Access to an Online Tutorial Service: College Algebra Student Outcomes

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Abstract

This study investigated outcomes (achievement, attitude, and retention) of College Algebra students who had access to an online tutoring resource using a pre-posttest control group research design. Students in the experimental groups were provided access to an online tutoring service and students in the control were not. Both groups had access to other forms of tutorial services available at the university. Collected data included algebra content knowledge test, attitude survey, online tutoring logs, and retention data. The content knowledge gain scores of students in the experimental group who used the online tutoring service (*E-Users*) were significantly higher than the students in the experimental who did not use the service (*E-Non Users*). E-Users had better attitudes about help seeking than E-Non-Users. More students in the experimental group persisted and remained in the course than did in the students in the control group.

Keywords: Tutoring, College Mathematics, Algebra, Attitudes, Mathematics Achievement

To address challenges students experience with mathematics, many educators and others recognize the need to provide learning supports to enhance and improve students' learning experiences and content knowledge (Center for Mental Health in Schools, 2010). Many national and international educational institutions, both at the secondary and postsecondary levels, address this need by providing tutorial services for students. Tutorial services are available and used in various settings all around the world (see for example, Kim & Park, 2010; Underhill & McDonald, 2010; and Ferjolja & Vickers, 2010).

Tutoring[1] refers to a supplemental learning experience in which one person (the tutor) supports and promotes the learning of another individual (the tutee) or group of individuals. The definition of tutor, according to Merriam-Webster's Collegiate Dictionary (2010), is "a person charged with the instruction and guidance of another" or "to teach or guide usually individually in a special subject or for a particular purpose" ("Tutor", para. 1). Hock, Deshler and Schumaker (1999) describe two different models of tutoring – *instructional* and *assignment-assistance*.

These models for tutoring are different in the intent and the engagement of the tutors in providing learning support. Instructional tutoring is described as an instructional practice where the tutor(s), (a) analyze the assignment in terms of learner skills needed to complete the assignment; (b) analyze the student's current level of skill and strategy knowledge; (c) instruct the student through explanation, modeling, and guided practice in relevant skills, strategies and content knowledge that the student can use to complete similar tasks in the future; and (d) provide sustained corrective feedback . . .; and (e) provide immediate support for current assignment to keep the student academically "afloat" while the student develops proficiency as an independent learner. ("Tutoring Models", para 2.)

In contrast, the major focus of assignment-assistance tutors is to provide assistance based on the assignment or task that the students bring to the tutor's attention. Specifically, assignment assistance tutoring (a) provide small-group or one-to-one homework assistance; (b) react to the demands of the general curriculum and review content with the student; (c) provide brief feedback on student performance; and (d) make little or no systematic attempt to teach skills and learning strategies relevant to the homework assignment at hand and generalizable to similar assignments in the future. ("Tutoring Models", para 4.)

Although the primary objective of tutoring is to enhance the knowledge and skills of the tutee, there is great variation in the approaches used to provide tutoring in terms of setting (informal or formal), number of individuals to be served (one individual or a small group), and the setting in which it is provided (academic setting, community organization, or online). Additionally, many tutorial services are provided on scheduled dates, times, and locations and students are expected to take advantage of the available resource.

Review of the Literature

The literature was reviewed to gain insights about what is known about tutoring and the effect of tutoring on student outcomes. Specifically, the review of the literature will address the use of tutoring in various settings, the effects of online tutoring, and the use of tutoring and help seeking behaviors. Each of these is discussed below.

Tutoring as a Learning Support

Tutoring is an instructional arrangement that has been used at the elementary (Nath & Ross, 2001; Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003), secondary (Kamps et al., 2008; Mastropieri et al., 2006) and post-secondary levels (Flachinov, 2001, Richardson, 2009).
In many cases, tutoring by peers allow students to obtain individualized support and feedback during the independent practice phase of instruction. Tutoring has been used with a wide range of students including those considered at risk (Nesselrodt & Alger, 2005; Rohrbect et al, 2003)

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[1] This paper does not address computer-based tutorial programs in which a computer software is tutor and the tutee engages with a computer-assisted learning intervention (see, e.g., Xu, 2009).

and those with learning disabilities (McDuffie, Mastropieri, & Scrugss, 2009; Osborn et al., 2007; Spencer, 2006; Vogel, Fresko, & Wertheim, 2007). In several countries, private tutoring is seen as a means to address instructional shortcomings of the public school system (Ireson, 2004; Lee, 2007; Nath, 2008). Collectively, these studies reveal that tutoring is a viable means to enhance students' learning experiences and content knowledge.

Effect of Tutoring

Most studies related to tutoring were conducted in face-to-face peer-tutoring environments (e.g., Duran & Monereo, 2005; Robinson, Schofield, & Steers-Wenzell, 2005). Such environments provide individualized attention to each student, conversation about the subject matter, and an opportunity for students to pose and receive responses to questions. Research indicates that while students may be inactive in class, they are more likely to ask questions spontaneously during tutoring sessions, thereby clearing their misconceptions and leading to enhanced understandings (e.g., Falchikov, 2001).

Research on tutoring shows that tutoring has a positive effect in a variety of content areas including reading (Burns, Senesac, & Silberglit, 2008; Hendriksen, Yang, Love, & Hall, 2005; Patterson & Elliot, 2006), social studies (Lo & Cartledge, 2004; Mastropeiri, Scruggs, Spencer, & Fontana, 2003), science (Mastropieri, Scruggs, & Gaetz, 2005; Topping, Peter, Stephen, & Whale 2004), and mathematics (Fuchs et al., 2008; Robinson, Schofield, & Steers-Wentzell, 2005; Topping, Campbell, Douglas, & Smith, 2003). Collectively, these studies suggest that tutoring is an effective intervention for supporting student learning. Studies on tutoring report benefits for both the tutor and the tutee that include (a) acquisition of contentspecific academic skills (Falchikov, 2001; Lock & Layton, 2008; Robinson, Schofield, & Steers-Wentzell, 2005); (b) better understanding of course content (Belawati, 2005; Falchikov, 2001); (c) just-in-time or relatively immediate corrective feedback (Nath & Ross, 2001); (d) retention in courses or programs (Belawati, 2005); (e) improved class behavior (Nazzal, 2000; Robinson, Schofield, & Steers-Wentzell, 2005); and (f) improved attitudes about the subject matter (Robinson, Schofield, & Steers-Wentzell, 2005). Although all types of tutoring were found to be effective, researchers conclude tutoring provided by content experts (e.g., certified teachers) yielded larger effects than those provided by volunteer tutors (Elbaum, Vaughn, Hughes, & Moody, 2000).

Tutoring Provided Online

Typically, tutoring is carried out in face-to-face settings in which the tutor and tutee meet at a specified time and location. However, recent and rapid improvements in information and communication technologies, and the increase in access to the Internet have made it possible for tutoring to be conducted via the Internet (see e.g., Fleisher, 2006). Consequently, providing learning support to students is no longer limited by space or time. Furthermore, such assistance is not limited to services provided by known individuals (i.e., a peer or individuals in a local learning center) because the tutor can be any expert with an online connection. Students who use online tutoring are in charge; they identify areas of needed assistance, propose the topic to be discussed, and monitor their own progress. Although both face-to-face and online tutoring provides interaction between the tutor and the tutee, online tutoring provides partial anonymity in communication and independence in space and time.

Online tutoring supports both synchronous (real time) and asynchronous (delayed) communication. However, the nature of interactions and the type of instructor support permitted by those environments differ. In a synchronous environment, real-time interaction allows the simulation of a real classroom learning situation and immediate, interactive clarification of meaning (Goodyear, Jones, Asenio, Hodgson, & Steeples, 2005). In contrast, asynchronous communication requires that the sender wait for a response in a time delayed fashion. Although there is ample research on face-to-face tutoring environments, research on online (not computerbased) tutoring supported by live individuals is scarce.

Use of Tutorial Supports and Help Seeking Behaviors.

All students encounter situations in which there is a gap between academic expectations and their ability to meet them. A direct response to this would be to seek assistance. Although the goal of providing tutorial services is to enhance students' learning experiences and achievement, research reveals that only a relatively small percentage (25 – 30%) of students take advantage of learning supports such as tutoring when they are not mandated (Williams, Howell, Laws, & Methen, 2006; Primary Research Group, 2009). This may be due, in part, to the changing nature of society in which many high school and college students have other work or family-related responsibilities that influence the use of their time. These responsibilities may limit their ability to take advantage of tutorial services provided at a specific time and location. In addition, students in remote or rural settings may have other concerns (e.g., transportation) that limit their ability to take advantage of learning support services (Belawati, 2005). This suggest a needed to understanding the help seeking behaviors of college level students. Help seeking is defined as "an achievement behavior involving the search for and employment of a strategy to obtain success" (Ames & Lau, 1982, p. 414.) Most research on help seeking have been conducted with school-aged student (e.g., Turner et al., 2002; Wolters, 2004) and have documented factors related to seeking help from the instructor or peers. Results from these studies indicate that there are many threat factors that influence students' reluctance to seek help including academic self-efficacy, instructor expectation, lack of confidence, and threat to self-esteem (Karabenick & Knapp 1991; Newman & Goldin 1990; Ryan, Gheen, & Midgley, 1998)

According to Karabenic (2004), "there have been no systematic studies of college students, especially those in large classes that provide pivotal gateway experiences that have an important influence on students' persistence and vocational choices" (p. 510). College Algebra is such a gateway course. Furthermore, little is known about the association between college students' help seeking behaviors when the sources for help is provided in an online format rather than other formal (i.e., teachers) or informal sources (i.e., peers). However, a few studies show that the use of electronic resources (i.e., email) is less threatening than face-to face communication (Karabenic & Knapp, 1988; Kistantas and Chow, 2007). Karabenic and Knapp reported that 86% of the participants who had the option to seek help privately using electronic media did versus 36% who opted to use face-to-face interactions for assistance. Similarly, Kistantas and Chow reported that college students preferred to use electronic means to seek help from instructors and found this approach effective. Collectively, these findings suggest that the possible elimination of threat influences (i.e., embarrassment) provided in electronic formats might be a motivating factor in seeking assistance.

Although not examining the psychological influences on help seeking (i.e., self-esteem), as studied by other researchers, we view help seeking in an online environment as an important site for exploration. If more students seek help in an online environment than is currently reported that would suggests that there are other factors related to help seeking that need to be examined (e.g., anonymity of interactions). If on the other hand, there are no differences in help seeking behaviors in online and face-to-face environments then additional research will be needed to learn about other influences on academic helping seeking behaviors in both settings. As revealed in the literature review, there are many unanswered questions related to the use of online tutorial supports, in general, and its use for supporting mathematics learning (the focus of this study), in particular. Specifically, there is a need to examine factors related to its usage, including the extent to which it is used, how it is used, and its influence on various student outcomes. This study is an attempt to address this gap in the research literature. Although extant research documents the efficacy of peer tutoring programs in mathematics at the university level (e.g., D'Souza & Wood, 2003; Xu, Hartman, Uribe, & Mencke, 2001), there is limited information about students' use of online tutoring in the area of mathematics that is facilitated by "live" tutors synchronously or asynchronously.

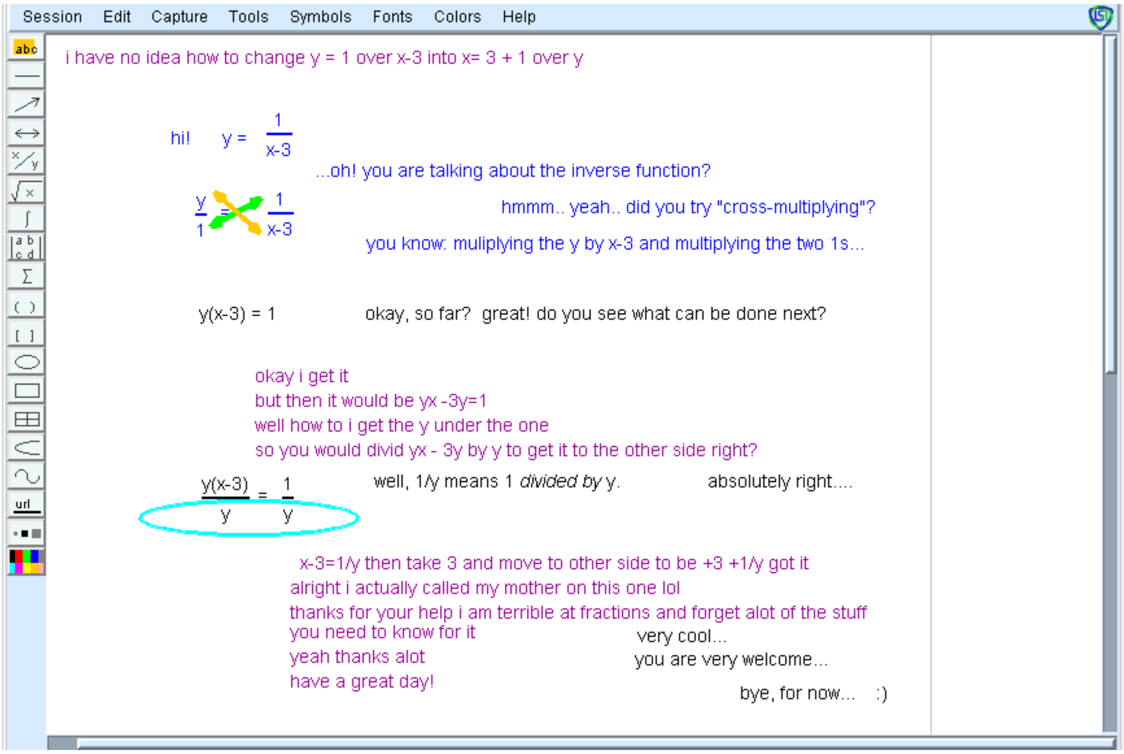
The Study

This study explored College Algebra students' use of an online tutoring service in a naturalistic environment (as opposed to a contrived setting in which the nature of the learning environment is altered). Rather than study the use of online tutoring in mathematics in a highly structured tutoring program in which a predefined curriculum is used or particular students are targeted, the use of online tutoring was examined in a university setting in which the use of online tutoring is one of several learning support options available to students. Because student participation in tutoring programs is voluntary, no limit was placed on the availability of other learning supports (i.e., college learning center, mathematics lab, or peers). In addition, students were not overtly encouraged to use the online tutoring service over other resources or mandated to use it as part of or as an alternative to other course requirements. To learn about the efficacy of such programs, it is important for students to determine independently that the use of an online tutorial program is a viable resource to support their learning.

Online Tutoring Resource

NetTutor, the online tutoring service used in this study, provides an interface that allows tutees to interact online with a trained tutor about the course content. All of the tutoring sessions are facilitated locally by experienced tutors who have a master's or doctoral degree in mathematics. The tutors were provided a copy of the course text to facilitate their interactions with students. Tutoring occurs through the use of a whiteboard interface that includes the necessary tools and symbols to communicate mathematics ideas. Students can engage with tutors synchronously or asynchronously. To interact synchronously, students engage an on-duty tutor in a written dialogue about areas of difficulty. An example of a synchronous exchange between a tutor and a tutee is provided in Figure 1. As an alternative to a live tutorial, a student may submit an offline question at any time using the same whiteboard interface. Students are notified by email to let them know when an answer to an asynchronously submitted question is available, typically by the next business day.

Figure 1 An online conversation between tutor and tutee



This type of tutoring environment can be considered *reactive* (De Lievre et al., 2006) or *assignment-assistance* (Hock, Deshler, and Schumaker, 1999) tutoring in which the tutor reacts to spontaneous requests for help from the learner. This is different from *proactive (*De Lievre et al., 2006) or *instructional* (Hock, Deshler, and Schumaker, 1999) tutoring in which the tutor initiates or intervenes in the tutees' learning process.

Methods

The study employed a nonequivalent pretest-posttest, control group design (Gall, Gall, & Borg, 2007). Both groups were administered a pretest composed of algebra content knowledge and an attitude survey on the first day of class in the semester the study was conducted. During the interim between the pretest and posttest, students in all sections of the experimental group were provided access to an online tutoring service through the online course management system (Blackboard), while those in the control group did not have access to this resource. A posttest, in the form of a common course final exam for the College Algebra class and the same attitude survey, was administered at the end of the semester to students in both groups.

Instruments

Content Knowledge. The pre- and posttest address content that is typically included in College Algebra courses. Items assessed students' understanding of basic concepts of algebra such as solving equations and inequalities, factoring quadratic binomials, multiplying polynomials, and the like. The pretest consists of 20 -multiple choice items that were selected from among items that are part of a departmentally developed and administered final exam for a prerequisite course. The common course final exam that is generated by faculty in the mathematics department was used as the posttest. It consisted of 40 multiple choice items that addressed similar content.

Attitude Survey. The attitude survey used in this study is an adaptation of the Modified Fennema-Sherman Attitude Scale created by Doepken, Lawsky, and Padwa (n.d.). Their instrument consisted of 47 items and was designed to look for differences in attitudes about students' confidence in mathematics, how useful students thought mathematics would be to them, students' perceptions of teacher attitudes and the idea that mathematics is a male dominated field. Items were rated by participants on a 5-level, Likert scale (*Strongly Agree*, *Agree*, *Neutral*, *Disagree*, *Strongly Disagree*). Their survey was adapted to address topics of interest related to this study. To address students' attitudes towards seeking assistance (from a tutor, an instructor, or a peer), some items were modified and new items were created. In addition, all items (n=11) related to gender in the original survey were eliminated because they did not relate to the intent of the study. The adapted attitude survey included 12 items to measure students' confidence (e.g., *I know I can do well in math*), 10 items for usefulness (e.g., *Mathematics is a worthwhile, necessary subject*), and 8 items concerning help-seeking behaviors (e.g., *When I have difficulty solving a math problem, I ask someone else for help*). To ensure the reliability of the attitude survey, a Cronbach's alpha statistic was obtained for the entire instrument ($\alpha = 0.92$) and for the items on each subscale (Confidence $\alpha = 0.93$, Usefulness $\alpha = 0.78$, Help-Seeking $\alpha = 0.75$). These alpha values indicate that the survey and each of the subscales are internally consistent in measuring the identified constructs.

Sample

The sample for this study were undergraduate students enrolled in two out of the seven large group sections of College Algebra courses taught by two different instructors during the fall 2008 semester at a large urban university in the southeast United States. The College Algebra courses are comprised of three one-hour lectures and two one-hour recitation classes (8 different sections) in which graduate level mathematics teaching assistants support the lecture sections by addressing student questions and clarifying information shared as part of the class lectures. These two instructors were selected because the their pedagogical approaches were similar and they had vast teaching experience: the experimental group was taught by Instructor A, a female with over 30 years of teaching experience; the control group was taught by Instructor B, a male with over 40 years of teaching experience. Institutional Review Board consent was obtained to gather data from the students in these two course sections and participation was voluntary. Table 1 provides the demographic information about the students enrolled in College Algebra courses at the university and in the course taught by Instructors A and B. After attrition, pre- and post-test achievement test scores were obtained for 341 students (195 in the experimental group; 146 in the control group) that were included in the analysis of content knowledge. Of the 341 students who completed both content knowledge assessments, 305 (89.4%) completed both the pre- and post- attitude assessment; 127 from the experimental group and 178 from the control group. The demographic information, including the racial/ethnic background of students in the sample was similar to the overall course, the course sections, and the overall institution.

Data Collection.

The pretest was administered during the first class session and the posttest was administered as part of the course final exam. The attitude surveys were administered along with the pre- and posttest instruments, and were completed after students completed the content portion of the exams. Data were also collected regarding students' usage of the tutoring service. Logs were kept of the amount of time students in the experimental group utilized an online tutor and the amount time that was spent for each session. Records of the tutoring sessions in the form of screen shots of tutor-tutee interactions were also obtained.

Table 1 Student Demographics Percentages for the University and College Algebra Courses in Fall 2008

	University n=47,576	All Sections Combined n=1456	Course taught by Instructor A Total n=271 (Sample n=195)	Course Taught by Instructor B Total n=240 (Sample n=146)	Total Sample n=341
Male	42%	37%	33%(29%)	37%(32%)	30%
Female	58%	63%	67%(71%)	63%(68%)	70%
White	63%	62%	59%(65%)	63%(69%)	66%
Black	11%	14%	11%(13%)	10%(10%)	12%
Hispanic	14%	17%	13%(15%)	15%(17%)	16%
Asian	6%	5%	4%(5%)	4%(3%)	4%
Other[2]	6%	2%	12%(1%)	9%(1%)	3%

Data Analysis

Prior to conducting the various analyses, all of the data were checked to ensure that they met model assumptions for the analysis to be performed. We describe the procedures used for analyzing the data below.

Content knowledge. Each item on the pre- and posttest was scored either right or wrong. Since there were different numbers of items on the pre- and posttest, content knowledge analysis was performed using the percentage correct rather than raw scores. Gain scores between the pre and post were calculated. To determine differences between the groups, t-test analyses were conducted. First, differences were examined between the experimental group (those with access to the online resource) and the control group (those without access to the online resource). Then, differences between students in the experimental group who opted to use the online resource at least once *(*E-Users*)* and those who did not (E-Non-Users) were analyzed. To determine if differences were significant, data were also subjected to a two-way analysis of variance (ANOVA).

Attitude. The attitude surveys were analyzed to determine the differences between the groups (E-Users, E-Non-Users, Control) on each of the Attitude survey subscales (Confidence, Usefulness, and Help Seeking) and on the overall total. A process similar to the one above for the t-test analysis was used. However, because differences were found between the experimental and control groups, data were subjected to a one-way ANOVA using the attitude survey gain scores to determine whether the differences between the various groups were significant.

[2] Includes unknown or left blank

Results

Tutorial Service Usage Patterns

Although all the participants in the experimental group were given direct access to the online tutoring service through the course management system, data obtained from the *NetTutor* interface revealed that 25% (49 out of 194) of students who had access to it used it at least once either synchronously or asynchronously. Of these E-Users, 15 used the synchronous feature only, 13 used the asynchronous feature only, and 21 used both features. There were 190 synchronous interactions that accounted for more than 62 logged hours of provided assistance. One student used the system 37 times and accounted for 19 hours of tutoring. This frequency of usage was more than double the next highest number (15), so this student was considered an outlier. For the remaining 35 participants who used the live tutoring option, the mean number of interactions with a live tutor was 4.37 and the average interaction lasted for 16.9 minutes. Thirty-four students submitted questions asynchronously with a range from 1 to 20 questions per student. The mean number of questions submitted was 4.06 with more than half (n=18) submitting only one or two questions. Examination of the pretest scores revealed that the scores of the majority of the E-Users were lower than the scores of the E-Non-Users. A t-test analysis on the pretest performance of E-Users versus E-Non-Users indicated that the average performance on the pretest for E-Users was statistically significantly lower than those for E-Non-Users [$t(227) = 2.54$, $p = 0.012$].

Differences between Control and Experimental Groups on Content Knowledge

The means, standard deviations and gain scores on the content knowledge pretest and posttest for the total group (N=341), the experimental group (N=194), and the control group *(N*=147 were examined. Students' performance on the posttest (M=53.32, SD = 14.33) were slightly higher than their performance on the pretest (M=52.29, SD = 15.67). A t-test analysis on these scores revealed that, for the entire group of participants (irrespective of group), the performance on the pretest was not statistically different from that on the posttest [$t(340) = 1.06$, $p = 0.29$]. An analysis of the gain score averages indicates that the control group (M=1.67, SD=18.41) improved more than the experimental group (M= 0.57, SD = 18.10), but that this difference in gain scores was not statistically significant [$t(339) = 0.55$, $p = 0.58$].

Table 2 Means and Standard Deviations of Participants' Achievement Scores by Group and Use

Experimental Group		Pretest		Posttest		Gain Score	
N	M	SD	M	SD	M	SD	
Users	49	48.88	14.26	55.92	12.18	7.04	17.51
Non-Users	145	54.93	15.16	53.31	15.13	-1.62	17.82

Differences between E-Users and E-Nonusers on Content Knowledge

Because there were no differences in performance between the control and experimental group, the gain scores of E-Users and E-Non-Users within the experimental group were analyzed. Table 2 provides information on the sample sizes, means, standard deviations and gain scores for E-Users and E-Non-Users. A t-test analysis on the average gain scores revealed that the gain scores of E-Users was statistically significantly higher than those of E-Non-Users [$t(338) = -2.91$, $p = 0.004$]. The effect size of this difference ($d = 0.39$) is considered to be small (Cohen, 1992).

Attitude Survey

Unlike the content knowledge results, difference were found between the experimental and control on each of the attitude survey as well as the total of the attitude scores. Because of this, the control group was included as part of the further analyses. To determine if those differences existed for both E-Users and E-Non-Users, the remaining analysis was performed with three groups: Control (N = 127), E-Non-users (N = 143) and E-Users (N = 34).

Table 3 Analysis of Variance of Attitude Difference Scores

Variable	Source	df	Type III SS	Mean Squares	F
Confidence	Model	2	395.97	197.99	3.47[3]
	Error	302	17229396	57.05	
	Total	304	17625.93		
Usefulness	Model	2	316.28	158.14	4.26[3]
	Error	302	11205.49	37.10	
	Total	304	11521.77		
Help-Seeking	Model	2	229.76	114.88	4.10[3]
	Error	302	8453.32	27.99	
	Total	304	8683.08		
Attitude Total	Model	2	1791.97	895.98	4.57[3]
	Error	302	59236.36	196.15	
	Total	304	61028.32		

Using this new grouping variable, data from the differences scores were examined using a one-way ANOVA. The model results are summarized in Table 3. To determine where the differences existed when the model was significant, we used a difference of means t-test as a follow-up analysis. A difference was found between Control and E-Non-Users (a) on the Confidence gain score [t(302) = 2.57, p = 0.011] with the E- Non-Users obtaining scores that were 2.42 points higher (on a scale of 60) than the Control group, (b) on the Usefulness gain score [t(302) = 2.74, p = 0.007] with the E-Non-Users obtaining scores 2.08 points higher (on a scale of 50) than the Control group, and (c) on the Attitude Total score [t(302) = 3.01, p = 0.003] with the E-Non-Users obtaining scores 5.26 points higher (out of 150) than the Control group. On the Help-Seeking gain score there were differences between Control and E- Users [t(302) = 2.86, p = 0.005] and between E-Users and E- Non-Users [t(302) = 2.03, p = 0.043]. Out of a possible 40 points, the E-Users obtained scores that were 2.59 points higher than the Control and 1.83 points higher than the E-Non-Users. The effect sizes of these differences ($0.16 < d < 0.35$) are considered to be small (Cohen, 1992).

To determine if there was any sort of "ceiling effect", the data from the pretest were analyzed using a one way ANOVA with the same grouping variable. This analysis indicated that there were no significant differences among the three groups on the pretest attitude subscales or total. This indicates that the differences seen in these gain scores are truly differences in the changes in attitudes over the course of the study.

[3] $p < 0.05$

Retention

The data was examined to determine whether the availability of additional learning support, in this case the online tutorial service, had an effect on the retention of students who were taking College Algebra. In this study, retention refers to the number of students who were enrolled at the beginning of the course and who remained in the course through the administration of the final exam. There was a marked difference between the groups. Of the 215 students enrolled in control group sections of the face-to-face College Algebra course and completed the pretest, indicating participation in the first class session, only 147 (68%) completed the final exam. In contrast, a larger percentage of students who had access to the online tutoring remained in the course. Of the 229 students who enrolled in the course with access to the online tutoring service and completed the pretest, (194) 85% also completed the final exam. Of the 50 students who used the online tutoring system and took the pretest, 49 (98%) also took the final.

Discussion and Conclusion

This study was conducted in a naturalistic environment to determine the extent to which students would take advantage of an online tutorial service to support their learning of mathematics, in this case College Algebra. Given the ubiquitous nature of technology one might assume that students would readily take advantage of online tutorial services, however, this was not the case for the majority of the students in this study. Although the online tutorial service was available and conveniently accessible to students through an online course management structure, only 25% of those who had access used it. This percentage is comparable (25-30%) to the rate of usage found in other research on the use of face-to-face tutors (Williams et al., 2006; Primary Research Group, 2009). Glikman (1999) offered the following reasons for why students fail to seek assistance from tutors:

> • some learners get together in order to find the information they need in other resources at their disposal;
> • other learners do not dare to ask the tutor for help for fear of having to reveal their lack of understanding;
> • a few no longer ask the tutors for help because their first contact with them was unsatisfactory (as cited in De Lievre et al., 2006, p. 103)

In this study, students who were least prepared for College Algebra (as identified by their pretest performance) were more likely to seek help from the online tutoring service than those who were relatively better prepared. This is contrary to the findings from other research (Karabenick & Knapp, 1988, 1991) that reported that more academically engaged students are more likely to seek assistance. Taken together, these findings suggest that other factors may play a role in whether an individual chooses to seek assistance or to seek assistance provided in online formats.

More research is needed to examine motivational factors that influence students' decisions to seek assistance, in general, and to seek assistance online in particular.

Consistent with other research, we found that the gains in content knowledge of students who used the tutoring services was better than those who did not use it (Belawati, 2005; Falchikov, 2001) and that students with access to tutoring services persisted in the course when compared with those who do not (Belwati, 2005; House & Wohlt 1990, 1991). It may be that the availability of learning supports may be a stronger indicator for retention than the actual usage of the learning support service. A student with access to online tutoring might feel empowered by the knowledge that assistance will be available if needed.

The focus on the use of online tutoring in mathematics raises a number of issues in need of additional examination. Because mathematics is a technical language (Thompson, Kersaint, Richards, Hunsader, & Rubenstein, 2008) with its own technical vocabulary, syntax, and symbolism, additional challenges might exist when communicating about mathematics in asynchronous online environments. Tutors and tutees might find it difficult to understand intended communications that might be unclear, particularly when other cues are not available to support meaning making. When working in a face-to-face environment, the tutor receives paralinguistic cues in addition to the verbal or written cues to guide his or her work with the tutee. To make sense of incoherent tutee utterances, the tutor can ask questions and respond to body language and facial expressions. These cues provide insights regarding the extent to which a tutee is making sense of the communication in which he or she is engaged. However, in the online tutoring environment used in this study, that was not possible. The tutor and tutee were completely reliant on written communication with all of its inherent assumptions.

Students who are weak in mathematics may find it difficult to communicate mathematically or articulate their specific difficulty in written form. Students might not benefit from assistance if the utterances of tutors are incomprehensible to them. Price, Richardson, & Jelfs (2007) suggest that it might be important to provide training to students, in addition to tutors, regarding how to communicate online in the absence of paralinguistic information that is available during face-to-face interactions. This might be particularly important in mathematics given its technical nature. Additional research is needed to examine the extent to which the means of communication, in this case an interactive whiteboard interface, influences students' use of and understanding gained from an online tutorial service.

Although studies exist that examine the differences between face-to-face and online tutoring in other content areas such as humanities (Richardson, 2009) and Informational Technology (Ng, 2007), similar studies are needed in the area of mathematics at all levels. In what ways do the quality of tutor-tutee interactions and learning experiences differ in online versus face-to-face settings? What affordances and hindrances are provided by each environment? In the context of mathematics, are online tutorial services limited to developing students' mathematical skills (e.g., step-by-step directions) as opposed to concepts? To supportconcept development, a tutor must guide students' thinking about a topic. This is likely very different from helping students determine the next step in a symbolic manipulation process. There also needs to be more studies on how face-to-face tutorials compare with online tutorials informed by student academic achievements.

Limitation of the Study

The results reported above must be interpreted within the limits of this study. It is not possible to explain all of the found differences because the control and intervention groups were taught by two different instructors who may have had a differential effect on student outcomes. For example, it is not possible to explain or describe potential causes of the attitudinal differences because course instruction was not observed during this study. Also, one might interpret the lack of significance difference between the pre- and posttest on content knowledge as an indication that no learning took place in the course. However, a number of factors may have contributed to this that requires further examination. For example, students who had already earned the desired grade in the course might not have revealed their true performance. This suggests that in addition to obtaining test results, it may be important to obtain data regarding students' efforts on tests and their views about their course performance. Despite these limitations, this study provides some insights about the potential that online tutoring resources may provide, but it also raises a number of issues that require additional examination.

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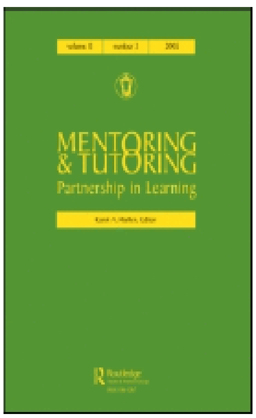

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The Effect of Access to an Online Tutorial Service on College Algebra Student Outcomes

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