Instructional Delivery in Developmental Mathematics: Impact on Retention

By Carol A. Zavarella and Jan M. Ignash

ABSTRACT: ***Studies of students enrolled in computer-based instruction have yielded mixed results, with some reporting a high dropout rate. This article describes a quantitative study examining the probability of students' withdrawal from a computer- versus lecture-based developmental math course based on learning style, reasons for selecting the instructional format, and entry test scores. Students in the computer-based format were more likely to withdraw from the course compared to those in the lecture-based format, and personal reasons for choosing a specific format appeared to influence completion rates. Implications for practice include suggestions for providing appropriate information to students prior to their enrollment in online developmental education courses.***

There is a well-documented high dropout rate in courses delivered via computer instruction in general and distance learning courses and programs in particular.

Computer-based instruction, including distance learning, is fast becoming an integral part of higher education. Among its many advantages, computer-based instruction reaches "a broader student audience, better addresses student needs, saves money, and more importantly uses the principles of modern learning pedagogy" (Fitzpatrick, as cited in Tucker, 2001, p. 1). Questions remain, however, about the effectiveness of computer-based instruction with different types of learners, especially with those enrolled in developmental education courses. In this study, computer-based instruction is used as a general overarching term that includes online courses (distance learning) and/or computer-mediated instruction where the delivery format requires a computer and a packaged software product to deliver the content of the course.

Much of the current research on the effectiveness of computer-based instruction has found that it is as effective as lecture-based instruction (Lesh & Rampp, 2000; Perez & Foshay, 2002; Tucker, 2001). These studies mainly examined student outcomes, attitudes, and overall satisfaction (Phipps & Merisotis, 1999). Although the evidence supports that students enrolled in computer-based instruction perform equally well compared to their lecture-based counterparts, there is a well-documented high dropout rate in courses delivered via computer-based instruction in general and distance learning courses and programs in particular (Carr, 2000; Diaz, 2002; Kozeracki, 1999; Parker, 2003; Phipps & Merisotis, 1999;). Far less research has investigated the effectiveness of computer-based instruction specifically for students in developmental education. One such study conducted by Bendickson (2004) found the retention rates for developmental mathematics in computer-based courses were as low as or lower than retention rates in traditional lecture-based courses.

Although research designed to understand why the dropout rate is higher in computer-based instruction compared to traditional instruction is limited, the high dropout rate has prompted critics of computer-based instruction to question whether it is an appropriate delivery method for every student or for every subject area. Some researchers posit that retention and success in computer-based instruction is affected by the particular learning style of the student (Boles, Pillay, & Raj, 1999; Diaz & Cartnal, 1999; Gee, 1990; Grasha & Yangarber-Hicks, 2000; Sherry, 1996; Terrell, 2005; Tucker, 2001). Other researchers claim that students' reasons for choosing computer-based instruction may be related to the high dropout rate within this particular delivery format (Berg, 2001; Kinney & Robertson, 2005; Roblyer, 1999). For example, several studies designed to measure student perceptions of computer-based instruction have found that students perceive that the use of a computer will help them to understand the material and that courses delivered via computer-based instruction will be less time-consuming (Lesh & Rampp, 2000).

Of the few studies that examined learning style and student choice within computer-based instruction, none focused on the developmental student enrolled in a community college, a group that has been documented as high risk for dropout (Roueche & Roueche, 1993; Tinto, 1996). A key component of the effectiveness of computer-based learning, especially for students in developmental education, may be students' preferred learning styles (Berg, 2001; Terrell, 2005; Tucker, 2001). Researchers have developed varying definitions and descriptions of learning styles. For example, Higbee and Ginter (1991)

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state that learning style may refer to personality type, cognitive processes, environmental factors, or affective variables. James and Galbraith (1985) and Ginter, Brown, and Scalise note that "a person's learning style is directly related to ability to process and retain information" (as cited in Higbee & Ginter, 1991, p. 5). Gee (1990) states that "the majority of studies that connect positive academic achievement to students' preferred learning style have focused on student achievement and perception in the traditional classroom setting" (p. 3). In contrast, detailed research on learning style within computer-based instruction is limited.

Students' reasons for choosing a course delivery format is an often-overlooked area of investigation within distance learning. Instead, most studies concentrate on the demographic characteristics of students choosing computer-based instruction over the traditional lecture-based format (Perez & Foshay, 2002; Valentine, 2002; Phipps & Merisotis, 1999). An equal number of studies examine the characteristics of students who are successful in the computer-based format. However, it is important to investigate students' reasons for choosing one particular instructional format over another. Roblyer (1999) argues that, as they begin to consider replacing traditional formats with distance learning formats, the administrators need to better understand the potential impact upon students. In addition, if a preference for distance learning is found in a certain type of student, such as "students at certain educational levels, with more experience using technology, or with greater academic commitment" (p. 3), this information may help institutions determine who is most likely to succeed in distance learning endeavors.

Research Questions

This study attempted to examine the differences in students' withdrawal and completion rates in classes delivered via different instructional formats (distance learning, hybrid, or traditional). The three research questions guiding this study were:

1. Is there a relationship between students' learning styles and their completion or withdrawal from a beginning algebra developmental math course by a particular instructional delivery format (i.e., lecture-based, hybrid, or distance learning)?
2. Is there a relationship between students' reasons for choosing a particular instructional delivery format (i.e., lecture-based, hybrid, or distance learning) and their completion or withdrawal from a beginning algebra developmental math course?
3. Is there a relationship between students' College Placement Test (CPT) mathematics score and their completion or withdrawal from a particular instructional delivery format (i.e., lecture-based, hybrid, or distance learning) of a developmental basic algebra math course?

This nonexperimental quantitative study examined the relationship between student learning styles, student reasons for choosing a particular course delivery format, and students' entering math placement test scores on the College Placement Test, and the completion or withdrawal from a particular course delivery format (traditional, hybrid, or distance learning). Participants were students in a beginning algebra developmental mathematics course at a large urban community college. The hybrid format is an instructional delivery method that requires a computer and a packaged software product to deliver the content of the course. The course meets on campus, and the instructor acts as a facilitator who offers personalized instruction as needed. The instructor may or may not deliver minilectures, but the majority of the content is delivered via the computer. The distance learning format is an instructional delivery method that is taught completely online from packaged software and is delivered at a distance.

Social interaction is an important scale to include in distance learning research.

The research questions were examined using data from student test scores, a learning style survey, and a survey of students' reasons for selecting a delivery format which was modified from an existing Roblyer (1999) survey.

Method

Site and Sample Demographics

The site of the study was a large, urban, multicampus community college located in Florida. The population consisted of students who were enrolled in different sections of the same developmental math course offered in a traditional lecture-based format, a hybrid format, and a distance learning format. The study was limited to students who were enrolled at two of the college's five campuses because these were the only two campuses that offered all three methods of instructional delivery for the course. The main campus had the highest enrollment (12,710 unduplicated headcount in Fall 2006) and the other campus, located in an historical, urban setting, was smaller (7,090 unduplicated headcount in Fall 2006). In addition, the developmental course studied was limited to beginning algebra because it was the only developmental course offered in all three instructional formats. The sample consisted of three groups: (a) 69 students enrolled in three sections of a basic algebra traditional lecture-based course on the two campuses, (b) 67 students enrolled in three sections of the hybrid version of the course on both campuses, and (c) 56 students enrolled in three sections of the course delivered via distance learning. Random sampling was not possible for this study because students self-selected into their courses. A nonprobability (purposive) sampling technique was used to choose the sections involved in the study in an effort to obtain a sample that was as representative as possible of the population being studied.

Data Collection

Data from three sources were used for this study: (a) the Grasha-Reichmann Student Learning Styles Scales" (Hruska-Riechmann & Grasha, 1982), (b) an institutionally developed survey of students' reasons for selection of delivery format, and (c) college-level institutional data on participants' demographic characteristics and mathematics entry test scores.

The Grasha-Riechmann Student Learning Style Scales (GRSLSS) was the instrument used to determine the learning styles of the students involved in the study. For over 20 years, the GRSLSS has "been used to identify the preferences learners have for interacting with peers and the instructor in classroom settings" (Grasha, 1996, p. 127). The GRSLSS was selected for this study because "the scales fall into the general learning style category of social-interaction models…as opposed to other categories of learner differences such as cognitive styles or developmental-stage models" (Hruska-Riechmann & Grasha, 1982, p. 81). Although several other learning style instruments have been used in research involving distance learning, "the GRSLSS focuses on how students interact with the instructor, other students, and with learning in general" (Diaz & Cartnal, 1999, p. 2). Social interaction is an important scale to include in distance learning research because one of the defining characteristics of distance learning is "the separation of teacher and student" (Garrison, 1989, p. 2). Therefore, the GRSLSS addresses "one of the key distinguishing features of a distance class, the relative absence of social interaction between instructor and student and among students" (Diaz & Cartnal, p. 2). In addition, the GRSLSS "is one of the few instruments designed specifically to look at student differences in senior high school and college/univer-

Table 1
Description of Grasha's Six Learning Styles

Learning Style	Characteristics
Competitive	Students who learn material in order to perform better than others in the class. Believe they must compete with other students in a course for the rewards that are offered. Like to be the center of attention and to receive recognition for the accomplishments in class.
Collaborative	Typical of students who feel they can learn by sharing ideas and talents. They cooperate with teacher and like to work in groups and teams.
Avoidant	Not enthusiastic about learning content and attending class. Do not participate with students and teachers in the classroom. They are uninterested and overwhelmed by what goes on in class.
Participant	Good citizens in class. Enjoy going to class and take part in as much of the course activities as possible. Typically eager to do as much of the required and optional course requirements as they can.
Dependent	Show little intellectual curiosity and who learn only what is required. View teacher and peers as sources of structure and support and look to authority figures for specific guidelines on what to do.
Independent	Students who like to think for themselves and are confident in their learning abilities. Prefer to learn the content that they feel is important and would prefer to work alone on course projects than with other students.

Note. The descriptions are from Teaching with style: *A practical guide to enhancing learning by understanding teaching and learning styles* (p. 169), by A.F. Grasha, 1996, Pittsburgh: Alliance Publishers. Copyright 1996 by Alliance Publishers. Adapted with permission.

sity classrooms" (Hruska-Riechmann & Grasha, p. 81).

The GRSLSS is comprised of six different learning style scales: competitive, collaborative, avoidant, participant, dependent, and independent (see Table 1). These scales represent a blend of characteristics that are found within each student, with "certain qualities more pronounced than others" (Grasha, 1996, p. 170). For this study, student learning style has been classified by the dominant style as indicated by the six subscales.

The second instrument was a survey designed to identify reasons why students selected a particular instructional delivery format. The survey was drafted using a combination of two sources: an existing study by Roblyer (1999) and a locally developed survey. Roblyer conducted a study that examined the importance of choice and its impact on distance learning by studying students' motivation for selecting either an Internet-based course or a face-to-face course. She used the following four constructs to develop the 13-item survey and established construct validity for the survey's Likert scale:

1. Logistical factors: Distance and driving time to course site, access to parking, and access to computer resources.
2. Control factors: Choosing when to accomplish learning activities and flexibility in time students needed to complete them.
3. Personal interaction factors: The need for personal interaction with instructors and other students.
4. Technology perspectives: Attitudes about and prior experiences with technology and DL. (p. 6)

A questionnaire developed by a full-time instructor who currently teaches Basic Algebra through distance learning was also consulted to develop this study's second survey. The researcher compared several years of recent college-level, institutional data regarding the reasons students chose to enroll in a distance learning course to the items found in Roblyer's (1999) survey. There were several comments from students related to logistical and control factors that were not included in the Roblyer survey. As a result, Roblyer's original survey was modified to incorporate these additional items for the study.

The third source of data for this study was information obtained from the college database. It included student demographic characteristics and entering CPT math test scores.

Each of the research questions was addressed by logistic regression, chosen for its predictive ability. "Logistic regression allows one to predict a discrete outcome such as group membership from a set of variables that may be continuous, discrete, dichotomous, or a mix" (Tabachnick & Fidell, 2001, p. 517). This type of regression can be used to predict a dichotomous dependent variable based on either continuous or categorical independent variables.

Results

Results of the study are discussed below in five major sections. In the first section, some descriptive statistics are provided for the research sample, including frequencies for general student characteristics (gender, race/ethnicity, age) and for general findings relating learning styles to student course completion rates. The latter four sections present results for each of the research questions.

General Student Characteristics

Frequencies comparing gender, age, and ethnicity of the research group as a whole and by instructional delivery method revealed some differences between the groups. Although the research population was small, the similarity of participant demographics in all three groups supported comparison. Similarity of characteristics to developmental students in other studies further supported some transferability for findings.

Gender. Females represented a higher percentage (71%) of the research group than males. The higher proportion of females is consistent with other studies that have found more women enrolled in developmental courses (Saxon & Boylan, 1999; Young, 2002) and in distance learning (Phipps & Merisotis, 1999). Within each of the three subgroups, the proportion of females versus males stayed fairly constant, showing no significant difference between gender and type of instructional delivery format.

Race/Ethnicity. Race/ethnicity was a variable in which the research group differed from the population of other studies. Two-thirds of the research group in this study (65%) was reported as non-Caucasian, including African American (34%), Hispanic (28%), Asian/Pacific Islander (2%), and American Indian/Alaskan (1%). These results differed from the proportion reported in a similar study by Baltzer (as cited in Young, 2002) who found that only one-third of students in developmental classes were from a minority group. Further, both Diaz (2002) and Saxon and Boylan (1999) found that more majority students enrolled in distance learning classes than minority students. Therefore, the minority group representation in this study was higher than would have been expected, in light of representation reported in similar studies.

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Table 2

Completion Status by Instructional Delivery Format

Completion Status	Lecture Format *n* = 69		Hybrid Format *n* = 67		Distance Learning Format *n* = 56		Total All Sections *N* = 192	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Completed	55	80%	39	58%	34	61%	128	67%
Withdrew	14	20%	28	42%	22	39%	64	33%
Total	69	100%	67	100%	56	100%	192	100%

Note. From "Computer-Based Instruction and Remedial Mathematics: A Study of Retention at a Florida Community College," by C.A. Zavarella, 2008, Doctoral Dissertation, University of South Florida, p. 81. (UMI No. 3326039). Printed with permission.

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Age. The age of the participants in this study, however, was comparable to age ranges reported in similar studies. Two-thirds of the participants in this study were under 25 years of age; this group also composed the highest percentage enrolled in the hybrid (72%) and the traditional, lecture-based format (65%), compared to only 48% of students in the distance learning format. Consistent with these results, Diaz and Cartnal (1999) found that most students enrolled in distance learning courses/programs were older than the traditional-aged college student.

Learning styles. The collaborative and participant learning styles were the predominant learning styles among students in the research group as a whole and in each of the three instructional delivery formats. This distribution is consistent with the learning styles among college students found in a national sample. Grasha (1996) analyzed the distribution of learning styles of pre-med students and found that "the students displayed relatively higher scores on the independent, collaborative, dependent, and participant styles and relatively lower scores on the avoidant and competitive styles" (p. 174).

Instructional Delivery Format and Course Completion Rates

Results reported in Table 2 show that the students enrolled in the hybrid or distance learning formats had a higher withdrawal rate (42% and 39% respectively) than those students enrolled in the lecture-based format (20%). A total of 64 students withdrew from all sections of the course. An attempt was made to contact these students to ascertain their reasons for withdrawing from the course. Although the response rate was low (*n* = 30, 47% response rate), 55% of those responding (*n*=11) from the computer-based sections stated that the course presented challenges they did not expect.

Of the students who selected common reasons for withdrawing from the course (job, family, or medical reasons), all but one student were from the computer-based sections.

Learning Styles and Course Completion Rates

We examined study data to determine whether there was a relationship between students' learning styles and their completion or withdrawal from a developmental math course by a particular instructional delivery format (i.e., lecture-based, hybrid, or distance learning). Based on the sample size of this study and controlling for delivery format, the results indicated that learning style did not appear to impact the completion or withdrawal of students enrolled in the course (see Table 3).

Reasons for Choosing an Instructional Format and Course Completion Rates

Personal factors (i.e., whether the course was offered at a convenient time) and learning needs (i.e., as whether the student perceived online courses to be easy) were statistically significant in predicting withdrawal from the course when controlling for delivery method, age, ethnicity, marital status, and gender (see Table 4). Specifically, students who enrolled in a course because it met their personal needs had greater odds of completing the course. In contrast, students who

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Table 3

Main Effect Variables as Predictors of Completion Status

Predictor	Completion Status	Odds Ratio	95% CI (Odds Ratio)	
			Lower	Upper
Hybrid	**Noncomplete**	**2.54**	**1.13**	**5.69**
Distance	**Noncomplete**	**2.83**	**1.16**	**6.89**
Learning Style				
Avoidant	Noncomplete	2.16	0.63	7.44
Competitive	Noncomplete	1.30	0.40	4.26
Dependent	Noncomplete	0.74	0.21	2.62
Independent	Noncomplete	0.68	0.24	1.97
Participant	Noncomplete	0.46	0.19	1.12
Ethnicity	Noncomplete	0.62	0.30	1.30
Gender	Noncomplete	1.31	0.65	2.66
Age	Noncomplete	0.70	0.33	1.46

Note. Bold Items Indicate Statistical Significance. From "Computer-Based Instruction and Remedial Mathematics: A Study of Retention at a Florida Community College," by C.A. Zavarella, 2008, Doctoral Dissertation, University of South Florida, p. 92. (UMI No. 3326039). Printed with permission.

Table 4

Student Reasons for Choosing Format as Predictors of Completion Status (N=192)

Predictor	Completion Status	Odds Ratio	95% CI (Odds Ratio)	
			Lower	Upper
Hybrid	**Noncomplete**	**4.55**	**1.90**	**10.92**
Distance	**Noncomplete**	**8.15**	**2.68**	**24.80**
Personal Factors	**Noncomplete**	**0.59**	**0.35**	**0.98**
Learning Needs	**Noncomplete**	**1.79**	**1.24**	**2.60**
Ethnicity	Noncomplete	0.70	0.34	1.43
Age	Noncomplete	0.66	0.31	1.42
Gender	Noncomplete	1.25	0.61	2.57

Note. Bold Items Indicate Statistical Significance. From "Computer-Based Instruction and Remedial Mathematics: A Study of Retention at a Florida Community College," by C.A. Zavarella, 2008, Doctoral Dissertation, University of South Florida, p. 92. (UMI No. 3326039). Printed with permission.

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enrolled in a course based upon their perceived need for face-to-face instruction versus online access to either the instructor or their peers were more likely to withdraw from the course.

Placement Scores and Course Completion Rates

Research question three asked "Is there a relationship between students' College Placement Test (CPT) mathematics score and their completion or withdrawal from a particular instructional delivery format (i.e., lecture-based, hybrid, or distance learning) of a developmental math course?" Students who enrolled in either the hybrid or distance learning formats had greater odds of withdrawing from the course compared to students enrolled in a lecture-based format regardless of their placement test scores. CPT scores appeared to have no relationship with completion status of the course while controlling for delivery method.

Discussion

The results from this study revealed three major findings: (a) Students enrolled in either a distance learning or hybrid developmental mathematics course were twice as likely to withdraw from the course as those who enrolled in a lecture-based course; (b) students who enrolled in a hybrid, distance, or lecture-based developmental mathematics course for personal reasons were more likely to complete the course as compared to those who enrolled based on their perceived learning needs; and (c) student learning styles and CPT scores did not seem to affect their completion status in a developmental mathematics course delivered via any of the three instructional formats.

Instructional Format and Completion Rates

The results revealed that the instructional format involving the computer-based section negatively affected the retention rate within the course. Other research findings also have shown a higher dropout rate for students using computer-based instruction compared to those students taking courses or programs delivered in a traditional lecture-based format (Carr, 2000; Diaz, 2002; Kaplan 2004; Phipps & Merisotis, 1999; Parker, 2003; Searcy & Others, 1993).

Choosing an Instructional Format and Completion Rates

The results of the analysis further suggest that while controlling for delivery method, age, ethnicity, and gender, students who enrolled in the course because it met their personal needs were more likely to persist in the course. In contrast, those students who enrolled in a course based upon their perceived need for face-to-face instruction versus online access to either instructor or their peers were more likely to withdraw from the course. The results show a statistically significant difference in the prediction of withdrawal in the course based on students' reasons for selecting a particular delivery format. An examination of students' reasons for withdrawal from the course provides insight: Although only a small number of students shared their reasons, 55% (11/20) of the students who withdrew from the computer-based sections did so because this mode of instruction presented challenges that they did not anticipate. For example, a student wrote, "this proved to be much harder than I thought," and another student wrote, "learning math online was a problem . . . it was a mistake signing [sic] up for an online math class." Students enrolled in the developmental course may have perceived the computer-based instruction to be less challenging than that of a traditional lecture-based course. Specifically, students' may have believed that the course material delivered via computer would be more comprehensible than that same material delivered in a classroom setting. Students may also have perceived computer-based instruction to be less time-consuming than that of traditional courses.

Distance learning students came on campus to access the computers in the lab but did not seek tutoring.

Another challenge students reported experiencing in their computer-based sections was the lack of available tutorial services. Although students were informed during their mandatory orientation session that tutoring was available, the instructor who taught the distance learning courses reported students rarely utilized posted office hours, even when encouraged to make appointments during or outside posted hours. The instructor also stated that the distance learning students came on campus to access the computers in the lab but did not seek tutoring.

Participants' Learning Styles, CPT Scores, and Completion Rates

The study found that student learning style and CPT score do not appear to impact the retention rate within the course. It must be noted however, that some of the values may be too small to be reliable (see Table 3, p. 6), which could impact the results. Another possible explanation of why learning styles do not appear to influence course withdrawal or completion rates may be attributed to the nature of the learning styles. Hruska-Riechmann and Grasha (1982) state that every student will have some combination of each of the six styles and that no one person will prefer one style exclusively. Although the researcher was able to identify a dominant learning style for each of the participants, the interaction of the other five learning styles that each person possesses may have played a confounding role in the study.

Implications for Practice and Future Research

The results of this study suggest a number of recommendations for practice and for research. Arguably, the most important recommendation has to do with student retention. A major finding of this study is that students enrolled in a developmental mathematics course taught in a computer-based format had a higher dropout rate than students enrolled in a traditional lecture-based course. Postsecondary institutions are affected by student attrition because state funding is often based, at least in part, on individual college retention rates. Another financial implication is the number of dollars spent on recruitment of students into the college. Persistence in college has a direct impact on students as well, and studies have shown that students who have successfully completed a developmental program are as successful in college-level work as those who entered the institution academically prepared (Young, 2002).

More importantly, the mission of the U.S. community college is to provide open access to higher education for students who hold a high school diploma or equivalent or who have the ability to benefit from a postsecondary education. Technology has made it possible to provide access to an even greater number of students. If a large number of students who are enrolled in computer-based developmental instruction are not completing their courses, however, then the goal of increasing access is not being attained.

Regarding the impact of students' reasons for enrolling in a particular delivery format and their completion of the course, the results of this study revealed that students who enrolled in the course based on personal factors and/or direct experiences with computer-based instruction and technology were more likely to complete the course as opposed to those students who enrolled because of their perceived need for

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face-to-face versus online interaction between the instructors and/or their peers. This finding suggests that students who are enrolled in developmental courses may not be cognizant of their particular learning needs or have misconceptions of computer-based instruction. They may believe that learning online is easy or less time-consuming than "regular" classes, only to discover that, at least for them, this is not the case.

In an effort to improve the retention rate within computer-based courses and programs including distance learning, an increase in two-way communication between the institution and the student is recommended. This recommendation is a direct result of the second major finding of this study, which showed that students who withdrew from computer-based sections of the developmental math course had misconceptions of both their learning needs and what was expected when enrolling in a computer-based course. More specifically, results also suggest that students need to be aware of the particular demands of online and Web-enhanced learning delivery systems, whether their particular reason for selecting a delivery format bodes well for their success in these courses, and what resources they can use to enhance their understanding of Web-based course content. Colleges might consider establishing an informational Web site that students are required to access prior to enrolling in computer-based courses which outlines expectations for and characteristics of successful students in such courses.

Garrison and Shale (as cited in Garrison, 1993) expanded the notion of quality within distance education by arguing that an increase in two-way communication is the most important component in the education process. A well-designed computer-based course or program is the result of expertise in the areas of academics, course/curriculum design, and production of media materials. This implies that, in order to have an effective distance education program, an institution should have a dedicated department to meet the special needs and challenges associated with computer-based instruction and teaching at a distance. The department would then be responsible for communicating information to students who wish to enroll in computer-based instruction as well as provide the necessary expertise to address the unique problems and/or unanticipated events that may arise with computer-based courses and programs.

The finding that students who enrolled in the developmental course based on personal factors including previous experience with computer-based instruction and/or technology—either positive or negative—had greater odds of completing the course further implies that there is a need for choice in instructional format to meet students' needs. The study revealed that 55% of those students who withdrew from their computer-based sections did so due to unexpected challenges. As discussed earlier, these results may indicate that students lack an understanding of what is expected in a computer-based course/program or that the institution is not effectively communicating to students what is required to be successful in a computer-based course/program. These misconceptions may result from the disparity between characteristics of a typical student enrolled in a developmental course and the characteristics of a successful distance learner. Training workshops for students with limited or no previous experience with computer-based courses, offered by the college prior to beginning such a course, might be another way to assist students' enrollment decisions and success.

An area for which it was difficult to collect information but may prove beneficial to future researchers is student reasons for withdrawal from computer-based courses. A consistent procedure for the accurate collection of reasons for student withdrawal from a course may provide invaluable information to the institution and data for future research. Information regarding students' impetus for withdrawing from a particular instructional delivery format, systematically tracked and recorded, may help guide educators interested in the area of retention.

The accurate collection of reasons for student withdrawal from a course may provide invaluable information to the institution.

Another possible explanation of why students reported the computer-based sections to present unexpected challenges is in the area of time management. Students who have outside responsibilities may enroll in computer-based instruction with the perception that it will allow them more time to attend to their other responsibilities than if they enrolled in a traditional lecture-based course. It could be beneficial to conduct exit surveys or focus groups with students who have withdrawn from a computer-based course to gain a better understanding of their perceptions of computer-based instruction as well as their reasons for withdrawal from the course in order to gain a deeper understanding of retention in general and particularly in computer-based instruction.

Although study findings do not indicate a relationship between students' learning style and retention in various course delivery formats, some affective characteristics of students may be related to reasons for choosing computer-based instruction. Clearly, no one medium can meet the expectations and needs of every student. Distance learning theorists suggest that a well-designed computer-based course or program is one that "delivers information in various forms, suited to various learning styles, and gives the greatest range of alternative communication modes" (Moore, 1989, p. 9).

In terms of students' ability to assess their capabilities, students in developmental courses are often uncertain about their goals and demonstrate low self-efficacy toward academic tasks (Saxon & Boylan, 1999). Perin and Greenberg (1994) suggest that issues related to goal attainment and motivation affect persistence for students enrolled in adult basic education as students "realize that academic demands are higher than expected and that specific educational steps (e.g., college-level study) needed for career advancement may be difficult to achieve" (p. 185). These characteristics are in opposition to the characteristics of successful distance learners who have been found to have a high tolerance for ambiguity and a need for autonomy and flexibility (Valentine, 2002).

Another recommendation for practice concerns the area of computer-based instruction and access to tutorial services and/or utilization of instructor office hours and its impact on success and retention. The fact that distance learning students came to campus to access computers but did not access tutoring may imply that, although help was available and accessible, students did not perceive they needed help beyond the course materials they had to access. The implication is that students may not understand the importance of combining tutoring with their computer-based instructional materials. The effectiveness of tutoring alone and in combination with computer-based instruction and its effect on retention is supported in the literature. Students who receive both tutoring and computer-based instruction have significantly higher retention rates than those who receive computer-based instruction alone (Kaplan, 2004). Therefore, the importance of receiving tutoring for students enrolled in computer-based instruction for developmental courses should be communicated early and often throughout the semester. In addition, institutions might consider implementing mandatory or optional on-

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line tutoring for students enrolled in hybrid or distance courses.

Although student CPT scores did not appear to affect retention within the course, there was a statistically significant negative correlation between age and CPT score. The issue of how much time had elapsed since a student's interaction with math may explain this association. The average age of the community college student in this study was 25.9 years. It had been several years since most students had taken a mathematics course, which may have negatively affected their CPT score. However, once a student enrolls in the course, the concepts and ideas are refreshed, and the student often continues to successfully complete the course. In another scenario, a student may take the CPT the semester following high school and perform well on the test. However, many semesters may pass before he or she takes the required mathematics course. The student may then struggle to relearn math concepts and ideas, negatively affecting his or her ability to complete the course.

Further research should also be conducted to track the subsequent enrollment status of those students who withdrew from a computer-based course to ascertain whether they re-enroll the next semester in the same instructional delivery format, a different instructional delivery format, or dropout of college completely.

If colleges implement the preceding recommendations and examine the viability of their computer-based courses and programs, they may be better able to project the number of sections of hybrid and distance learning courses that should be offered each semester, especially in developmental education. This practice may help the overall retention rate while still maintaining a choice in instructional delivery formats to meet students' needs.

Conclusion

Student retention in general, and within developmental programs in particular, is an important issue for institutions of higher education. A large number of students enrolling in college require at least one developmental math course. It is important for both the student and the institution that these students complete and successfully pass their developmental courses in a timely manner.

The high dropout rate within computer-based instruction implies that computer-based instruction is not a panacea for teaching and/or learning in a developmental mathematics course. Computer-based instruction can be a viable educational alternative for some students, as shown in this study. However, this study also has found that the withdrawal rate was double for those students enrolled in a computer-based format compared to those students enrolled in a traditional lecture-based format of a developmental mathematics course, with more than half withdrawing because the course presented challenges they did not expect. Students may not fully understand what it takes to learn mathematics in a computer-based format.

Before institutions spend additional time and money increasing their distance learning offerings or developing new computer-based programs for developmental mathematics, institutions should increase the communication between themselves and their students to gain a better understanding of their issues and concerns. Armed with accurate information about students' needs in computer-based developmental courses, educators can better address the issues that interfere with success and retention in computer-based developmental courses.

Institutions should increase the communication between themselves and their students to gain a better understanding of their issues and concerns.

References

Bendickson, M. M. (2004). *The impact of technology on community college students' success in remedial/developmental mathematics.* Unpublished doctoral dissertation, University of South Florida, Tampa.

Berg, E.S. (2001). An assessment of community college students' learning styles, choice of instructional delivery method, withdrawal rates, and performance in writing intensive courses. *Dissertation Abstracts International, 62*(10), 3246A.

Boles, W.W., Pillay, H., & Raj, L. (1999). Matching cognitive styles to computer-based instruction: An approach for enhanced learning in electrical engineering. *European Journal of Engineering Education, 24*(4), 371-383.

Carr, S. (2000). As distance education comes of age, the challenge is keeping the students. *The Chronicle of Higher Education, 46*(23), pp. A39-A41.

Diaz, D.P. (2002, June). *Online drop rates revisited.* Chapel Hill, NC: UNC School of Public Health. Retrieved October 21, 2006, from http://technologysource.org/article/online_drop_rates_revisited/

Diaz, D.P., & Cartnal, R.B. (1999). Students' learning styles in two classes: Online distance learning and equivalent on-campus [Electronic version]. *College Teaching, 47*(4), 1-6.

Garrison, D.R. (1989). *Understanding distance education: A framework for the future.* New York: Routledge.

Garrison, D.R. (1993). Quality and access in distance education: Theoretical considerations. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 9-21). New York: Routledge.

Garson, G. D. (2006). *Logistic regression.* Retrieved April 23, 2007, from http://www2.chass.ncsu.edu/garson/PA765/logistic.htm

Gee, D.B (1990). The impact of students' preferred learning style variables in a distance education course: A case study (Research/Technical Report). Lubbock: Texas Tech University. (ERIC Document Reproduction Service No. ED 358836)

Grasha, A.F. (1996). *Teaching with style: A practical guide to enhancing learning by understanding teaching and learning styles*. Pittsburgh, PA: Alliance Publishers.

Grasha, A.F., & Yangarber-Hicks, N. (2000). Integrating teaching styles and learning styles with instructional technology. *College Teaching, 48*(1), 2-10.

Higbee, J.L., & Ginter, E.J. (1991, Spring). Enhancing academic performance: Seven perceptual styles of learning. *Research & Teaching in Developmental Education, 7*(2), 5-9.

Hruska-Riechmann, S., & Grasha, A.F. (1982). The Grasha-Riechmann student learning style scales. In J. W. Keefe (Ed.), *Student learning styles and brain behavior* (pp. 81-86). Reston, VA: National Association of Secondary School Principals.

James, W.B., & Galbraith, M.W. (1985). Perceptual learning styles: Implications and techniques for the practitioner. *Lifelong Learning, 8*(4), 20-23.

Kaplan, C. R. (2004). *The use of tutoring and computer based instruction with community college developmental education students and their relationship to student success.* Las Cruces: New Mexico State University. (UMI No. 3138933)

Kinney, D.P., & Robertson, D.F. (2005). Identifying students' reasons for selecting a computer-mediated or lecture class. *The AMATYC Review, 27*(1), 37-47.

Kozeracki, C.A. (1999, Winter). Scratching the surface: Distance education in the community colleges. *New Directions for Community Colleges, 108,* 89-98.

Lesh, S.G., & Rampp, L.C. (2000). Effectiveness of computer-based educational technology in distance learning: A review of the literature.

(ERIC Reprodution Service No. ED 440628.)
Moore, M.G. (1989). Distance education: A learner's system. *Lifelong Learning: An Omnibus of Practice and Research, 12*(8), 8-11.
Parker, A. (2003, January). Identifying predictors of academic persistence in distance education. *USDLA Journal, 17*(1). Retrieved November 19, 2006, from http://www.usdla.org/html/journal/JAN03_Issue/article06.html
Perin, D., & Greenberg, D. (1994). Understanding dropout in an urban worker education program: Retention patterns, demographics, student perceptions, and reasons given for early departure. *Urban Education, 29*(2), 169-187.
Perez, S., & Foshay, R. (2002). Adding up the distance: Can developmental studies work in a distance learning environment? *T.H.E. Journal, 29*(8), 16-24.
Phipps, R.A., & Merisotis, J.P. (1999). *What's the difference? A review of contemporary research on the effectiveness of distance learning in higher education.* Washington, DC: Institute for Higher Education Policy.
Roblyer, M.D. (1999). Is choice important in distance learning? A study of student motives for taking Internet-based courses at the high school and community college levels [Electronic version]. *Journal of Research on Computing in Education, 32*(1), 1-12.
Roueche, J.E., & Roueche, S.D. (1993). *Between a rock and a hard place: The at-risk student in the open door college.* Washington, DC: The Community College Press.
Saxon, D.P., & Boylan, H.R. (1999). *Characteristics of community college remedial students.* Research contracted by The League for Innovation in the Community College. Retrieved October 12, 2006, from http://www.ncde.appstate.edu/reserve_reading/Student_Characteristics.htm
Searcy, R.D., & Others. (1993). *Grade distribution study: Telecourses vs. traditional courses.* Research report prepared for the Calhoun Telecourse Steering Committee. Decatur, AL: Calhoun Community College.
Sherry, L. (1996). Issues in distance learning. *International Journal of Educational Telecommunications, 1*(4), 337-365.
Tabachnick, B.G., & Fidell, L.S. (2001). *Using multivariate statistics.* Needham Heights, MA: Allyn and Bacon.
Terrell, S. R. (2005). Supporting different learning styles in an online learning environment: Does it really matter in the long run? *Online Journal of Distance Learning Administration, 8*(2). Retrieved March 12, 2007, from http://www.westga.edu/~distance/ojdla/summer82/terell82.htm
Tinto, V. (1996). Persistence and the first year experience at the community college: Teaching students to survive, stay and thrive. In J.N. Hankin (Ed.), *The community college: Opportunity and access for America's first-year student* (pp. 97-104). Columbia: University of South Carolina, The National Resource Center for the Freshman Year Experience.
Tucker, S. (2001). Distance education: Better, worse, or as good as traditional education? *Online Journal of Distance Learning Administration, 4*(4). Retrieved September 23, 2006, from http://www.westga.edu/~distance/ojdla/winter44/tucker44.html
Valentine, D. (2002). Distance learning: Promises, problems, and possibilities. *Online Journal of Distance Learning Administration, 5*(3). Retrieved October 21, 2006, from http://www.westga.edu/~distance/ojdla/fall2002/valentine53.html
Young, K.M., (2002). *Retaining underprepared students enrolled in remedial courses at the community college* (Evaluative report). Champaign, IL: Parkland College. (ERIC Reproduction Service No. ED 467 850)
Zavarella, C.A. (2009). Computer-based instruction and remedial mathematics: A study of retention at a Florida community college. *Dissertation Abstracts International, 69*(08), 3005. (UMI 3326039)