Abstract

Minimal research has been conducted contrasting the effectiveness of various testing accommodations for college students diagnosed with ADHD. The current assumption is that these students are best served by extending the time they have to take a test. It is the supposition of these investigators that paced item presentation may be a more beneficial accommodation than extended time. To test the effects of paced item presentation, the investigators designed a mixed methods sequential explanatory study to explore the relationship between computer-paced and student-paced item presentation on the academic test performance in college students diagnosed with ADHD. The participants were randomly assigned to 1 of 2 testing conditions. Half of the participants were provided a computer-paced testing condition, and half were provided a student-paced testing condition within a computer-based environment. Interviews were conducted after the test administration to discern the students' perceptions of the value of the various components of the testing environment. No significant differences were found in performance scores between the students tested under the two conditions; however, the interview data illuminated the quantitative findings in that the students reported that the computer-based testing environment itself, as well as other environmental variables, provided a beneficial structure and format conducive to their overall successful performance under both accommodations. The practicability of university disability offices offering a computerized format for students diagnosed with ADHD is also discussed.
The Effects of Pacing on Academic Testing Performance of College Students with ADHD: A Mixed Methods Study

Attention-Deficit/Hyperactivity Disorder (ADHD) is not outgrown during adolescence as was once thought (DuPaul, Guevermont, & Barkley, 1991). It is considered a valid adult disorder (Kessler, et al., 2006), and approximately 2% to 4% of college students are affected by it (Weyandt & DuPaul, 2006). Studies examining the academic performance of college students diagnosed with ADHD show that these individuals typically earn lower grade point averages, are on academic probationary status more often, report more academic problems, and have greater difficulty managing time and conforming to schedules than their non-ADHD peers (DuPaul & Weyandt, 2006; Heiligenstein, Guenthter, Levy, Savino, & Fulwiler, 1999).

Dowrick, Anderson, Heyer, & Acosta (2005) powerfully present the rationale for the providing educational support for adults with disabilities in the US:

Postsecondary education is becoming increasingly important in obtaining quality employment for people with disabilities. Significant relationships exist between disability, level of education, and employment outcomes. While employment rates for people with disabilities have a dramatically positive correlation with educational level, their postsecondary enrollment remains low in comparison to the general population. Individuals with disabilities in post-secondary education enroll in postsecondary education at a rate that is 50% lower than their non-disabled counterparts. Furthermore, only 12% of individuals with disabilities graduate from college as opposed to 23% of their non-disabled counterparts. For full participation in society, people with disabilities need increased levels of participation and completion in postsecondary education programs (p. 41).

Literature addressing the legal and educational contexts of accommodating students with disabilities is abundant. The reauthorization of the Individuals with Disabilities Education Act in

1997 and the passage of the No Child Left Behind Act in 2002 emphasizing the inclusion and accountability of students with disabilities in high stakes testing have spurred increased emphasis in this area (Fuchs, Fuchs, & Capizzi, 2005; Niebling & Elliott, 2005; Elliott, McKeveit, & Kettler, 2002).

There “is a glaring need to expand the types of strategies to enhance academic performance among students with ADHD” (DuPaul & Eckert, 1998, p. 9). Although few studies have targeted the performance of secondary school students (DuPaul & Eckert, 1998) and college students (Tindal & Fuchs, 2000; Wallace, Winsler, & NeSmith, 1999), several studies have examined other types of academic interventions to assist college students with ADHD. Various investigators have examined the effectiveness of course-specific strategy training, training in learning strategies and self-advocacy skills, coaching, and peer tutoring to name a few (Allsopp, Minskoff, & Bolt, 2005; Getzel, McManua, & Briel, 2004; Quinn, Ratey, & Maitland, 2000; Swartz, et al., 2005; Zwart, 2001). Students with disabilities are routinely counseled to advocate for themselves and take advantage of educational services provided by university disability offices (Dowrick, Anderson, Heyer, & Acosta, 2005).

The most consistent educational service to be offered for persons with disabilities in post-secondary education is testing accommodations (Tagayuna, Stodden, Chang, Zelenik, & Whelley, 2005). Although the most frequent testing accommodations provided by disability services in university settings are extended time for tests and the ability to take exams in minimal disturbance testing rooms away from peers (Farrell, 2003; Lancaster, Mellard, & Hoffman, 2001), few studies examining these routine accommodations have been conducted, particularly

with college students diagnosed with ADHD. In order to situate this study within the existing literature, this review will focus primarily on research investigating (a) the routine postsecondary testing accommodation of extended time, (b) paced item presentation, and (c) computer-based presentation.

*Extended Time*

Studies exploring an extended time accommodation for college students with learning disabilities have inconsistent findings. For example, Alster (1997) found no significant difference in algebra test scores between college students with learning disabilities in an extended time condition and students without learning disabilities in both timed and extended-time conditions. Medina (2000) found that although extended time benefited all participants in the study, extended time did not benefit college students with learning disabilities as compared to their non-disabled peers. Zuriff (2000) also found that although extended time benefited both learning disabled and non-disabled college students, the analysis of the five studies examined, did not support the theory that only students with learning disabilities benefit from extended time. In contrast, Weaver (2000) found that postsecondary students with disabilities made significantly higher gains on their reading test in an extended time condition as compared to students without learning disabilities.

Extended testing time may not be sufficient to "level the playing field" for this population (Wallace, Winsler, & NeSmith, 1999). In fact, some college students with ADHD report that extended testing time may actually hinder their performance and “that the pressure to finish the test quickly is what gives them the stimulation they need to focus” (Farrell, 2003, p. 51). It is our
hypothesis that providing a paced item presentation of the test will enhance the testing performance of this population by regulating their attention as they respond to test items at a specified rate. The computer served as the tool for providing our participants a paced item presentation.

Paced Item Presentation

Few studies have addressed paced item presentation as a testing accommodation for students with disabilities (Tindal & Fuchs, 2000; Thompson, Blount, & Thurlow, 2002) and those that have vary widely in the type of technology used as well as the method of pacing. In one study focusing on projected methods of test administration, Curtis & Kropp (1961) compared the administration of a School Ability Test under two conditions with 29 ninth grade general education students. Students who took the test with each test item projected on a screen in a teacher-paced manner performed better than those who took the test using a traditional paper and pencil format. Hoffman & Lundberg (1976) compared the administration of a test under similar conditions with 136 general education pharmacy students in their second year of study but with different findings. They also compared a standard paper and pencil administration of a test with test items visually projected on a screen and verbally read to the participants. They found the general scores were equivalent under both conditions; however decreased performance was noted for matching items. Helwig, Tedesco, Heath, Tindal, & Almond (1998) compared the math test scores of 33 students from sixth grade classrooms. Half were administered the test via a standard test booklet format and half were presented the test via a video monitor with an administrator reading and pacing the test. The investigators analyzed the data on various
subgroups related to reading and math ability and found only one statistically significant finding—the more verbs presented in a passage increased the success rate in favor of the video accommodation. Tindal, Glasgow, Helwig, Hollenbeck, & Heath (1998) compared the results of a video paced read aloud administration of a math test with a standard paper and pencil multiple choice test with 2000 students, 1000 elementary and 1000 middle school students. Significant effects were found for the elementary students and not the middle school in favor of the video paced read aloud administration. Finally, Hollenbeck, Rozek-Tedesco, Tindal, & Glasgow (2000) compared the effects of student-paced computer presentation versus teacher-paced video presentation of a large-scale math test with 50 seventh grade students, consisting of special education and general education students. The investigators found that both student-paced and teacher-paced accommodations significantly impacted the scores of both special and general education students. The student-paced computer accommodation resulted in slightly higher scores than the teacher-paced video presentation.

***Computer-Based Testing as an Accommodation***

Although our focus was on paced item presentation, using the computer as the tool to deliver this accommodation merits a review of the literature. Computer-based testing (CBT) “generally refers to using the computer to administer a conventional (i.e. paper-pencil) test” (Wise & Plake, 1989, p. 5). Since the research employing computer presentation as a test modification is extensive, the focus in this literature review will be on recent studies using secondary school students as the participants. The studies investigating computer-based presentation as a testing accommodation has had mixed findings (Thompson, Blount, &

Thurlow, 2002). Brown & Augustine (2001) found that computer use had no significant effect on the scores of 206 twelfth grade students. Hollenbeck et al. (1999) found no differences between stories written with computers and those written without. In contrast, Burk (1998) found that the performance of students with disabilities was significantly higher on a computerized administration of a test as compared to a paper and pencil format. Calhoon et al. (2000) also reported computer use had a positive effect on performance of ninth through twelfth grade students with math and reading learning disabilities, as well as Russell & Plati (2000) with a group of 8th and 10th grade students writing compositions via a computer.

**Research Summary**

Synthesizing the studies exploring testing accommodations for students with disabilities is a complex endeavor for a number of reasons. Often the studies differ substantially in terms of the ages and range of disabilities of the students sampled, the research methodologies used, as well as the type of technology used to deliver the various accommodations in which technology is a factor. In addition, the various accommodations investigated are often packaged with other accommodations and are seldom investigated in isolation (Tindal & Fuchs, 2000). Nevertheless, one can see that investigating the relationship between computer-paced and student-paced item presentation on the academic test performance in college students diagnosed with ADHD deserves attention. In this study, we compared the performance of students who manually self-paced their progression through the computerized test with students who were paced automatically through the computerized test as designed within the computer program.

**Methods**

This exploratory study utilized a mixed-methods quasi-experimental design to explore and explain the effects of paced item presentation for college students diagnosed with ADHD. This sequential explanatory strategy was appropriate, because our goal was to analyze two testing conditions and interpret their impact on a small number of participants who participated in the study.

Participants

Twenty-one students enrolled in a mid-sized public university in the southwestern US who were registered with the Office of Disabilities with a diagnosis of ADHD participated in the study. Participants were solicited through advertisements posted around the university campus. After numerous unsuccessful scheduling attempts and unsuccessful follow through on scheduled appointments, the investigators offered an all-day “open lab” on the day between the last class day and the first of the final exams for the students to come by the university psychology computer lab and take the test at their convenience. After completing the computerized test and a follow-up interview, each participant was given twenty dollars as an incentive to participate.

The average age of the participants was 26.8 years old with a standard deviation of 9.3 years. 5 participants were classified as Freshman; 9 were Sophomore; 2 were Junior; and 5 were Senior. See Table 1.

Table 1.

Participant Age and GPA

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<thead>
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\(^a\) Freshman students with a GPA of “0.00” were not included in the Mean or Standard Deviation results as those scores would have unfairly skewed the results. Those students had no official university grades at the time of the experiment.

Of the 21 participants, 11 were males and 10 were females. 15 were Caucasian; 4 Hispanic; 1 African-American; and 1 Island Pacific/Other. Although 13 participants were prescribed medication to manage their ADHD symptoms, only 6 participants used medication on the day of the experiment. See Table 2.

Table 2.

*Participant Demographics*

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<thead>
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**Medication**

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<td>used on experiment</td>
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<tr>
<td>day</td>
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<td></td>
</tr>
<tr>
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<td>2</td>
<td>18.20</td>
</tr>
<tr>
<td>on experiment day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not prescribed</td>
<td>5</td>
<td>50.00</td>
<td>3</td>
<td>27.30</td>
</tr>
</tbody>
</table>

**Materials**

The software program designed for the study was a Microsoft Windows application written in the programming language, Visual Basic.NET. The application recorded test results to a database located on a separate, designated computer. Additionally, an administrator's interface was written as an interactive web document in the PHP scripting language. By using the interface to access the database, a test administrator was able to monitor the results as they came in and also export these results to a raw text file for the purpose of data analysis.

The program displayed all screens in a simple grey color, had a clock display in the upper right hand corner of the screen for the timed portions of the experiment, and provided an auditory tone when a screen was advanced. Test items were displayed in a controlled sequence; the participants were unable to return to previously answered questions. Participants wore

Headphones during the experiment in order to hear the tone alerting advancement to the next question. Upon completion of the test, participants were interviewed about their testing experience.

In order to simulate testing conditions in a university setting as closely as possible, a passage from a college psychology textbook was selected as the prompt for the participants. The students were allowed five minutes to read the short passage. See Figure 1.

**Figure 1: Reading passage**

[Image of a reading passage with a timer set at 4:50 remaining]

Multiple-choice questions from the college textbook test bank were administered to assess the

students’ learning. The text and 11-item multiple-choice test were taken from a textbook routinely used in introductory psychology classes. See Figure 2.
Immediately following completion of the computerized test, each student participated in a face-to-face interview with the primary investigator. The guiding questions of the interview consisted of two open-ended questions: (a) Were there any conditions in the testing environment that helped your performance? and, (b) Were there conditions in the testing environment that hurt your performance?

Procedure

Participants were randomly assigned to one of two treatment conditions. In the computer-paced testing condition (CP), the students were allowed 90 seconds per question and were forced to move on to the next question when the time expired. The clock on the screen counted down the 90-second time limit for each multiple choice question. If the student answered the question before the maximum time allowed, s/he could manually advance to the next question. In the student-paced testing condition (SP), students were allowed an average of 90 seconds per question but were not forced to move on to the next question. They paced themselves by using a clock on the screen that counted down the total time (16.5 minutes) allowed for answering the 11 multiple choice test questions.

The computer software program first displayed a demographic questionnaire screen. Participants completed the brief questionnaire on demographic information and whether or not medicine for ADHD had been prescribed and whether medicine had been used the day of the experiment. After providing the online demographic information, the participants were given instructions regarding the upcoming text passage. Participants were instructed that they would have 5 minutes to read the brief text passage. After reading the instructions, the students indicated they had read and understood the instructions, by selecting an option given on the screen. After reading the text passage, the participant could either manually advance the screen, or the screen was advanced automatically after the five-minute time limit for reading the passage had expired. After reading the text passage, a screen with instructions for the multiple-choice questions was presented. All instructions were presented on a single screen and were not timed. After reading the exam instruction page, participants indicated that they had read and understood
the instructions by selecting an option to proceed. They were then instructed to begin answering the multiple-choice questions.

The computer-paced testing condition (CP) was achieved by restricting participants to a 90-second time limit for each multiple-choice question, for a total of 16.5 minutes to complete all questions. A clock in the corner of the screen counted down the 90-second time limit for each question. The test question automatically advanced to the next question after the 90-second limit had expired, unless the participant manually advanced the screen to the next question if he/she submitted the response prior to the 90-second limit. The student-paced testing condition (SP) was achieved by allowing participants to self-manage the amount of time spent on each question. The SP also allowed the participant a total of 16.5 minutes to complete all questions; however the participants paced themselves by referring to a clock in the corner of the screen that counted from the 16.5-minute maximum time to answer all questions.

Upon completion of either the computer-paced or student-paced test, each participant was individually interviewed face-to-face by the primary investigator to explore the student’s perception of the testing experience. After completing the interview, the participant received his/her monetary incentive.
Results

The data of primary interest to the study were mean differences in the two treatment conditions (computer-paced and student-paced) and the student interview data. The results will be presented in two parts. The quantitative data will be reported first, followed by the qualitative data provided by participant interviews.

Data Screening

Prior to conducting the quantitative data analysis, we screened the data for the assumptions of normality and equal variances (Kirk, 2008). For both, the data met the requisite assumptions to conduct an independent t-test of means.

Quantitative Data Analysis

Means were calculated for each participant in the two conditions and the mean scores were recorded. Mean differences and standard deviations were calculated for each of the two treatment groups, and an independent t-test of significance was employed. We found no significant difference between the treatment groups. Group one (CP) had a mean score of 8.10 with a standard deviation of 2.68, and group two (SP) had a mean score of 8.18 with a standard deviation of 2.75. Results are reported in Table 3.

Table 3

*Mean scores on reading comprehension test for computer-paced and student-paced testing conditions*

<table>
<thead>
<tr>
<th></th>
<th>Computer-Paced</th>
<th>Student-Paced</th>
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<tbody>
<tr>
<td>Mean</td>
<td>8.10</td>
<td>8.18</td>
</tr>
<tr>
<td>SD</td>
<td>2.68</td>
<td>2.75</td>
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*Qualitative Data Analysis*

Upon completion of the computerized test, each participant was individually interviewed face-to-face by the primary investigator in a room adjacent to the computer lab. The purpose of the interview was to explore the student’s perception of the testing experience. To ensure open inquiry and an emerging design, the guiding questions of the interview were open-ended. The guiding questions were (a) What conditions in the testing environment helped your performance—in what ways, and (b) What conditions in the testing environment hurt your performance—in what ways? Each interview lasted approximately 15-20 minutes. The primary researcher wrote the student responses verbatim in the form of notes and read back the written responses to ensure that the student had communicated what he/she intended.
After all student interviews were completed, the participant responses were reviewed and organized into two general categories: helpful testing conditions and unhelpful testing conditions. Three general themes emerged upon organization of the data: format, time, and physical environment.

**Formatting**

One theme that emerged was the formatting of the text and the questions presented on the computer screen. Of the 21 students, 15 reported that the structure of the reading passage enhanced their performance. Several participants commented that the text reading passage was spatially organized so that they could easily focus on content of the reading passage. For example, one participant said, “It was easy to see how it’s organized. The first paragraph explained one type of motivation. The second paragraph explained the other type. The third paragraph gave examples of each. Having only three paragraphs gave me the confidence that I could read easily.” Another participant said, “The text was clearly written and broken up well.” Another said, “The bold letters in the passage helped. The bold font emphasized the main ideas.”

Although most of the participants emphasized a perceived benefit of the formatting and succinctness of the reading passage, a few students found the text passage difficult to read. “The text clumped together in the reading passage made it hard. I see a big jumble of words. I can read it over and over but it doesn’t help. The more information that’s presented, the harder it is. Testing is really a crapshoot for me.” Another student said, “Lots of big words in succession—too many in a row—the academic wording—made it hard.” Another said, “The long passage of text was difficult to process and organize.”

Over one-half of the participants reported that having only 1 question on the screen at a time helped them to focus and increased their confidence. For example, one student said, “Paper tests that are pages full of questions make me nervous. I liked having each question, one at a time.” Another participant commented, “I liked seeing one question at a time. Lots of questions on a page makes me anxious.”

A second theme that emerged was the structure and visibility of the time component within the test. Whether testing under the computer-paced experimental condition with the 90-second maximum time limit per question or testing under the student-paced condition with the 16 minute overall time limit, most participants reported that the timer was an added distraction. One student said, “Timers make me feel rushed. I hate timed tests.” Another said, “Timers make me feel rushed. I need to time to think.” “The timer made me feel pressured,” said another. Although most of the students in both the computer-paced and student-paced conditions reported a distaste for timers, a few in the student-paced condition only said knowing they had 16 minutes to complete 11 multiple-choice questions relieved them. “The timer scared me at first, but when I realized I had 15 minutes for 11 questions, it didn’t affect me at all.” Another said, “I liked the timer telling me how much time I had left to take the test. It was nice not worrying about the time.”

A third theme that emerged was the students’ overwhelming emphasis of their need for a distraction free testing environment. Most of the students emphasized a preference for an isolated and quiet environment. “I liked the quiet and calmness, the lack of sound and no other people in the room.” Another said, “It was quiet—no cell phones.” Another said, “Any background noises

really distract me. I give equal attention to everything around me.” It should be noted that students completed this test in a computerized research lab with fewer than 2-3 other students present. This, of course, more closely mimics the accommodated testing conditions available to most students via disability services than conducting such research in a classroom setting with multiple participants completing the exam at the same time and in the same room.

**Discussion**

Finding no significant differences in the mean scores between our treatment groups was surprising. Our quantitative data suggested that forcing students to advance at a computer-prescribed pace (CP) did not enhance their performance as compared to allowing students to pace themselves (SP), as we had predicted. Information gleaned from the student interviews suggested that for many of the students in the computer-paced condition, the 90-second time limit structure for each test question actually increased their anxiety. It is interesting to note, however, that this self-reported increase in anxiety was not associated with decreased performance on the test in comparison to the student-paced test takers.

The qualitative data analysis revealed that the computerized testing environment itself provided structure for the students through the formatting of the reading passage and test items--displaying one question only on the screen at a time. This may account for the average of 8/11 correct responses for participants under both conditions, allowing them to perform equally well. Perhaps the reported increased anxiety was “washed out” by the structure provided by computerizing the exam, providing a sufficient advantage, resulting in no quantitative differences in total correct responses under both conditions. Although the quantitative data do

not allow us to validate this assumption, the qualitative data appear to be rich for making such connections and for suggesting future avenues for research.

Our findings suggest that this exploratory study is useful as primary research and that future research needs to investigate our unanticipated finding that computerized testing, in-and-of-itself, appeared to improve performance of ADHD students regardless of other types of accommodations. Although we did not have a non-ADHD control group to compare performances, the interview data suggested that computerized testing for college students diagnosed with ADHD may “balance the playing field” in comparison to students without ADHD. A future study may test this assumption directly by including both a non-ADHD control group and an ADHD control group that takes the exam via paper-pencil as well as a non-ADHD experimental group that takes the exam via the computerized format. Comparison of these added conditions may not only support the qualitative results found by the present study, but may also yield significant quantitative findings. The additional data may also illuminate the potential benefit of computerized testing to non-ADHD students as well as the ability of computerized testing to accommodate the needs of ADHD students better than the traditional accommodations of paper-pencil testing and extended time.

Based on our qualitative findings, we anticipate improved performance for students with ADHD in the computerized conditions in comparison to any non-computerized conditions. Students with ADHD taking the exam paper-pencil, for example, would not be expected to perform as well as the students with ADHD in any of the computerized conditions. Comments from participants strongly suggest that the focus of being at the computer and being presented
one question at a time alleviated much of the anxiety they typically experienced in testing situations. Although extended time may assist students with ADHD in performing more effectively, our findings suggest this may be due more to pacing. If a student with ADHD in a traditional time paper-pencil condition were “paced”, we would expect improved performance in comparison to traditional paper-pencil conditions.

Implications

What is the feasibility of university offices of disability providing computerized testing to accommodate students diagnosed with ADHD? Approaches to creating test administration software may be divided into three broad groups: commercial/proprietary, open-source, and custom-written software. All of these approaches are practicable, and each has its own positive and negative aspects. The following briefly examines each approach, along with some of its relative advantages and disadvantages.

Commercial/proprietary software is software that is usually licensed to an educational institution for a fee. Examples include Blackboard, WebCT, and Desire2Learn. The widespread use of these software packages makes them easily accessible to many English-speaking educators, including grade-school level (Blackboard, 2006a). While many of these products are “closed-source,” meaning that the software may not be edited (or in some cases, not even be viewed) by a licensee, some packages include the ability to extend the basic features, such as by augmenting its built-in online test administration component. Thus, depending on the package, features may be added to the online test-facilitating component by a licensee to accommodate the various needs of special population students. Universities using this type of software routinely

employ staff skilled in programming that could easily make modifications to the online test-facilitating component. One possible drawback to using commercial/proprietary software, at least in the US, is a presently hostile legal climate due to efforts by Blackboard, Inc. to protect its patent on “Internet-based education support system and methods” (Blackboard, 2006b).

Different than commercial/proprietary software packages in several ways are open-source packages such as Sakai, Moodle, and ATutor. Both commercial and open-source types of software packages are typically Internet-based e-learning systems, and all major packages include computerized testing components (although at varying levels of sophistication). Open-source projects offer many advantages over their commercialized counterparts. The former are almost always usable without costly licensing fees (Sakai, 2004). A package’s source code being “open” means the entirety of the code may be viewed and edited to suit the needs of a given educational agenda. It also indicates that an online development community exists for the software. For example, Sakai has a large non-profit organization backing it. Such a community can be sought after for assistance and feedback in the development of electronic test-facilitating modules designed to meet the needs of students with disabilities. Universities using these open-source packages routinely employ staff skilled in customizing components of the groupware to meet the stated needs of the institution, including online test administration. Finally, open-source software seems to be safe from the hostile legal climate that Desire2Learn is currently experiencing, as Blackboard, Inc. has pledged not to file patent infringement suits against those developing and using open-source projects (Carnevale, 2007).

The last of the three approaches, and the one utilized in the present study, is custom-written software. Perhaps the most salient advantage is the ability to “custom-tailor” the software directly toward meeting the needs of a specific student population. The ability to avoid Internet congestion issues that may arise using either of the previously discussed approaches is also a significant advantage. Custom-written software can be designed to simply operate on a local area network (LAN) that would be linking desktop machines together in a student computer lab. With the exception of a remote backup database to which test results were sent, this is how the present study’s software was designed. Another advantage of the custom approach is that it does not require a large, pre-existing e-learning software package used by an educational institution. This means that while some institutions may use Desire2Learn and others, all would still be able to use a small, custom-written, test-facilitating application that accepts Microsoft Word files containing test questions.

A disadvantage of the custom approach requires the utilization of technically proficient personnel to design, write, and further customize the software. Further, the software would be unfamiliar to anyone not involved in its design or use. This is not the case when simply adding onto pre-existing software such as Blackboard or Sakai—software with which many educators and institutions are familiar. However, whether familiar to educators and institutions or not, each of the aforementioned approaches requires available, proficient technical personnel in support of its software package.

In conclusion, each of the three approaches allows for modification of testing procedures with the assistance of technical personnel skilled in programming. When comparing the
advantages and disadvantages of the three approaches to computerized testing, custom computer software seems a viable and beneficial solution to the problem of meeting the needs of a specific student population, such as those diagnosed with ADHD. The current study has demonstrated that fully modular test-facilitating software packages can be custom-designed at low cost, and with ease-of-use in mind for both the testing administrators and students.

Conclusion

In an effort to understand appropriate testing accommodations for college students with ADHD, this exploratory study illuminated several important issues: (a) a continued need for a distraction free testing environment, (b) further investigation of benefits and drawbacks of formatting on exam performance, and (c) the effects of the structure and visibility of the time component within the testing environment. Clearly, there is a need to investigate the perceived usefulness of various accommodations by the students themselves. The interview data in this study was rich in insight. Numerous participants expressed a long history of academic difficulty and frustration, using a “trial and error” approach in attempting to discover effective academic strategies to help them deal with the limitations of their ADHD symptomology. Many of the participants expressed a willingness to add to the knowledge base in hopes to help others avoid their “hit and miss” approach in trying to successfully learn the necessary skills and competencies required to be successful in an educational setting. Although conducting studies exploring testing accommodations for students with disabilities is complex, it certainly merits our attention and study. Clearly it is our responsibility as educators to provide accommodations...

to this underserved and underrepresented population of college students with ADHD to increase their chances of graduating from college and contributing to and participating fully in society.

References


*Accommodating students with disabilities in post-secondary settings.* Lawrence, KS: Kansas University, Center for Research on Learning. (ED452617).


with attention deficit/hyperactivity disorder. *Psychology in the Schools, 42*(6), 647-655.


