Society relies on technology. Thus, it would seem natural that technology would be integrated into education classrooms. Educators have recognized that technology can transform learning. In 1989, the National Council of Teachers of Mathematics (NCTM) supported the use of technology in the K–12 mathematics curriculum and classrooms and stated that calculators and computers should be available to all students and in all classrooms for demonstrative and investigative purposes. Over the next two decades, mathematics associations supported the use of technology as an aid for teaching and learn-
The present research examined developmental mathematics instructors’ self-reported familiarity with educational technology and discovered their top technology applications of choice.

It is unreasonable to assume that every student pursuing higher education is fully prepared for success at the outset. Developmental education classrooms provide students who are underprepared for college the opportunity to gain the skills needed for college-level courses. The proportion of students who enroll in developmental mathematics has been higher than in reading and writing. A higher proportion complete their mathematics remediation at two-year institutions than four-year institutions (Parsad, Lewis, & Greene, 2003). Data collected from 1,186 postsecondary institutions indicated that the percent of students requiring developmental mathematics remained unchanged from 1995 to 2000 (i.e., 22%) with 35% of students enrolled at public two-year colleges requiring remediation (Parsad et al., 2003). Though the figures are somewhat dated, there is no evidence to suggest that these numbers have declined to any great extent. Even though the composition of developmental mathematics classrooms can be diverse, Radford, Pearson, Ho, Chambers, and Ferlazzo (2012) found certain characteristics that suggest a higher likelihood of being enrolled in a developmental education course. These characteristics included not being enrolled in a degree program, not completing a mathematics course higher than Algebra II, and having been out of high school for more than one year. The latter supports findings by Zientek, Schneider, and Onwueggbuzie (2014), who noted that the top two reasons faculty believed students were placed in developmental mathematics courses were a “time delay from previous mathematics course” and a “lack of basic math skills” (p. 72). In addition, Radford et al. (2012) found a higher proportion of Blacks and Hispanics were enrolled in developmental mathematics courses than Whites and Asians. Regarding who is teaching the students, Shults (2001) found that the majority, about 65%, of developmental education faculty were classified as adjunct or had a part-time status.

Integration of Technology in Mathematics Instruction

A review of the literature suggests that empirical research on technology in developmental mathematics courses has been sparse. The majority of technology research published in peer-reviewed journals has been in K–12 settings. Therefore, the following discussion regarding technology in K–12 classrooms begins with the assumption that many of the benefits and barriers associated with technology might be generalized to college classrooms.

Technology can transform teaching and learning. In order to be effective, technology must be integrated with “curriculum, instruction, and assessment” (Berlin & White, 1995, p. 51). Technology can be used to “learn content and skills,” to “complement or enrich” the curriculum,” and in “transformative ways” (Ertmer, Ottenbreit-Leftwich, Olgun, Sendurur, & Sendurur, 2012). The number and
variety of technology tools used in the mathematics classroom have continued to evolve. In 2006, AMATYC provided a comprehensive list of technology tools that might be used in mathematics classrooms. This list included “graphing calculators, student response systems, online laboratories, simulations and visualizations, mathematical software, spreadsheets, multimedia, computers or the Internet, and other innovations yet to be discovered” (p. 55). Concerning the use of computers, postsecondary institutional responses in a study conducted in the fall of 2000 indicate that 29% of institutions never or very rarely had developmental mathematics students use computers as a hands-on instruction tool and 40% answered occasionally used and 31% answered frequently used (Parsad et al., 2003). Bos (2009) identified typical methods for applying technology in math instruction. These included game, informational, quiz, static tools, and interactive formats. Cognitive fidelity has been defined as “whether a concept is better understood when the object is acted on” (Bos, 2009, p. 111). Most applications had low cognitive fidelity levels with activity mats categorized as medium-high and interactive formats categorized as high. Therefore, merely introducing technology in the classroom or in assignments will not guarantee that learning is improved.

Developmental Mathematics Courses

Course redesign. Technological innovations expanded the instructional format options (Kinney & Robertson, 2003) and provided the opportunity to redesign the delivery of developmental education. Technology allows for modes of instruction to be synchronous, asynchronous, or both and enables distance learning and computer-mediated learning. Course redesign success stories have been published in the literature (National Center for Academic Transformation, 2012; Vandal, 2011). Even though the evolution of technology has enabled instructors to deliver online distance-learning or hybrid courses, the research in this area is in the elementary stages and is not the focus of this manuscript (Ashby, Sadera, & McNary, 2011; Bendickson, 2004; Weems, 2002).

Some researchers believe there is a lack of rigorous efficacy research in developmental courses (Rutschow & Schneider, 2011; Zavarella & Ignash, 2009). As noted by Zavarella and Ignash (2009), “far less research has investigated the effectiveness of computer-based instruction specifically for students in developmental education” (p. 2). However, in recent years, several studies have been conducted in developmental mathematics classrooms. In particular, computer-assisted instruction has been investigated. Three studies reported no statistically significant differences on mathematics achievement between students who received computer-assisted instruction and those who did not (Gavitt, 2010; Spradlin, 2009; Taylor, 2008). Those results suggest that even though the use of computer-assisted learning did not increase achievement, student performance measures did not decrease. In other words, either computer-assisted learning or the traditional approach seemed appropriate. Despite no statistically significant differences between the two groups, Taylor (2008) reported that students who utilized computer-assisted learning had a decrease in mean mathematics anxiety scores compared...
with students who were taught in classrooms without computer-assisted learning. Also, Shah (2009) found promising results for the use of a learner-centered web-based intelligence system for improving student achievement.

One problem with evaluating the success of course redesigns has been that attrition rates have not always been considered. The importance of attrition rates for distance-based courses that are taught with technology was highlighted by Ashby et al. (2011). They found “distance-based and blended students performed worse than the traditional face-to-face developmental math students when not taking attrition into account, however considering only students who completed the course, face-to-face students performed worse” and noted that “student retention cannot be disregarded” (p. 138). In the Zavarella and Ignash (2009) study, students enrolled in traditional lecture courses were less likely to withdraw than students enrolled in a computer-based format. In addition, Duka’s (2009) results were promising for the use of MyMathLab™ (i.e., commercially available software and online resources for mathematics instruction). However, Duka (2009) did not include students who did not take the final or “students who did not complete more than 25% of their homework in” the MyMathLab™ section (p. 14). Researchers should consider whether student attrition rates are important to the assessment of the use of instructional technology.

**Handheld technology.** Research conducted across precollege and college mathematics courses provide evidence that students can benefit when calculators are used in instruction and assessment (see Burrill, Allison, Beaux, Kastberg, Leatham, & Sanchez, 2002; Ellington, 2003, 2006; Shore, 1999). In a review of research studies conducted in secondary mathematics classrooms, Burrill et al. (2002) found that handheld graphing technology can aid students in their learning, but the way the technology is used, approached, and integrated should be considered. Students need to avoid an over-reliance on technology.

The use of handheld technology has been declared a suitable tool for teaching and learning in developmental mathematics classrooms (Laughbaum, 2002), but there is a limited amount of research in this area. Hollar and Norwood (1999) found that handheld technology can benefit intermediate algebra students. In their work, students who were taught with a graphing calculator approach to the curriculum exhibited a better comprehension of functions than students who were taught in a traditional classroom. However, no statistically significant differences existed between these students’ final exam scores or mathematics attitude scores. The literature suggests that more research is needed on the use of handheld technology in developmental mathematics classrooms.

**Classroom response systems.** In mathematics courses, several studies have been published on the use of classroom response systems (CRSs), which are also referred to as clickers. A bibliography of studies has been provided by The Center for Teaching (2012). CRSs allow instructors to instantly assess students’ knowledge. Although the literature suggests CRSs improve student comprehension, there is agreement that the existing evidence is not sufficient to support a scientific conclusion that CRSs benefit student learning.
In mathematics classrooms, the research primarily has been focused on calculus-based or statistics courses (The Center for Teaching, 2012). However, Blodgett (2002) conducted a study on CRSs in college algebra, which typically is the course that follows intermediate algebra. Blodgett (2002) detected no statistically significant differences in student achievement between classes that utilized CRSs and those that did not utilize CRSs; however, students perceived CRSs as beneficial. Then again, college-level courses usually have a predetermined curriculum with a fast-paced schedule. Blodgett (2002) concluded that for the traditional college algebra course, the “time involved with incorporating an interactive student response system . . . is not an ideal setting for an interactive student response system . . . ” (p. 70). Blodgett’s conclusion supported that of Caldwell (2007) which suggests that CRSs tended to result in less content coverage. In addition, King and Robinson (2009) concluded that pedagogical changes need to be made when using CRSs. Developmental mathematics courses typically also have a predetermined curriculum, which might impact the ability to use CRSs in any significant capacity.

**Internet-based blogs and chats.** The need for students to “analyze and evaluate the mathematical thinking and strategies of others” has been advocated by NCTM (2000, p. 60). Blogs and chats are relatively new applications that can be used as learning tools. Empirical research on the use of blogs in developmental mathematics classrooms is lacking. However, Cooper (2012) noted that the introduction of blogs and forums opens the possibility of encouraging communication by incorporating writing within the mathematics curriculum. In a sociology course, Pearson (2010) found that the use of blogs could aid in identifying students’ level of understanding, which improved discussions during class time.

Barriers exist that might deter the introduction of Internet-based blogs and forums into the mathematics curriculum. Cooper (2012) concluded that “one likely question in this discussion is whether this Internet-based, informal writing can really be considered writing” (p. 84). A second concern identified by Cooper (2012) was that teachers might not utilize technology that can increase writing in mathematics because they are not sure of the worth or are simply uncomfortable using technology. Pearson (2010) did note some problems with using blogs in a sociology course. These included difficulty accessing and posting to the site, remembering to post by a particular due date, and formulating new ideas in the course of reviewing previously published postings. Because blogs and chat forums are relatively new, the research in this area will need to evolve.

**Professional Development**

The successful integration of technology will depend on teachers’ pedagogical beliefs. Ertmer (2005) surmised that in order for pedagogical beliefs to change, teachers need to have both personal and vicarious experiences. Professional development can provide pedagogical-changing experiences, but will need to be rigorous and attentive to the needs of the postsecondary mathematics instructors (Epper & Baker, 2009). The importance of providing professional development
for the successful integration of technology has been acknowledged by several researchers, although their focus was on high school mathematics (see Burrill et al., 2002; Heller, Curtis, Jaffe, & Verboncoeur, 2005). From their review of research, Burrill et al. (2002) concluded “that simply providing teachers with information about how the technology functions is not likely to result in effective integration in the classroom” and “substantial professional development and support is necessary for teachers to make informed decisions about how to best use handheld technology in their classrooms” (p. i).

In addition, the application and integration of instructional technology might also be affected by developmental faculty employment status. As is the case for the field in general, most developmental mathematics courses are taught by adjunct faculty (see Gerlaugh, Thompson, Boylan, & Davis, 2007). Boylan and Saxon (2012) documented several challenges to campus and program engagement that have been encountered by some adjunct faculty. Spending less time on campus was one challenge that might limit these faculty members’ participation in discussions about technology applications and usage. Adjunct faculty might also be less likely to engage in professional development activities. These challenges might impact adjunct faculty propensity to learn and apply technology in support of developmental mathematics instruction.

**Purpose**

In Texas, where this study was conducted, House Bill (HB) 1244 requires the integration of technology in developmental education courses. As legislators begin making education mandates that impact classroom practices, they must realize that the success of these directives will depend on faculty members’ beliefs and practices. The purpose of this statewide study was to gain information from developmental mathematics faculty at postsecondary institutions on their priorities, familiarity, and preferences pertaining to the integration of technology. For this study, the K–12 definition for integrating technology by Hew and Brush (2007) was modified: “Technology integration is thus viewed as the use of computing devices” in postsecondary institutions of education “for instructional purposes” (p. 225), which includes content-delivery. The present study builds off of the Developmental Education Program Survey (DEPS), which was administered by the Texas Higher Education Coordinating Board (THECB; 2011).

A unique characteristic of the Developmental Education Technology Survey (DETS, Skidmore, Saxon, Zientek, & Edmonson, 2012), from which the current study derives its data, compared to that of the initial DEPS, is that information was collected from individual developmental mathematics faculty rather than from a single institutional contact person. Participants responded to a survey regarding the use of technology in their own developmental education classroom. The following research questions were investigated with differences between teaching status examined:

- To what extent do developmental mathematics instructors prioritize
the incorporation of technology in their developmental education classrooms?

• How familiar are developmental mathematics instructors with the applications and uses of technology in the learning environment?

• What are developmental mathematics instructors’ preferences for (a) hardware and commonly used software, (b) content-delivery tools, (c) online resources, (d) communication tools, and (e) collaborative online tools?

Method

Sample

The sample for the present study is a subset of the sample from the DETS which was sent to the 98 institutions that participated in the DEPS. For mathematics, 379 developmental mathematics faculty members from 55 institutions (56%) responded to the DETS. Within institution response rates were not available. Two-thirds of the faculty respondents were female, and 87% were from a 2-year or technical college. Of the 356 faculty who reported their teaching status, roughly half of the respondents indicated they were full-time (51% and 49%, full-time and part-time, respectively). The majority (65%) of the respondents had not taught an online or hybrid course within the past three years. Of the faculty members who had taught an online or hybrid course within the past three years, the majority (70%) were required to complete training prior to teaching the course. A few faculty members (15%) indicated they also had duties as an administrator. Almost two-thirds of the respondents had master’s degrees, a quarter had bachelor’s degrees, and a tenth had doctoral degrees. The majority (62%) of respondents indicated they had taught as a certified teacher in any grade level in K–12. At least 62% had a minimum of six years of experience teaching developmental education at a community college.

Instrument

The purpose of the DETS was to understand developmental education instructors’ current instructional technology practices. The DETS built off of the existing DEPS, which “was designed to better understand how developmental education is performed across the state and at individual institutions” (THECB, 2011, p. 1). The instrument initially was developed by the research team by identifying relevant factors from the literature and expanding upon the technology questions on the DEPS. Researchers convened with representatives from each of the three advisory colleges who were content experts in their teaching field. Advisory teams, which were comprised of developmental education instructors and administrators, iteratively refined and revised the questionnaire items. After consensus was reached, the final version of the DETS was distributed. Questions analyzed in this study are included in the Appendix. A contact person at
each institution was invited to participate and was asked to distribute an e-mail invitation containing a link to the DETS to all full- and part-time developmental instructors. To examine differences between full-time and part-time instructors and differences between institutional and departmental policy requirements, t tests for differences in means were conducted.

Results

Research Question I: Use and Prioritization

The majority of participants (82%, $n = 377$) indicated that they use instructional technology in the developmental education classroom. When asked about the extent to which they prioritized the incorporation of technology in their classrooms, more than half (63%, 232 of $n = 367$) of the respondents marked a 4 or a 5 on a scale of 1 to 5, where 1 = “not a priority” and 5 = “an essential priority.” Statistically significant differences existed between full-time and part-time instructors on (a) their reported use of instructional technology ($\chi^2_1 = 11.52$, $p < .01$) 89% (Did use, $n = 161$; Did not use, $n = 20$ ) and 75% (Did use, $n = 130$; Did not use, $n = 43$), full-time and part-time, respectively, and (b) ratings on their use of technology in the classroom as essential ($t_{343} = 3.12$, $p < .01$; Cohen’s $d = .33$; $M_{FT} = 3.91$, $SD_{FT} = 1.31$; $M_{PT} = 3.46$, $SD_{PT} = 1.39$; full-time and part-time, respectively).

Local policies. Because policies would impact use of technology, instructors were asked to rate the extent to which (a) institutional/campus policies and (b) division/departmental policies “require or not require the use of technology in the development education classrooms?” Responses were rated on a 5-point scale from 1 = “require” to 5 = “not required.” A paired samples $t$ test indicated statistically significant differences existed between instructors’ reported institutional/campus and departmental/division policy requirements ($t_{367} = 5.73$, $p < .001$; Cohen’s $d = 0.30$; $M_{IC} = 2.99$, $SD_{IC} = 1.41$; $M_{DD} = 2.62$, $SD_{DD} = 1.45$, institutional and departmental, respectively).

Research Question II: Familiarity With Technology

Instructors’ responses indicated that instructors perceive themselves as familiar with using technology to promote student learning ($M = 2.19$, $SD = 0.97$, 95% CI [2.09, 2.28], $n = 378$). When asked to rate their familiarity with applications and uses of technology in the learning environment, almost two-thirds (63%, $n = 239$) rated themselves a 1 or 2 on a scale of 1 to 5, where 1 indicated “extremely familiar” and 5 indicated “not at all familiar.” Approximately 10% ($n = 39$) of the respondents rated themselves a 4 and one rated a 5. Statistically significant differences did not exist between full-time and part-time instructors on their familiarity with technology ($t_{153} = 1.73$, $p = .08$; Cohen’s $d = 0.19$; $M_{FT} = 2.09$, $SD_{FT} = 1.01$; $M_{PT} = 2.27$, $SD_{PT} = 0.93$, full-time and part-time, respectively).
Research Question III: Most Important Instructional Technology

Instructors were asked to identify their *top choice* for the most important instructional technology tool used in their developmental mathematics courses across five categories (see Appendix). Differences between full-time and part-time instructors were investigated.

**Hardware or commonly used software.** As seen in Figure 1, when graphing and non-graphing calculators were combined together, the calculator was the top choice as the most important hardware or commonly used software in developmental mathematics classrooms. However, 23% (41 out of 182) of full-time and 26% (45 out of 174) of part-time instructors chose “not applicable” for this category. Even though the use of tablets was the only category where differences existed between full-time and part-time instructors, tablets were the top choice by only 3% ($n = 5$) of full-time instructors and by none of the part-time instructors. Of the faculty who chose “not applicable” for hardware or commonly used software, 64% (62 out of 97) had marked a 3, 4, or a 5 on the question about institutional/campus policies and 56% (52 out of 93) marked a 3, 4, or a 5 on division/departmental policies on a 5-point Likert scale, 1 = “require” to 5 = “not required.”

**Content-delivery and communication tools and online resources.** As seen in Figure 1, “commercialized content-based instructional software products” was developmental mathematics instructors’ top choice as the most important content-delivery tool used for both full- and part-time instructors. As seen in Figure 1, most instructors chose “not applicable” when asked to provide their top choice as the most important online resource, with a larger proportion of part-time instructors than full-time instructors choosing this option. The next most important online resource chosen by both full- and part-time instructors was “online tutoring.” A larger proportion of full-time instructors than part-time instructors chose “websites.”

**Communication tools.** “E-mails about course communications” (i.e., course progress, course feedback; 40%, 73 out of 182, and 35%, 61 out of 174, full-time and part-time instructors, respectively) and “online grade/performance updates” (32% or $n = 58$ and 35% or $n = 61$, full-time and part-time instructors, respectively) were developmental mathematics instructors’ top choices for the most important tools used to facilitate communication between instructors and students. “E-mails about services” (tutoring, special events, etc.) was chosen by 8% ($n = 15$) of full-time and 12% ($n = 21$) of part-time instructors.

**Collaboration tools.** The majority of instructors did not select a top choice for the “most important online collaborative tool used” and opted to choose “not applicable” (67%, 122 out of 182, and 74%, 128 out of 174, full-time and part-time instructors, respectively). Another 9% ($n = 16$) of full-time instructors and 13% ($n = 22$) did not respond to this item. However, 18% ($n = 32$) of full-time and 9% ($n = 16$) of part-time chose “discussion boards.” The other options
that were selected by a trivial number of instructors were “blogs,” “social media,” “videoconferencing,” and a “wiki.”

Discussion

The high proportion of students who are placed in developmental education courses is a concern at the national level. Increasing the number of students who obtain a college degree is contingent on the successful remediation of these students. The effective use of instructional technology has been accepted as a tool that can increase student learning at the K–12 level (see Ozel, Yetkiner, & Capraro, 2008), and mathematics associations agree and provide statements of support for the use of technology in K–12 and college classrooms (AMATYC, 1995, 2006; Mathematical Association of America, 2003; NCTM, 1989). Therefore, it is a logical assumption that instructional technology could have a positive impact on student learning in developmental mathematics classrooms. In Texas, where the current study was situated, the use of instructional technology in de-
Prioritization of and Familiarity with Technology

Instructors’ use of technology will likely relate to their prioritization of and familiarity with technology. The majority of developmental mathematics instructors in our study reported that (a) technology was a priority, (b) they had a high degree of familiarity with technology, and (c) they used instructional technology. On the whole, these perceptions about technology were more prevalent in full-time instructors than part-time instructors. Thus, there appears to be an inconsistency between full-time and part-time instructors on the use of instructional technology. Statistical tests and small effect sizes indicated requirements to use technology were more likely made at the departmental level rather than the institutional level. With evidence that technology was valued by many instructors, we sought to discover instructors’ top choices of instructional technology.

Top Choice of Technology in Classrooms

Because technology can be used for different instructional purposes, we disaggregated technology use into several categories. Developmental mathematics instructors then responded to their top choice of technology for each category. To determine the extent to which differences existed by teaching status, results were disaggregated by full-time and part-time instructors.
Hardware or commonly used software. Graphing or non-graphing calculators in their teaching were chosen by approximately 40% of instructors as their top choice of hardware or commonly used software. There was almost even division between graphing and non-graphing calculators. The results provide evidence that developmental mathematics classrooms can be a setting for future research on the use of calculators in the instructional setting. As seen in Figure 1, approximately 25% selected “not applicable” as their top choice of the most used hardware or commonly used software category. This suggests that many instructors prefer not to use software or hardware in developmental mathematics instruction.

Only a small percent of instructors chose Word, iPads/tablets/readers, podcasts, or classroom response systems (CRSs). In light of previous research on CRSs (see Caldwell, 2007), there are several reasons CRSs might not have been chosen. First, class sizes in developmental mathematics, on average, tend to be small (i.e., 21 students; Gerlaugh et al., 2007). Second, instructors of traditional developmental mathematics courses might lack the flexibility to reduce the amount of content covered. If CRSs are to be used in developmental mathematics courses, more research needs to be conducted to determine the extent to which (a) the curriculum is flexible enough to accommodate the time needed for incorporating CRSs (see Caldwell, 2007); (b) there are benefits to using CRSs in small classrooms; and (c) there are professional development opportunities available to address the pedagogical changes that need to be made when using CRSs (see King & Robinson, 2009).

Content-delivery tools. As seen in Figure 1, full-time instructors were more likely than part-time instructors to select commercialized content-based instructional software products as their top choice as the most important content-delivery tool. In addition, 22% of part-time instructors marked “not applicable,” which suggests that part-time instructors might not be as likely as full-time instructors to embrace instructional technology for content delivery. Given the widespread employment of part-time faculty in developmental education, this finding suggests that future research might want to focus on the effectiveness of content-delivery tools. To the extent that these delivery tools prove to be important to student learning, full-time instructors need to spend more time communicating with part-time instructors on implementing these tools.

Communication. Evolutions in technology provide new opportunities for instructor-student interactions. Today, because of online handheld devices and wireless Internet, students instantaneously can access the Internet almost anywhere to initiate communication with instructors. In the current study, regardless of teaching status, respondents recognized the value of using technology as a communication tool. At least 85% chose one of the four options; 70% of instructors selected either “E-mails about course communications” (i.e., course progress, course feedback) or “online grade/performance updates” as their top choice.
According to Myers, Martin, and Mottet (2002) students’ motives for communication with teachers are “relational, functional, participatory, excuse making, and sycophantic” (p. 126). Because e-mail is a popular mode of communication, instructors should consider the reasons student choose to communicate by e-mail. In particular, instructors should begin to think about how the use of e-mail course communications (e.g., course progress, course feedback, etc.) and online grade updates can help facilitate student-instructor interactions. For example, Young, Kelsey, and Lancaster (2011) found that both teacher immediacy and the beliefs that teachers frequently e-mailed the entire class increased “students’ positive predicted outcome value of fostering a student-teacher relationship” (p. 383). Immediacy could be fulfilled in e-mails by including students’ names and emoticons. In addition, they found that students actually may “prefer inclusive, all-group/mass e-mail communication to targeted one-on-one emails” (p. 381). Other predictors in their model for fostering student-teacher relationships included “when students e-mail teachers for procedural/clarification reasons, and when students do not e-mail teachers simply as a means of efficiency” helped (Young et al., p. 381). Thus, because developmental mathematics instructors were using e-mails to communicate about the course, future studies could investigate in detail the purpose for their e-mails, instructors’ interpretations of why they believe students communicate by e-mail, and if instructors believe e-mails are fostering positive student-instructor relationships.

**Collaboration.** Developmental mathematics instructors in this sample did not integrate technology as a collaborative tool in their classrooms as evidenced by the large percentage of instructors who marked “not applicable” (i.e., 67% and 74%, full-time and part-time instructors, respectively). A research topic that warrants further consideration is whether developmental mathematics instructors might lack training on how to use technology for collaborative learning techniques. Furthermore, some of the contemporary course redesign methods such as modularized mathematics and computer-based mastery learning actually apply technology as such to preclude opportunities for collaborative learning.

Respondents also were not identifying blogs, videoconferencing, wikis, or social media as a top choice for a collaborative tool, though as noted, the literature suggests that some of these tools might stimulate increased written communication between students (Cooper, 2012; Pearson, 2010). A small percentage of the instructors selected discussion boards as their top choice for a collaborative tool. Future research could be conducted to determine if instructors teaching both developmental and college-level math courses utilize collaborative tools differently depending on course level.

**Online resources.** As seen in Figure 1, the large percentage of instructors that chose “not applicable” in regards to online resources implies that many instructors are not utilizing online resources in their developmental mathematics courses. This finding supports the conjecture that more training and professional development should be provided on how online resources can be incorporated in these classrooms. The large percentage of instructors who chose either online
tutoring or websites as their top choice for an online resource is encouraging because students can access these resources as needed. In addition, lessons and examples that are posted on the web allow students to replay the information as many times as needed and also allow them to learn from various instructors. Given that full-time instructors are more likely than part-time instructors to choose websites as their top choice, more web resources need to be made available to part-time instructors.

**Delimitations and limitations.** One limitation of this study is that the fidelity of instructors’ perceptions and the extent of their use of particular technology applications were not measured. In addition, the percentage of full-time instructors was higher than the reported percentage of full-time faculty across several states, particularly at public two-year institutions (see Gerlaugh et al., 2007). A higher representation of full-time faculty than that of the population probably is represented in this study, and therefore, caution should be warranted about generalizing the results. Another limitation is that survey response rates could not be determined because the number of full-time and part-time faculty who taught developmental education at each institution was unknown. Regardless, a contribution of this study is that data was collected at the instructor level versus collecting data as one representative from the entire institution that has been done in some previous studies (see Parsad et al., 2003; THECB, 2011). There is also the possibility that some colleges and universities are more represented within the sample because a larger percentage of faculty members at a given institution completed the survey. With regard to the DETS instrument, the utilization of more than one tool within each category or the absence of a top choice could not be identified. This represented a limitation with regard to survey design. This research was also subject to the limitations of self-reported data such as those intrinsic errors associated with perceptual recall and bias. Finally, the sample was limited in scope to one state.

**Conclusions and Implications**

Developmental mathematics classrooms provide interesting settings to study instructional technology applications because of the varied opportunities and options for applying them. Implications from this study might inform developmental education practice and research as to instructors’ top choices of technology. One implication from this work is the importance of meaningful discourse about the ability to fully scale the integration of technology in a situation where part-time instructors are the primary providers of instruction. Generally, a consideration must be whether resources, support, and training for instructional technology applications adequately can be deployed to instructors that might be less than fully engaged on a day-to-day basis with the institution. Specifically, to the state investigated in this work, administrators and policy makers must take into consideration the challenges to effectively implement a mandate that calls for the integration of technology in developmental education classrooms. These challenges include resource disparity across institutions, skill and attitude
differences across instructors with regard to technology, and a predominantly part-time faculty base.

Overall, the study provided empirical evidence that developmental mathematics teachers are receptive and somewhat knowledgeable about using instructional technology in the classroom. However, it does not appear that the goal is to utilize technology to promote collaborative learning among students. More research is needed on the integration of technology in developmental mathematics classrooms, particularly with regard to how technology applications might promote the principles and strategies of effective teaching and learning.

References


Appendix

DETS Questions Analyzed

6.1 In your opinion, to what extent do you prioritize incorporating technology in the developmental education classroom?

NA 1 not a priority ......2....... ......3....... ......4....... 5 an essential priority

8.1 My familiarity with applications and uses of technology in the learning environment is:

1 extremely familiar ......2....... ......3....... ......4....... 5 not at all familiar

9.1 To what extent do institutional policies require or not require the use of technology in the developmental classrooms?

Require 1.......2....... ......3....... ......4....... 5 Not Require

11.1 To what extent do division/departmental policies require or not require the use of technology in the developmental classrooms?

Require 1.......2....... ......3....... ......4....... 5 Not Require

20.1 I use instructional technology in my developmental education classroom.

Yes No

For each category, please identify your top choice as the most important instructional technology tool in your Developmental Mathematics courses.

27. Hardware and commonly used software

NA
Clickers (rapid response system)
Document reader (ELMO)
Excel
Graphing calculator
Interactive whiteboard (SmartBoard)
iPad/Tablets/eReaders
Non-graphing calculator
Pencasts

28. Content-delivery tools

NA
Commercialized content-based instructional software products
Course management software (e.g., Blackboard, Angel)
Instructor-generated technology-based supplements
Online Lecture Notes (PowerPoint, Prezi)
Podcasts/vodcasts/webcasts
29. Collaborative tools

- NA
- Blogs
- Discussion boards
- Social media (Facebook, twitter)
- Videoconferencing (Skype, Elluminate Live, Tegrity, etc.)
- Wiki
- Word

30. Tools to facilitate communication between instructors and students

- NA
- Early intervention (e.g., technology-based warning systems such as Starfish)
- E-mails about course communications (course progress, course feedback, etc.)
- E-mails about services (tutoring, special events, etc.)
- Online grade/performance updates

31. Online resources

- NA
- Google or other search engines
- Online tutoring
- Online chats or online labs
- Websites (e.g., Youtube.com)
- Wolfram Alpha

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**Footnote**

This study was supported by the Texas Higher Education Coordinating Board (Contract Number 07272) and was part of a larger project designed to explore the use of technology in developmental education programs.