guaranteed that these adoptions would ensure student success in all schools. There is a need for educators to come up with alternatives to traditional learning. All students who employed web-learning elicited positive academic performance from the continuous assessment tests. This is a clear indication that cyberlearning can be of great significance, especially for those students who require an alternative to the traditional method. Teachers should continuously carry out literary research aimed at improving such an initiative. The success of this methodology would mean that students will become more enthusiastic toward learning. Positive social change can be seen from positive correspondence through online means and the zeal of the students to get to know the world around them. Schools need to offer students alternatives to traditional learning. Cyberlearning has been shown to be an effective way to learn in low-performing high schools in Puerto Rico. Therefore, it is only a matter of time before cyberlearning can be used as an alternative for secondary school students.

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