EFFECTS OF A TEST TAKING STRATEGY ON POSTSECONDARY COMPUTER
ASSISTED CHEMISTRY ASSESSMENTS

A Dissertation in
Special Education

by
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Abstract

Abstract of Dissertation Presented to the Graduate School of The Pennsylvania State University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

EFFECTS OF TEST TAKING STRATEGIES ON POSTSECONDARY COMPUTER ASSISTED CHEMISTRY ASSESSMENTS

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Metacognitive test taking strategies have proven advantageous in improving content-based test scores in a wide variety of disciplines and age/grade levels using traditional paper-and-pencil tests. However, despite the increase in computer assisted assessment (CAA), little research has examined whether these test taking strategies are effective for computer assisted tests. Research was conducted to determine if learning a proven test taking strategy would improve the online quiz scores of six university students in an introductory chemistry course intended for science, technology, engineering and math majors. Participants completed six to ten chemistry quizzes prior to intervention - learning the test taking strategy - and four to eight chemistry quizzes after intervention. Results indicated that, while students learned the strategy, it had little effect on their online chemistry quiz scores. Additionally, at the end of the semester, participants completed a satisfaction survey indicating general satisfaction with having
learned the test taking strategy and generalization to other courses and types of tests. Furthermore, results suggest that adaptations to the on-line delivery method of the quizzes and to the test taking strategies may improve the robustness of the effect. Due to the increased use of computer assisted assessment, additional research is warranted to determine appropriate test taking strategies for online tests.
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**Introduction**

The number of students entering colleges and universities has risen sharply from 13.8 million in 1990 to 21.0 million in 2010 – an increase of 35% (U.S. Department of Education, 2012). However, many of these students are not prepared for the demands of college course work. One study found that 60% of first year college students are underprepared for college and university course work as evidenced by the need to complete remedial or developmental courses, especially in English and math (Shulock, 2010). Unfortunately, the majority of these students never graduate (Shulock, 2010). Underprepared students are generally those whose achievement levels are in the low average ranges. These may include those with disabilities including learning disabilities, students who are not identified as disabled yet achieve at lower levels than required for college level courses, and those for whom English is a second language (Gresham, MacMillan, & Bocian, 1996; Goldschmidt & Ousey, 2011; Shaywitz, Fletcher, Holahan, & Shaywitz, 1992; Ysseldyke, Algozzine, & Shinn, 1982).

In order to address the needs of these developmental students and to improve retention rates, colleges and universities have implemented developmental or remedial courses – especially in math, reading and writing - for students who are not prepared for college level course work (Mireles, Offer, Ward, & Dochen, 2011). While such courses may be effective at addressing deficiencies of content, they provide little in the way of metacognitive strategies, which are often lacking in low achieving students (Hall &
Ponton, 2005; Mireles, et al. 2011). Stated differently, these remedial courses focus more on what to learn than how to learn important content effectively and efficiently.

Metacognition is monitoring one’s own understanding of content, planning, and budgeting time in order to commit those understandings to memory and use them in appropriate settings (Mastropieri & Scruggs, 2010). It can be described as thinking about one’s own thinking and results in an understanding of the actions and strategies that accompany mental processes (Flavell, 1979). Successful students organize, plan, and implement effective activities that enable them to learn and remember course material.

Nist, Simpson, Olejnik, and Mealey (1991) describe effective learners as those who take control of their learning by implementing strategies that allow them to manipulate, organize, and make sense of the material to be learned. The planning, predicting and organizing that allow students to do well on tests are metacognitive skills. Hughes (1985) demonstrated that these strategies and skills could be successfully taught to struggling learners who often have difficulty implementing these metacognitive skills. In such cases, explicit and direct instruction provides a sequenced, structured method of approaching learning tasks that guides such students through an overt strategy to plan and engage in their own learning (Archer & Hughes, 2011).

Strategy training provides students with the metacognitive tools to benefit from instruction. Rather than looking to something outside themselves (e.g. extended test time), strategy training empowers students to take responsibility for their own learning. Learning strategies are techniques and tools that enhance students’ abilities to learn and recall information (Hughes, Schumaker, Deshler, & Mercer, 1988). These strategies cover a wide range of content including learning new vocabulary, writing essays, taking
notes, completing math word problems and taking tests (Hughes, et al. 1988; Schumaker, 2009). High achieving students seem to develop and use these strategies on their own, but low achieving students often rely on less systematic and ineffective surface level learning like rote memorization, organization, and rehearsal (Hong, Sas, & Sas, 2006). When faced with a novel problem, ineffective learners often fail to generalize strategies to solve it (Schumaker, 2009). These deficits in strategy use often occur during tests where students are required to read and understand questions, recall key pieces of information, and respond in a manner that answers the questions.

Due to the importance of test results in both education and employment, much attention has been placed on the use of test taking strategies (Carter, Wehby, Hughes, Johnson, Plank, Barton-Atwood, & Lunsford, 2005; Cohen, 2006; Conderman & Pedersen, 2010; Hughes, et al. 1988). Test taking strategies are procedures that assist students to demonstrate their knowledge of course material by using test format cues (Cohen, 2006; Holzer, et al. 2009). Test taking strategies include specific tasks and procedures that enhance skills required to complete a wide variety of tests, quizzes and examinations (Hughes, et al. 1988, Haynes, 2011). More general strategies include looking over the entire test, allotting time for each item or section, and doing the easiest items first (Carter, et al. 2005; Conderman & Pedersen, 2010; ETS, 2014; Hong, et al. 2006; Hughes, 1985; Orth, 1995; Songlee, Miller, Tincani, Sileo, & Perkins, 2008; Steele, 2007). More specific strategies include: (a) eliminating answer choices known to be incorrect or absurd and choosing an answer from the remaining options (Carter, et al. 2005, Cohen, 2009; ETS, 2014; Holzer, 2007; Hong, et al. 2006; Hughes, 1985; Songlee, et al. 2008); (b) skipping difficult or perplexing items, marking them as skipped, and
returning to them after answering all other items (Carter, et al. 2005; Cohen, 2009; ETS, 2014; Holzer, 2007; Hong, et al. 2006; Hughes, 1985; Songlee, et al. 2008; Steele, 2007); and (e) paying particular attention to items containing absolute words (all, none, always, every, etc.), which are generally incorrect, and qualifying words (some, usually, many, frequently, etc.), which are frequently correct (Carter, et al. 2005; Conderman & Pedersen, 2010; Hong, et al. 2006; Hughes, 1985; Orth, 1995; Songlee, et al. 2008, Steele, 2007). These strategies create an orderly process whereby students can marshal what they know in a way that effectively addresses test requirements.

Test taking strategies have been recommended to improve test performance of diverse students (e.g. those with and without disabilities and those for whom English is a second language) in a wide variety of settings from middle school through post-secondary levels (Carter, et al., 2005: Cohen, 2009; Conderman & Pedersen, 2010; Goldschmidt & Ousey, 2011; Holzer, Madaus, Bray, & Kehle, 2009; Hong, et al., 2006; Hughes, et al., 1988; Hughes & Deshler, 1993; Hughes, Deshler, Ruhl, & Schumaker, 1993; Hughes & Schumaker, 1991). Previous studies with adolescent students, demonstrated some improvement in results of classroom science, social studies and math tests by students who had learned a test taking strategy (Carter, et al., 2005; Hughes & Deshler, 1993; Hughes & Schumaker, 1991). Additionally, students who were described as low achieving (Holzer, Madaus, Bray, & Kehle, 2009; Hong, et al. 2006; Hughes, et al. 1988) and/or students with high-incidence/mild disabilities (Carter, et al. 2005; Conderman & Pedersen, 2010; Hong, et al. 2006; Hughes et al.1988; Hughes, Deshler, Ruhl, & Schumaker, 1993) were found to perform poorly on tests because they did not employ effective learning and test taking strategies. Similarly, students for whom English
is a second language show similar deficits in strategy use (Cohen, 2009; Goldschmidt & Ousey, 2011). At the postsecondary level, students who were taught a test taking strategy reported lower levels of anxiety when taking classroom tests (Holzer, et al., 2009).

Given these potential deficits, researchers have examined methods to teach strategies to low-performing students across a variety of grades and ages. For example, several teams of researchers have demonstrated the positive effects of teaching middle school students with learning disabilities to use test taking strategies (Haynes, 2011; Hughes & Schumaker, 1991; Hughes, et al., 1988; Steele, 2007). Others have successfully taught test taking strategies to middle school students with emotional and behavioral disorders (Hughes & Deshler, 1993; Hughes, et al 1993) and high functioning (tested IQ between 110 and 140) students with autism spectrum disorders (Songlee, et al. 2008).

At the post-secondary level, researchers have also demonstrated the effectiveness of teaching test taking strategies to a wide array of students. Butler (1998) found test taking strategies an important part of supporting and encouraging self-regulated learning among college students with learning disabilities. Others compared the use of test taking strategies between high achieving and low achieving college students and found positive effects for the use of these strategies to improve test scores, reduce test anxiety and increase learning (Holzer, 2007; Holzer, et al. 2009; Orth, 1995; Wadsworth, Hunsmann, Duggan, & Pennington, 2007). Reinhardt and her colleagues (2012) successfully taught test taking strategies as part of a general study skills and tutoring program to a group of nursing students who had previously failed the required exit exam that would allow them to take the licensure exam. Cohen (2006) recommended teaching test taking strategies to
adult students preparing to take the Test of English as a Foreign Language prior to their attending colleges and universities in English-speaking countries. Additionally, Cohen (2009) and Salehi (2011) found that teaching test taking strategies to students is effective in improving students’ test scores without compromising test validity and, therefore, leads to greater success in school, post-secondary education, and employment.

One of the most widely researched strategies for effective test taking is The Test Taking Strategy (Hughes, et al. 1988). This strategy uses the mnemonic PIRATES to assist learners to successfully complete tests. The seven parts of the PIRATES strategy include:

1. **Prepare to succeed** is further described by the mnemonic PASS, i.e. Put your name and PIRATES on the test, Allot time and order to the sections of the test, Say an affirmation, and Start within two minutes.

2. **Inspect the instructions** includes the mnemonic RUN, i.e. Read instructions carefully, Underline what to do and where to respond, and Notice special requirements.

3. **Read, remember and reduce** directs students to read carefully, remember what they have studied, and reduce the number of answer choices.

4. **Answer or abandon** recommends that students answer the questions to which they know the answers and skip the items about which they are uncertain.

5. **Turn back** instructs students to go back to the items they skipped and to choose an answer for each based on the strategies in the next step.
6. **Estimate** what is likely to be the correct answer by employing the mnemonic ACE, i.e. Avoid absolutes (all, always, none, every, etc.), Choose the longest or most detailed response, and Eliminate similar answers.

7. **Survey**, the final step, directs students to look back over the entire test to make sure that all questions are answered. Students are cautioned to only change answers if they are certain their initial response was incorrect.

The strategy instructs students to employ PIRATES and to “PASS and RUN to ACE the test” (Hughes, et al. 1988).

The PIRATES test taking strategy has an extensive research base. Hughes (1988) and his colleagues found that training in the use of this strategy is particularly useful for low achieving students. Social studies and science classroom test scores of middle school students with learning disabilities (LD) and emotional and behavioral disabilities (EBD) improved by an average of 11 percentage points for students with EBD and 14 percentage points for students with LD (Hughes & Deshler, 1993; Hughes & Schumaker, 1991). High functioning students with autism spectrum disorders in secondary school were able to learn the test taking strategy and expressed satisfaction with the strategy and improved attitudes regarding tests (Songlee, et al., 2008). At the postsecondary level, students with learning disabilities reported lower test anxiety after learning *The Test Taking Strategy* (Holzer, 2007; Holzer et al. 2009). Schumaker (2009) suggested that this strategy is particularly effective for unsuccessful learners because these students fail to develop strategies for completing tests on their own, as do their more successful peers.
While researchers have demonstrated the effectiveness of *The Test Taking Strategy* using traditional paper-and-pencil tests, many courses, both face-to-face and online, now use computer assisted assessment (CAA), particularly in higher education settings (Holzer, 2007; Holzer, et al. 2009; Orth, 1995; Wadsworth, et al. 2007). At the postsecondary level, the number of students taking at least one course online has increased an average of 18.3% every year since 2002 and many traditional face-to-face courses include computer assisted components (Allen & Seaman, 2011). In 2002, 9.6% of all college and university students took at least one online course. By 2012, that level had increased to 32% of students taking at least one online course (Allen & Seaman, 2013). The increased use of online courses has resulted in an increase of CAA to support the assessment needs of those courses. Despite the increased use of CAA and the research demonstrating its effective use in a variety of settings, little research exists regarding effective test taking strategies for CAA (Clariana & Wallace, 2002).

**Purpose**

All tests are intended to provide students the opportunity to demonstrate mastery of course content without interference from extraneous variables such as proficiency with language, perceptual impairments, ability to navigate the test platform, etc. Test taking strategies have been shown to be effective in improving content-based test scores without compromising test integrity. The purpose of this study was to determine the effects of *The Test Taking Strategy* on the scores of college students using content-based assessments delivered in computer assisted format. To that end, two specific research questions were examined.
1) What are the effects of *The Test Taking Strategy* on student scores on computer assisted tests in a university introductory chemistry course?

2) What perceptions do students have regarding the efficacy of *The Test Taking Strategy* for online content-based assessments in a university introductory chemistry course?

**Method and Procedures**

**Participants**

Prior to recruiting participants, permission was obtained from University Office of Research Protections (IRB). Participants attended a small campus of a large state supported multi-campus university in the northeastern United States. All participants were enrolled in one of five sections of an introductory chemistry course having a total of 76 students. The researcher visited each section of the chemistry class, described the project, distributed flyers, and invited all students to participate. Initially, ten students volunteered to participate in the project, however only six participants, two females and four males, completed all parts of the project. The non-participating volunteers either requested access to the CD strategy training at the end of the semester when they did not have sufficient chemistry quizzes remaining to ascertain changes in chemistry quiz scores, said they did not have time to participate and dropped out of the study, or withdrew from the chemistry course.

All of the participants had majors in science, technology, engineering and math areas (i.e., STEM). Five of the six participants were directly admitted to the academic college and major of their choice. Of the six participants who volunteered and completed all parts of the study, four were first semester freshmen. The two participants who had
completed some college coursework prior to this study were Jenny, who was in her third semester, and Maria, who was a fourth semester student, but had only completed one prior semester at this university. Two of these participants, Andy and Peter, were enrolled in a developmental level writing class in their first semester. Three of the six participants were English language learners, and one participant reported the presence of a diagnosed disability, but did not request nor receive accommodations at this institution. For the semester in which the study was completed, all participants achieved final passing grades in the chemistry course ranging from A to C+.

Charlie, age 20, was a first semester student enrolled in earth and mineral sciences who had taken a year off between high school and college. Charlie’s only language was English.

Jenny, age 20, a third semester student majoring in science, was born outside of the United States, but attended all of her K-12 schooling in the United States. While English was not her home language, she was not literate in the home language. Jenny had completed 32 credits prior to participating in this study.

Maria, a food science major, age 22, entered the university as a fourth semester transfer student who had completed culinary school and worked as a chef for several years. Including the transferred credits, Maria had completed 50 credits prior to this study.

Andy, age 18, was a first semester student majoring in biology. He had lived in the United States for less than four years when he began his college studies. He was literate in his first language, which was spoken at home. In his first semester, Andy took
a developmental writing course to improve his familiarity and facility with written English.

Peter, age 19, was admitted in the general undergraduate studies major and had been in the United States for less than three years. He completed most of his K-12 schooling in his native country and was literate in that language which was used in his home. In his first semester, Peter took a developmental writing course to improve his familiarity and facility with written English.

Keith, age 18, was a first semester student enrolled in the computer science major and an honors student. English was Keith’s only language.

**Materials**

**Chemistry quizzes.** Strategies, in general, and test taking strategies, in particular, are intended to improve students’ performance on content-based assessments; therefore, using content-based assessments is a recommended method for gauging the effectiveness of these strategies (Holzer, 2007; Hughes, et al. 1988; Orth, 1995). For this study, student performance was documented by a series of multiple choice quizzes based on the chemistry curriculum. As part of the general education chemistry course, students were required to complete a minimum of ten timed quizzes. The quizzes were developed by the chemistry faculty to reflect the material taught in the course and were accessed online by students from home or school computers. Completion of the quizzes was intended to provide feedback to students regarding their progress in the chemistry course and to prepare students to take each of the three exams.
The content of each chemistry quiz was aligned with the course content and was made available by the instructor after s/he had taught the material in class. Questions for each quiz were randomly drawn from a bank of approximately two hundred items per quiz. Students were given the opportunity to take each quiz twice in order to achieve a sufficiently high score, but for this study only the first attempted quiz grade was recorded. Since the quizzes varied, the second attempted quiz did not contain the same questions as the first. Quiz grades were factored as part of each student’s final chemistry grade. Quizzes were delivered online, and each quiz was timed, with the maximum time varying from fifteen to thirty minutes. Students completed the quizzes independently. Because the chemistry quizzes contained varying numbers of questions – from as few as five items to as many as sixteen items – they were scored as a percentage of questions answered correctly. The time required to complete each quiz was also recorded.

**Test Taking Strategy CD.** This interactive hypermedia CD was modeled closely on the manual of *The Test Taking Strategy*. The CD presents instruction that allows students to individually progress through the training. It includes techniques that have been validated for teaching learning strategies such as descriptions and rationales for each step of the strategy, modeling of the use of each step, memorization activities, practice of each strategy and quizzes that check for understanding. (Lancaster, Lancaster, Schumaker, & Deshler, 2006). Each step of the PIRATES strategy was presented in its entirety with opportunity for participants to respond, review and practice via the interactive hypermedia CD. Participants individually completed the intervention training on the use of *The Test Taking Strategy* by viewing and interacting with *The Test Taking Strategy CD*. Three copies of the CD were housed on course reserve in the campus library. The date
and time were recorded when each student borrowed and returned the CD. The delivery of *The Test Taking Strategy* is discussed below in the Procedures section.

**Strategy-use assessments.** In order to determine proficiency on use of the test taking strategies, participants completed timed pre-intervention and post-intervention strategy use tests included in the published teaching materials for *The Test Taking Strategy* (Appendices A, B, C). These assessments are intended to determine the strategies participants use when taking tests. As suggested by Hughes et al. (1988), assessing whether students already apply these strategies before training is essential. Likewise, assessing the use of the strategies post-training is necessary to draw any conclusions regarding the effects of the strategy training. Hughes and colleagues (1988) offer a scoring rubric for the tests and define mastery at the 90% level. These paper-and-pencil tests consist of five sections designed to assess student strategy use across multiple choice, matching, essay, true/false, and fill-in-the-blank items. The multiple choice and true/false sections each have seven items, and the matching and fill-in-the-blank sections each have four items. Participants completed these strategy use tests under the supervision of the researcher who instructed them to complete these paper-and-pencil assessments in the same manner they would use for typical course tests.

**Verbal practice checklists.** To further assess mastery of the PIRATES strategy, at each post-intervention meeting with the researcher, participants verbally stated the parts of the strategy. Participants recited the steps of the PIRATES strategy in response to a prompt asking them to do so. Using the Verbal Practice Checklist (Appendix D) provided with the materials, the researcher recorded and scored the responses as the percent correct.
**Satisfaction survey.** At the final meeting with the researcher, participants completed a survey that assessed their satisfaction with the strategy. This Likert-type survey addressed each step in the PIRATES sequence (Appendix E). Participants indicated their agreement/disagreement on a scale from 1-5 ranging from strongly agree to strongly disagree. The survey included a section for participants to comment freely on their perceptions of the utility and value of learning *The Test Taking Strategy.*

**Procedures**

**Initial informational meeting.** Prior to the initial informational meeting, participants had completed approximately five weeks of the chemistry course and the accompanying online chemistry quizzes. At the initial meeting, each participant met with the researcher individually in an office on campus to sign an informed consent form and to complete a brief interview that included information about the project, responsibilities, contact information, course schedules, semester standing and major as well as the approximate time commitment to complete the study.

**Baseline.** During baseline, which included quizzes administered prior to and after the initial informational meeting, students received content instruction in face-to-face chemistry classes and were assigned to complete online content-based quizzes at specified intervals. Two experienced professors using the same content, materials, methods, and assessments taught the five sections of the chemistry course. After completing a topic in the chemistry class, the corresponding quiz was opened online and students had three to four days to individually complete each quiz at a location of their choice. The time allowed for each chemistry quiz ranged from 15 to 30 minutes. No make-up quizzes were available. Chemistry quiz scores, as well as time to complete each
quiz, were recorded on the online quiz delivery system. While students were able to complete each quiz twice, only the first attempted quiz score was counted for this study.

**Strategy training.** During the initial meeting with the researcher and prior to any training, each student completed *The Test Taking Strategy* pretest to determine his/her knowledge and use of the strategies. The researcher told each student that after completing 6-10 chemistry quizzes, s/he would be notified via e-mail to begin the strategy training using *The Test Taking Strategy* CD. As indicated by the staggered intervention delivery of a multiple-baseline design, participants individually completed the intervention training on the use of *The Test Taking Strategy* by viewing and interacting with *The Test Taking Strategy* CD at intervals varying from one to three weeks after the initial informational meeting. The date and time were recorded when each student borrowed and returned the CD. Participants completed the CD training in approximately three hours in either one or two sessions depending on the time constraints of the individual.

After completion of the training CD, students met again with the researcher and completed the posttest of strategy use. In addition, they were each asked to state the steps of the PIRATES test taking strategy. Their responses were recorded on the Verbal Practice Checklist provided with the teaching materials. Reminders to use the PIRATES strategy for all tests were sent via individual e-mails to all participants approximately four weeks after the posttest meeting.

Approximately four to eight weeks after the posttest meeting, students again met with the researcher and completed a maintenance test of strategy use and again verbally stated the steps of the PIRATES strategy. A second individual e-mail reminder to use the
PIRATES strategies for all tests was again sent to each participant prior to the final exam week.

At the completion of the semester and after the chemistry final exam, participants met with the researcher and again completed a maintenance test of strategy use, verbally stated the steps of the PIRATES strategy, and completed the student satisfaction survey.

**Experimental Design, Treatment Integrity, and Interobserver Agreement**

**Experimental Design.** A multiple probe design across subjects was used to evaluate the effects of The Test Taking Strategy training using the interactive hypermedia CD on students’ scores on computer assisted assessments in the introductory chemistry course. The multiple probe design is effective for this type of research because it demonstrates the effects of an intervention across subjects and does not require the intervention to be withdrawn (Gay, Mills & Airasian, 2009).

The sequence of the delivery of the intervention was initially set up a priori such that pairs of participants (Andy-Peter, Maria-Charlie, Keith-Jenny) were yoked with each successive pair completing one more quiz than the previous pair prior to receiving the intervention. This sequencing remained in place for two of the pairs (Andy-Peter, Maria-Charlie). However, participant scheduling constraints made it impossible to schedule the intervention training in sequence for Keith and Jenny. As a result, these two participants deviated from the a priori arrangement.

**Treatment integrity.** Treatment integrity is the extent to which the independent variable is applied precisely as planned and described in order to control for variations that would effect the ability to determine a correlation between the independent and dependent variables (Cooper, Heron, & Heward, 2007). Upon completion of six to ten
chemistry quizzes in baseline, participants were invited to complete the training/intervention by viewing and interacting with *The Test Taking Strategy CD*. In order to provide flexibility and to accommodate diverse student schedules, participants borrowed the CD from the library reserve desk and viewed the CD while in the library at times convenient for each of them. Each participant recorded the date and time s/he borrowed the CD and returned it to the library desk. Participants were not permitted to leave the library with the CD. The use of *The Test Taking Strategy CD* insured consistent and identical delivery of content. This flexibility, however, made it impossible for the researcher to directly observe participants as they viewed the CD. Treatment integrity was evaluated both indirectly and directly in three ways 1) the date and time of pick up and return of the CD were recorded, 2) a pre- and post-treatment qualitative interview indicated increased knowledge of the strategies, and 3) quantitative data via pre- and post- treatment strategy use assessments were recorded.

**Interobserver agreement.** To assess interobserver agreement, all strategy use tests - pretests, posttests, and maintenance tests - were scored by both the researcher and an independent trained professional. Simple agreement [(lower score/higher score) x 100%] yielded an agreement coefficient of 96%. Reliability data for the online chemistry content quizzes were not available because items for each test were randomly selected from a pool of items for each participant.

**Results**

The two research questions addressed in this study included the following: What are the effects of *The Test Taking Strategy* on student scores on computer assisted tests in a university introductory chemistry course? What perceptions do students have regarding
the efficacy of *The Test Taking Strategy* for online content-based assessments in a university introductory chemistry course?

**Chemistry quizzes and strategy use tests**

Participants completed a total of 13-14 online chemistry quizzes during the semester. Their scores on these quizzes were recorded in baseline before the strategy training intervention and after completion of the strategy training. They completed six to ten quizzes in baseline prior to instruction in *The Test Taking Strategy* – PIRATES. Table 1 presents the mean and range on the chemistry quizzes in baseline and after the training in the PIRATES strategies. Figure 1 presents the chemistry quiz scores for each participant. Participants also completed a strategy use pretest, a strategy use posttest and two strategy use maintenance tests (Tables 2 & 3).
Andy completed six online chemistry quizzes prior to strategy training. His pre-intervention average on chemistry quizzes was 92% (range 60% - 100%). After completing the PIRATES training CD, Andy completed seven additional chemistry quizzes with a mean score of 76% (range 50% - 100%). He completed the pretest of *The Test Taking Strategy* with a score of 56%. He completed a strategy use post-test two days
after completing training with a score of 83%. In addition, he completed two strategy-use maintenance tests, one approximately seven weeks after the post test with a score of 88% and the other approximately nine weeks after strategy training with a score of 86%. He verbally stated the PIRATES strategies at each post-intervention meeting with a mean of 88% (range 65% - 100%). His highest score on the strategy use tests was 88%, which did not reach the 90% mastery level, but he achieved 100% verbally stating the steps of PIRATES.

Charlie completed seven online chemistry quizzes prior to strategy training. His pre-intervention chemistry quiz average was 92% (range 80% - 92%). After completing the PIRATES training CD, Charlie completed six additional chemistry quizzes with a mean score of 66% (range 30% - 88%). He completed the pretest of *The Test Taking Strategy* with a score of 60%. He completed the strategy use post-test six days after completing the training with a score of 82%. In addition, he completed two strategy use maintenance tests one approximately six weeks after the post test with a score of 85%, and one approximately eight weeks after the post test with a score of 94%. He verbally stated the PIRATES strategies at each post-intervention meeting with an average of 80% (range 68% - 95%). He reached a high score of 94% on the strategy use tests and 95% on the verbal practice demonstrating his ability to state the steps of the strategy and apply the strategy.

Jenny completed ten online chemistry quizzes prior to strategy training. Her pre-intervention chemistry quiz average was 70% (range 20% - 100%). After completing the PIRATES training CD, Jenny completed four additional chemistry quizzes with a mean score of 85% (range 60% to 100%). She completed the pre-assessment of *The Test*
Taking Strategy with a score of 54%. She completed the strategy use post-test 13 days after completing the training with a score of 71%. In addition, she completed two strategy use maintenance tests, one approximately eight weeks after the post test with a score of 67% and one approximately ten weeks after training with a score of 79% She verbally stated the PIRATES strategies at each post-intervention meeting with an average of 71% (range 35% - 97%). Her highest score on the strategy use tests was 79%, which did not reach the 90% mastery level, but she achieved 97% verbally stating the steps of PIRATES.

Keith completed seven online chemistry quizzes prior to strategy training. His pre-intervention chemistry quiz average was 86% (range 60% - 100%). After completing the PIRATES training CD, Keith completed six additional chemistry quizzes with a mean score of 79% (range 40% - 100%). He completed the pretest of The Test Taking Strategy with a score of 68%. He completed the strategy use post-test ten days after training with a score of 86%. In addition, he completed two strategy use maintenance tests, one approximately seven weeks after the post-test with a score of 90% and one approximately two weeks later with a score of 83%. He verbally stated the PIRATES strategies at each post-intervention meeting with an average of 75% (range 47% - 94%). He reached 90% on the strategy use tests and 94% on the verbal practice demonstrating his ability to state the steps of the strategy and apply the strategy.

Maria completed seven online chemistry quizzes prior to strategy training. Her pre-intervention chemistry quiz average was 83% (range 40% - 100%). After completing the PIRATES training CD, Maria completed seven additional chemistry quizzes with a mean score of 77% (range 40% - to 100%). She completed the pretest of The Test Taking
Strategy with a score of 50%. She completed the strategy use post-test approximately four weeks after the training with a score of 67%. In addition, she completed one strategy use maintenance test approximately five weeks after the posttest with a score of 76%. She verbally stated the PIRATES strategies at one post-intervention meeting approximately four weeks after training with a score of 71%. Her highest score on the strategy use tests was 76%, which did not reach the 90% mastery level, and she only verbally stated the steps of PIRATES once with a score of 71%. While she did not achieve mastery of the strategy, she did improve in application of the strategy from pretest to maintenance.

Peter completed six pre-intervention online chemistry quizzes with an average score of 85% (range 70% - 100%). After completing the PIRATES training CD, Peter completed eight additional chemistry quizzes with a mean score of 76% (range 50% - 100%). He completed the pretest of The Test Taking Strategy with a score of 44%. He completed a strategy use post-test two days after completing training with a score of 72%. In addition, he completed two strategy-use maintenance tests, one approximately seven weeks after the post test with a score of 82% and the other approximately nine weeks after strategy training with a score of 81%. He verbally stated the PIRATES strategies at each post-intervention meeting with an average of 80% (range 70% - 88%). His highest score on the strategy use tests was 82%, and he achieved 88% when verbally stating the steps of PIRATES. While his scores on these assessments of strategy improved he did not achieve mastery on either the written tests or the verbal practices.

Social Validity

At the end of the semester, participants completed a 15-item Likert-type satisfaction survey by indicating their level of agreement with statements about learning
The Test Taking Strategy (Appendix E). Results indicated strong agreement with items related to efficacy of the PIRATES test taking strategy and use of the strategy (Table 4). Responses ranged from strongly agree to strongly disagree. All participants agreed that the PIRATES strategy was useful with a mean ranking of 4.0. They further indicated that they had learned something new from The Test Taking Strategy instruction with a mean score of 4.6 (range 4-5). All participants also agreed that learning these strategies increased their confidence when taking tests by giving this item a mean score of 4.2 (range 4-5). Participants accorded a mean score of 4.2 (range 3-5) to the item regarding generalization of The Test Taking Strategy to other courses and tests. The participants indicated agreement with the item regarding the utility of the Inspect the Instructions step of PIRATES with a mean score of 4.3 (range 3-5). They also found the Read, Remember, Reduce step of PIRATES useful with a mean score of 4.0 (range 3-5). The lowest ranked items on the satisfaction survey were items related to abandoning items and returning to them later having mean scores of 2.7 (range 1-5) and 3.3 (range 1-5) respectively. Three of the participants, Charlie, Jenny and Keith, noted that it was impossible to go back to skipped items or to change responses on these chemistry quizzes. Five of the six participants commented that some of the strategies are not possible for online tests. For example, Charlie pointed out that it is impossible to underline instructions online. However, Peter said he now reads instructions more carefully. Maria and Jenny found allotting time useful, but both commented that on some of these online chemistry quizzes, the time they had to complete the task was not clearly evident.
Discussion

The primary purpose of this research was to determine whether learning the PIRATES test taking strategy would improve scores on computer assisted chemistry quizzes of postsecondary students. Prior research indicated that implementation of the PIRATES test taking strategies improved the scores of middle and high school students (Carter, et al. 2005; Hughes & Deshler, 1993; Hughes, et al. 1993; Hughes and Schumaker, 1991; Songlee, et al. 2008). Similarly, others have demonstrated that implementing *The Test Taking Strategy* led to greater success on tests, improved learning and lowered test anxiety for college and university students taking paper-and-pencil tests (Holzer, 2007; Holzer, et al. 2009; Orth, 1995). Moving this line of research one step further, Wadsworth and her colleagues (2007) demonstrated that general learning strategies improved the test scores of post-secondary students taking a developmental level online mathematics course.

In the current study, it was hypothesized that learning and applying the strategy would likewise positively impact online chemistry quiz grades of university students. As shown in Figure 1 and participant mean quiz scores across baseline and intervention, *The Test Taking Strategy* increased scores for only one participant. The lack of positive results for the other five participants may be due to a number of factors including ceiling effects, treatment fidelity, the use of authentic content-based assessments, the online platform, and the characteristics of these self-selected participants. Given that the findings of the current study only partially replicate those found elsewhere, the next section presents possible explanations as to why these discrepancies exist. More specifically, treatment fidelity, use of authentic settings and assessment, the online testing
platform, and characteristics of these participants, including self-selection are further examined.

**Treatment Fidelity**

One potential explanation for the observed findings is that participants did not receive the intervention as planned. Treatment fidelity is an issue with any evaluation of interventions. It is critical that all participants receive identical treatment and that those treatments are implemented as planned (Ihme et al. 2009). The researcher did not administer the Test Taking Strategy CD self-training program in person, and therefore cannot directly confirm that each participant viewed the entire CD and paid sufficient attention to it. To better control for variations in treatment delivery in the present study, the researcher used a three-phase approach. First, the researcher administered all post-treatment strategy use assessments to ensure objective assessment of learned strategy skills. Second, each student verbally described the steps of the PIRATES strategy to the researcher after training. Their responses were written on the Verbal Practice Checklists. Finally, each participant recorded the date and time s/he borrowed and returned the Test Taking Strategy CD from the library reserve desk. All participants demonstrated increased use of and ability to state the steps of the strategy. However, their level of proficiency was below that suggested by Hughes (1988). It is possible that while the participants had enough knowledge of the strategy to state steps, their level of proficiency was not at a level that permitted fluent use. Also, as in other cognitive strategy training research, it is unknown if the participants actually applied their knowledge of the strategy during the chemistry quizzes.
Use of Authentic Assessment

The use of actual chemistry quizzes presents challenges to controlling potential extraneous and confounding variables that affect student performance on any type of assessment. What is gained in applicability by using authentic assessments often results in loss of some experimental control and ability to demonstrate functional relations between independent and dependent variables (Belfiore, Lee, Scheeler, & Klein, 2002). Like many introductory college courses, this course was designed to include basic material that may have been introduced in previous secondary courses and advances to more complex content that is likely new to students. It is likely that the content of the course and subsequent quizzes became more difficult across time. The mean chemistry quiz scores of the participants were at or above the class average for twelve of the fifteen chemistry quizzes (see Table 5). Although increases in quiz scores were not consistently observed, it is possible that the Test Taking Strategy may have helped reduce precipitous declines in test scores that may have taken place as the level of difficulty of quizzes increased. This question should be evaluated by future research.

Use of Online Tests

The online testing platform in this course presented several challenges regarding applying the PIRATES strategy. The developers of PIRATES emphasize careful adherence to all of the steps of the strategy, but this was not possible in the online format (Hughes, et al. 1988). For example, it was impossible to write the acronym PIRATES at the top of the first page. Likewise, participants could not underline or circle significant parts of the test instructions. Additionally, on these tests, it was not possible to cross out answer choices that were known to be incorrect, thereby reducing the number of choices.
Similarly, participants could not return to previously answered items, and they could not skip questions and return to them later. The final step of the PIRATES strategy instructs students to survey the entire test before submitting it to be sure all questions were answered properly, but the delivery mode of these tests did not permit this action. The inability to implement all of the PIRATES strategies may have impacted test scores in some unknown way. Perhaps future researchers could examine ways to modify the strategy to accommodate online administration of exams.

**Student Characteristics**

Some of the characteristics of the participants in this study may have also affected the results. Success on the earlier quizzes may have left little room for improvement (i.e. ceiling effect). Hughes and his colleagues (1988) suggest that application of the PIRATES strategies can increase test scores by ten points, but several of these participants already were achieving at levels that would not have permitted significant increases. Five of the six participants had grades on the chemistry quizzes prior to strategy training that ranged from 83% to 92%. This may indicate greater familiarity with the chemistry content, especially that contained in the earlier quizzes. Additionally, with the exception of the study by Holzer and colleagues (2009), all of the research on PIRATES has involved middle school and high school rather than postsecondary students. Furthermore, the participants self-selected to participate in this study, which may have indicated greater motivation and attention to any and all factors that might improve grades. Certainly, knowledge of course content and preparation for tests generally leads to higher test scores. These participants may have prepared adequately for these
chemistry quizzes. Existing high quiz scores, prior knowledge of course content and student motivation may have diminished the effects of applying the PIRATES strategy.

A secondary purpose of this study was to ascertain student perceptions regarding the efficacy of these test taking strategies. All of these participants found value in learning these strategies. Participants indicated that they were generally positive about learning *The Test Taking Strategy* despite the limitations caused by the computer assisted delivery platform. They were also able to articulate the characteristics of online testing that made faithful application of the strategies impossible. Additionally, participants reported that they had generalized these strategies to other tests, including traditional paper-and-pencil tests, in other courses. Finally, these participants clearly indicated that having a defined sequence of steps to implement when taking tests improved their confidence. The participants’ responses to the satisfaction survey point to adjustments that might be made in both the PIRATES strategy and the design of computer assisted tests that would permit test achievement that better indicates student learning rather than attributes of design and delivery mode.

**Limitations**

This study has several limitations that should be considered in future research. While delivery of the content of the intervention via *The Test Taking Strategy CD* provided convenience and flexibility for participants, this flexibility made it impossible to ensure treatment fidelity. To accommodate participants’ individual schedules, it was impossible for the researcher to directly observe participants interacting with the CD training. The participants may have paid little to no attention to the CD. Future research might use other delivery modes that record student responses to training activities.
incorporated in the lessons. In addition, all of the previous research on the effect of the PIRATES strategy has been conducted using paper-and-pencil tests. Applying those findings to online tests may affect results. Furthermore, the students who volunteered to participate in this study were all motivated to do so and had academic backgrounds that qualified them for admission to the university. Additionally, transferring findings from research with middle school and high school students to college students presents some variables that may affect outcomes. For example, in this study, students self-selected to participate whereas in the studies involving middle school and high school students generally the researchers, teachers or parents chose the participants. Furthermore, the laws that apply to postsecondary education focus on accommodation rather than the support services and modifications that apply in K-12 education settings (Holzer, 2000).

As described by Bracht and Glass (1968), generalization of these results may be limited by pretest sensitization. A possibility exists that the initial assessment of strategy use may have increased students’ awareness of test taking strategies. In order to minimize this possibility, the pretests were all given at the initial interview. Test taking strategy instruction occurred approximately a week after the pretest. Another cause of the differences in scores on the chemistry quizzes may be due to outside factors such as the amount of time students spent preparing for each quiz, attendance in class and recitation sessions, and pressures unrelated to the course or the PIRATES strategy. Finally, research in authentic classes with authentic tests presents extraneous variables that cannot be controlled, which may cause less robust results.

This study provides a starting point for future research into test taking strategies that may be applied to computer assisted tests. Future research might focus on
modifications to computerized testing to allow students to implement the PIRATES strategies more faithfully. For example, structuring computer assisted tests so students can review the entire test before starting and upon completion and disclosing the amount of available time would allow students to manage time and order of completion as indicated in the Prepare to Succeed step of the PIRATES strategy. It would also allow students to review tests to make certain all items were answered properly prior to submission as suggested in the Survey step of PIRATES. Designing computer assisted tests to allow students to either highlight or strike through answer choices thought to be incorrect would allow students to employ the Estimate step of the PIRATES strategy. Finally, tests should be delivered in a way that allows students to skip questions and return to them later as suggested in the Turn Back phase of the PIRATES strategy.

**Summary**

Academic success is frequently based on test scores, but many students perform poorly on tests because they do not use effective test taking strategies (Hughes, 1985). Participants in this study learned the PIRATES test taking strategy, but this did not improve their scores on the online content-based tests they completed in their chemistry course. Participants reported that they appreciated the value of learning the PIRATES test taking strategy and had used the strategies for tests in other courses, but they pointed out several aspects of these online chemistry quizzes that prevented optimal use of the strategies. These findings suggest possible avenues for future research. Rather than a failing of the PIRATES strategy, this study highlights potential modifications in online testing that may make the strategy more accessible in the future.
Literature Review

Test taking, the process whereby students communicate what they know to the instructor, is one of the oldest and most impactful challenges in education. While much is known about the effects of test taking strategies to improve students’ content-based test scores for traditional paper-and-pencil tests, little is known about effective test taking strategies for computer assisted tests. The purpose of this study was to determine the effects of The Test Taking Strategy on the scores of college students using content-based assessments delivered in computer assisted format. To that end, this review of the literature examines 1) effective general study strategies for at-risk and underachieving students, 2) specific test taking strategies, and 3) computer assisted assessments.

Many students suggest that they do poorly on tests because they do not have sufficient time to complete the tests. Indeed, the most requested accommodation at the post-secondary level is extended test time (Cohen, Gregg, & Deng, 2005; Lesaux, Pearson, & Siegel, 2006; Ofiesh, Hughes, & Scott, 2004). However, a review of the literature related to the effectiveness of extra test time revealed inconsistent results. Five researchers concluded that extra test time either did not have a positive effect or equally benefitted both students with and without disabilities (DiRosa, 2007; Halla, 1988; Hill, 1984; Runyan, 1991b; Weaver, 1993). In contrast five researchers found that extra test time improved the performance of students with disabilities while having no impact on the performance of students without disabilities (Alster, 1997; Holzer, 2007; Jarvis, 1997; Ofiesh, 1997; Runyan, 1991a).
Instead of extra test time, several researchers have indicated that the use of test taking strategies may be a key element to improving the test scores of underachieving students and indeed permits students to demonstrate mastery of course content without compromising validity (Bicak, 2013; Holzer, 2007; Holzer, Madaus, Bray, & Kehle, 2009; Hong, Sas, & Sas, 2006; Hughes & Schumaker, 1991; Salehi, 2011). Instead of extra test time, implementing test-taking strategies puts the control of learning in the hands of students.

Metacognition is monitoring one’s own understanding of content, planning, and budgeting time in order to commit those understandings to memory and use them in appropriate settings (Mastropieri & Scruggs, 2010). It can be described as thinking about one’s own thinking and results in an understanding of the actions and strategies that accompany mental processes (Flavell, 1979). Successful students organize, plan, and implement effective activities that enable them to learn and remember course material (Cohen, 1988; Hughes, 1985; Kitsantas 2002). Nist, Simpson, Olejnik, and Mealey (1991) describe effective learners as those who take control of their learning by implementing strategies that allow them to manipulate, organize, and make sense of the material to be learned. In contrast, students who struggle with learning tasks do not use these metacognitive skills (Hughes, 1985). While successful students monitor their thinking about tasks and develop methods to solve problems, unsuccessful students do not do so (Cohen, 1988). Successful students create and apply strategies to accomplish tasks, but less successful students often do not (Hughes, 1985).

Since many underachieving students fail to apply the strategies that seem to benefit more successful learners, it is necessary to explicitly teach these strategies to
these students (Cohen, 1988; Hughes, 1985). The planning, predicting and organizing
that allow students to do well on tests are metacognitive skills. Hughes (1985)
demonstrated that these strategies and skills could be successfully taught to struggling
learners who often have difficulty implementing these metacognitive skills. In such cases,
explicit and direct instruction of test taking strategies is essential as it provides a
sequenced, structured method of approaching tests that guides such students through an
overt strategy to plan and engage in their own success (Archer & Hughes, 2011).

Strategy training provides students with the metacognitive tools to benefit from
instruction. Rather than looking to something outside themselves (e.g. extended test
time), strategy training empowers students to take responsibility for their own learning.
Learning strategies are techniques and tools that enhance students’ abilities to learn and
recall information (Hughes, Schumaker, Deshler, & Mercer, 1988). These strategies
cover a wide range of content including learning new vocabulary, writing essays, taking
notes, completing math word problems and taking tests (Hughes, et al.1988; Schumaker,
2009). High achieving students seem to develop and use these strategies on their own,
but low achieving students often rely on less systematic and ineffective surface level
learning like rote memorization, organization, and rehearsal (Cohen, 1988; Hong, Sas, &
Sas, 2006, Hughes, 1985). When faced with a novel problem, ineffective learners often
fail to generalize strategies to solve it (Cohen, 1988; Schumaker, 2009). These deficits in
strategy use often occur during tests where students are required to read and understand
questions, recall key pieces of information, and respond in a manner that answers the
question.
The Test Taking Strategy provides students with a systematic, structured method for effectively completing tests. It provides direct, explicit instruction to assist underachieving students to develop the strategies used by successful students. Successful students develop a routine for taking tests that includes strategies while taking tests. These include scanning the entire test before beginning, determining the time requirements and difficulty levels for each portion of the test, and recalling information from class and texts. For example, successful students scan tests before they begin answering questions and assess the time requirements and difficulty level of each segment of tests, whereas unsuccessful students do not generally do this (Hughes, 2001). Higher achieving students read instructions carefully, whereas less successful students often do not pay attention to instructions (Hughes, 2001). Effective test takers tend to read all of the options in multiple choice tests, eliminate choices they know are incorrect, answer all questions, recognize cues to correct answers within tests, and implement recall strategies (Hughes, 2001). Unsuccessful students do not use a systematic approach to test taking, often approach tests with negative thoughts of failure, and fail to answer some questions on tests (Hughes, 2001). Direct explicit instruction in the use of The Test Taking Strategy provides students with the tools necessary to effectively complete tests.

This review of the literature seeks to present issues related to improving test scores of post-secondary students. It is therefore organized to address three sections: 1) effective study strategies for students with and without disabilities, 2) specific test taking strategies and 3) computer assisted assessment.
Effective Study Strategies

A variety of study strategy programs that require students to identify the task, determine appropriate techniques for accomplishing the task, and monitor and evaluate progress have been shown to be effective in several postsecondary settings involving at-risk/underachieving students. In subjects including geography, history, political science, psychology, math and nursing, students learned specific strategies designed to improve test scores in both face-to-face and computer assisted formats. For example, Mireles and her colleagues (2011) combined face-to-face study skills instruction with computer assisted instruction to university students enrolled in a developmental level math course.

All of these studies involved metacognitive skills such as monitoring one’s own learning, selecting and applying effective strategies, predicting time requirements, assessing difficulty levels, tracking success and completion rates and developing a plan to best learn course content (Bicak, 2013). In addition, these studies, completed at community colleges and universities, involved students described as at-risk, underachieving, unsuccessful, developmental, and learning disabled. In each case, students first identified or selected tasks to improve, then analyzed the task requirements, next identified goals and learning activities, and finally evaluated their progress. In every study, students demonstrated marked improvement on course evaluations (Butler, 1998; Nist & Simpson, 1989; Cukras, 2006; Mireles, et al. 2011; Reinhardt, Keller, Summers, & Schultz, 2012). For instance, Reinhardt and her colleagues (2012) developed a mandatory remediation program that included content instruction along with test taking strategy
instruction for 13 university nursing students who had repeatedly failed the Health Education Systems, Inc. (HESI) exam that is routinely used as an exit exam in nursing programs. After completing the program, all students passed the HESI exam, and 12 of them successfully completed the National Council Licensure Examination for Registered Nurses (NCLEX-RN). In addition, students demonstrated that they were able to transfer these strategies across contexts and tasks (Butler, 1998; Reinhardt, et al. 2012). They also improved their ability to monitor their own learning and predict how they would perform on other assessments (Cukras, 2006; Nist & Simpson, 1989). These skills can be employed to improve test scores by applying specific test taking strategies.

**Test Taking Strategies**

Due to the importance of test results in both education and employment, much attention has been placed on test taking strategies (Carter, Wehby, Hughes, Johnson, Plank, Barton-Arwood, & Lunsford, 2005; ETS, 2014; Holzer, 2007; Holzer, et al. 2009; Hong, et al. 2006; Hughes & Deshler, 1993; Hughes, Deshler, Ruhl & Schumaker, 1993; Hughes & Schumaker, 1991; Hughes, Schumaker, Deshler, & Mercer, 1998; Schumaker, 2009; Songlee, Miller, Tincani, Sileo, & Perkins, 2008). Lack of test taking strategies was cited among the reasons students earn poor test grades (Bicak, 2013). A wide variety of test taking strategies have been developed for students at all levels and in all subject areas. Test taking strategies include specific tasks and procedures that are used to improve ability to take tests successfully. These often include carefully reading the directions, skipping items that are particularly difficult, eliminating obviously incorrect alternatives, paying
attention to wording especially the use of absolute (all, always, never, etc.) and qualifying (some, most, often etc.) words (Carter, et al. 2005; Conderman & Pedersen, 2010; ETS, 2014; Haynes, 2011; Hughes, et al. 1988; Songlee, et al. 2008; Steele, 2007).

Researchers have documented a marked difference in the use of test taking strategies between low and high achieving students. High achieving students use test taking strategies more frequently than low achieving students (Carter, et al, 2005; Hong, et al. 2006). Hong and colleagues (2006) found that high achieving math students more frequently assessed the difficulty level of problems and sequenced the items for completion on tests, i.e. more difficult items first or easier items first, than did low achieving students. High achieving students also checked their answers more than low achieving students. Pointing out that students with high incidence disabilities (learning disability, mild mental retardation and language impairment) fare poorly on academic tests compared to their peers without disabilities, Carter and his colleagues (2005) found significant improvement in math test scores after students received test taking strategy training. In addition, The Educational Testing Services suggests test taking strategies, such as budgeting one’s time, skipping difficult questions and returning to them later, answering every question, reducing the number of answer choices by eliminating those known to be incorrect, and looking for obvious errors, to students taking the Graduate Record Exam (ETS, 2014).

One of the most widely researched strategies for effective test taking is The Test Taking Strategy, part of the Learning Strategies Curriculum from the University
of Kansas Center for Research on Learning (Hughes, et al. 1988). Hughes (1988) and colleagues found that training in the use of this strategy is particularly useful for low achieving students. Other researchers have demonstrated the effectiveness of *The Test Taking Strategy* for students with disabilities including learning disabilities (Carter, et al. 2005; Holzer, 2007; Holzer et al. 2009; Hughes and Schumaker, 1991), emotional and behavioral disorders (Hughes & Deshler, 1993; Hughes, et al. 1993), mild autism spectrum disorders (Songlee, et al. 2008) and high incidence disabilities, defined as learning disabilities, mild intellectual impairment, and language impairment (Carter, et al. 2005). Schumaker (2009) recommended that this strategy is particularly effective for unsuccessful learners because these students are less likely to develop strategies for completing tests on their own, as do their more accomplished peers. *The Test Taking Strategy*, which uses the mnemonic PIRATES, involves seven steps for successfully completing tests - Prepare to succeed, Inspect the Instructions, Read, remember and reduce, Answer or abandon, Turn back, Estimate, and Survey (Hughes, et al. 1988).

Although several researchers have examined general study strategies at the post-secondary level (Butler, 1998; Cukras, 2006; Goldschmidt & Ousey, 2011; Mireles, et al. 2011; Nist & Simpson, 1989; Reinhardt, et al. 2012; Westberry; 1994), and many have shown the positive impact of test taking strategy instruction at the middle and high school levels (Carter, et al. 2005; Hong, et al. 2006; Salend, 2011; Hughes, 1985; Hughes & Deshler, 1993; Hughes & Schumaker, 1991; Hughes, et al. 1988; Lancaster, Lancaster, Schumaker & Deshler, 2006; Lancaster, Schumaker, Lancaster & Deshler, 2009; Songlee, et al. 2008), only one study examined the effect
of The Test Taking Strategy, known as PIRATES, with post-secondary students (Holzer, 2007). Holzer (2007) demonstrated positive results for use of the test taking strategies and higher scores on tests derived from the Graduate Record Exam (GRE) General Test for four of the five participants. In addition, four out of five participants indicated decreased levels of test anxiety after learning the strategy.

The developers of the PIRATES test taking strategy indicate that it is best taught to small groups (Hughes, et al. 1988). However, Holzer (2007) found it to be equally effective when taught face-to-face to individual students. Likewise, Lancaster and colleagues (2006) found the interactive hypermedia CD presented an effective method of teaching the strategy to individual students.

In response to the perceived need to teach test taking strategies in advance of high stakes testing in upper elementary and secondary schools while at the same time maximizing class time for content instruction, Lancaster, et al. (2009) developed a computerized program intended for middle school and secondary students that permits students to learn all of the strategies of the original Test Taking Strategy. The instructional methods – detailed description, modeling, verbal practice, and controlled practice with immediate feedback – were included in the computerized version. Lancaster and colleagues (2006 & 2009) found no significant difference in strategy learning, strategy use, think aloud scores, and satisfaction between students in experimental (computerized) and control (face-to-face) groups. All of the prior research of the effects of teaching The Test Taking Strategy have been completed using paper-and-pencil tests, yet computer assisted testing has increased at all levels.
**Computer Assisted Assessment**

The increase in the use of computer assisted instruction (CAI) has led to the increased need for computer assisted assessment (CAA) techniques (McCracken, Cho, Sharif, Wilson & Miller, 2012). CAA is used in diverse subject areas and in a wide variety of test formats including formative and summative assessments and tapping into both lower and higher order cognitive skills. The use of CAA is common among pre-service teacher education programs (Cassady & Gridley, 2005). Students in a graduate level teacher education program indicated that they not only preferred CAA, but they planned to incorporate it in their instructional practice (Boyles, 2011). Ackerman and Goldsmith (2011) compared the experience of Israeli undergraduate humanities and social studies students who completed tests either on-paper or on-screen with mixed results. McCracken and colleagues (2012) reported positive outcomes from CAA using case studies and virtual patients in a dental hygiene program to demonstrate authentic learning. CAA has also been used successfully as part of an MBA program to deliver a required comprehensive exam that is intended to demonstrate students’ ability to apply learning from the initial part of this program (Khare & Lam, 2008). CAA has also been used in a variety of science and mathematics courses (Bunce, VandenPlas & Havanki, 2006; Holschuh, 2000; Ibabe & Jauregizar, 2009; Mireles, et al. 2011; Wadsworth, Husman, Duggan & Pennington, 2007). This widespread use of CAI and CAA has provided a number of advantages for students, instructors and administrators.

The increased use of CAA has been fueled by the advantages these technologies offer to deliver and assess instruction. Both students and instructors
appreciate the benefits of CAA including freedom from traditional constraints of
time and place which permits access to a broader student base including students
from around the world and non-traditional students, ease of providing timely
feedback to students by programming feedback into the assessment, ability to
provide diverse assessment types including authentic assessment, and additional
class time and face-to-face interaction between students and instructors. (Cassady &
Gridley, 2005; Hall, Hughes & Filbert, 2000; Ibare & Jauregizar, 2009; Khare & Lam,
2008; Lancaster et al. 2009; McCracken et al. 2012; Peat & Franklin, 2002; Sim,
Holifield & Brown, 2004). A variety of assessment types can be offered via CAA
including summative and formative assessment as well as assessments of
knowledge, comprehension, application, analysis, synthesis and evaluation (Khare &
Lam, 2008; McCracken et al. 2012). Because computer assisted tests are scheduled
outside of the usual class time, more time is afforded for instruction and for
interaction with the instructor (Cassady & Gridley, 2005; Lancaster, et al. 2009; Peat
& Franklin, 2002). In addition, the ease of grading online tests allows the instructor
more time to develop course activities (Ibabe & Jauregizar, 2009; Sim, et al. 2004).

The advantages presented by use of CAI and CAA have led to some
reservations as well. These concerns come from administrators, faculty and
students. Chief academic officers at U.S. colleges and universities indicate that
online courses require more discipline on the part of students and greater time and
effort for faculty. They further cite lower retention rates for online courses (Allen &
Seaman, 2013). As the use of computer technologies has increased, concerns have
been expressed about several features including the validity of such tests and the

Some researchers have found that mode of delivery does not change the outcome of tests (Sim, et al. 2004) and that CAA can be an effective method of formative assessment leading to improved learning (Clariana, 1997). In terms of exam delivery preference, undergraduate social studies and humanities students expressed a preference for reading tests on paper, however test scores were the same whether the test was delivered on screen or on paper (Ackerman & Goldsmith, 2011). Similarly, Ihme and colleagues (2009) found no difference between online and offline versions of ability tests administered to undergraduate students.

Other researchers have found that test mode indeed does affect the outcome of exams. For example, in a beginning business/computer fundamentals course for undergraduate students, Clariana and Wallace (2002) found that computer-based delivery of a content area test resulted in higher test scores in comparison to the same test delivered on paper. Others have pointed out that while the literacy skills required for reading on screen and on paper are the same, the way in which they must be read differs (Richardson, Robnolt & Rhodes, 2010). Because of this difference, Cassady & Gridley (2005) suggest training students, especially those with a history of failure, to use effective strategies and techniques for online tests. While most of the skills required for successful completion of tests are the same regardless
of the test mode, students completing online exams have reported difficulty related to navigating the test online, issues related to saving and submitting responses, and lack of typing facility which causes slower response time (Thomas, Price, Paine & Richards, 2002).

Security and academic integrity also present problems related to online tests. Test developers have suggested several methods intended to counter cheating on exams. These range from strict time deadlines, random delivery of test questions, randomization of answer choices, and use of essay and application questions that require higher order thinking skills and extended responses (Thomas, et al. 2002). In addition, some have expressed uneasiness about protecting student information and prevention of interference in the transmission of student responses and tampering with students' grades (Sim, et al. 2004).

This review of the literature examined effective study and test taking strategies especially as they can be applied to computer assisted instruction and assessment at the post-secondary level. The study strategies that are most effective are those in which students actively planned and monitored their own learning. The programs reviewed here all involved metacognitive skills such as setting goals based on the material to be learned, identifying strategies and tasks to meet those goals, implementing those plans and monitoring progress toward achieving the goals. They all required that students use some method of determining what they needed to know, how they would learn it, and evaluating their own progress toward the goals.
In addition to general study strategies, educators recommend the use of specific test taking strategies particularly for underachieving students. These strategies frequently include budgeting one’s time, skipping questions that seem difficult, providing an answer for all questions, attending to vocabulary and grammar – particularly absolutes and qualifiers - and eliminating obviously incorrect choices. While there is some question regarding whether these strategies invalidate test results, Salehi (2011) found that was not the case.

The Test Taking Strategy, commonly known as PIRATES, which includes the type of tasks commonly recommended for test taking, has proved to be effective for a variety of students with disabilities and at grade levels from middle school through high school. The PIRATES strategy has also been adapted to a computer assisted method of delivery via an interactive CD. However, only one study examined the use of the PIRATES strategy by post-secondary students.

The widespread use of computer technology to deliver instruction and assess learning has led to an increase in computer assisted assessment. Most colleges and universities in the United States now offer some computer assisted learning activities. Computer assisted assessment is used in a wide variety of subject areas including, math, science, foreign language, humanities and social sciences. CAA has also been successfully used for formative and summative assessment, objective and subjective assessments, as well as assessment of the full range of cognitive skills – knowledge, comprehension, application, analysis, synthesis, and evaluation. Several advantages of computer assisted assessment include the freedom to complete exams and tests at a time and place that is convenient for students. This permits a
wider range of students to participate in post-secondary courses by removing the constraints of time and place. In addition, CAA can be programmed to provide immediate feedback allowing students to refine their ongoing study strategies. Likewise, it often makes grading exams easier for the instructors since correct answers and feedback can be programmed so that scores are calculated and additional data (beginning and ending times, item analysis, etc.) is reported. Finally, the advantage of completing tests outside of normal class times permits more time for instruction and interaction between students and instructors.

While these advantages are compelling, there are also concerns regarding CAA. These often involve questions about the validity of such exams. Some researchers have concluded that test mode does not impact the validity of these exams while others have identified differences between on paper and on screen tests (Ackerman & Goldsmith, 2011; Clariana, 1997; Clariana & Wallace, 2002; Ihme, et al. 2009; Richardson, et al. 2010; Sim, et al. 2004). Security and prevention of cheating have also been cited as issues related to computer assisted assessment. Several methods, including password protection and encryption, to secure test information have been recommended (Sim, et al. 2004). Likewise, developers suggest methods to deter academic dishonesty. These may include randomizing questions and response choices, strict time limits, and greater use of constructed response assessments (Thomas, et al. 2002).

This review of the literature suggests that students can improve learning and test scores by applying effective strategies. However, it also indicates that students at the post-secondary level – especially those who are underprepared for the rigors
of college courses - often rely on ineffective strategies rather than applying strategies that impact their grades. In addition, due to advancement in accessibility of technology, computer assisted assessment has become more widespread. This review further suggests that computer assisted assessment can be used to demonstrate student mastery of course content. However, research on effective test taking strategies for computer assisted assessments has not been explored.

The increase in students who are underprepared for college and who must therefore complete developmental level course work along with the increase in the use of computer assisted assessments led to the current research. While test taking strategy instruction has been shown to be effective at increasing test scores of students taking traditional paper-and-pencil tests, little research has been conducted to determine whether these test taking strategies are effective for computer assisted assessments. This research study was an initial step to determine the effects of learning *The Test Taking Strategy* on computer assisted test scores of students in an introductory university chemistry course. Two specific research questions were examined to begin to understand the effects of test taking strategy use on computer assisted assessments.

1) What are the effects of *The Test Taking Strategy* on student scores on computer assisted tests in a university introductory chemistry course?

2) What perceptions do students have regarding the efficacy of *The Test Taking Strategy* for online content-based assessments in a university introductory chemistry course?
References


Richardson, J. S., Robnolt, V. J. & Rhodes, J. A. (2010). A history of study skills; Not hot, but not forgotten. *Reading Improvement, 47*(2), 111-123.


Steele, M. M. (2007). Helping middle school students with learning disabilities pass the


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<th>Intervention M</th>
<th>Intervention Range</th>
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<td>30-88</td>
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<td>20-100</td>
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Table 1

Mean and Range for Chemistry Quiz Scores
Table 2

Mean and Range for Strategy Use Tests and Verbal Checks

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<th></th>
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*Scores for Strategy Use Tests and Verbal Checks*

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*Chemistry Quiz Scores*

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</table>
APPENDIX A

PRETEST

Section I. Put a circle around the letter next to the best choice.

1. Working conditions during the early paleonic period were
   a. always fair
   b. never fair
   c. usually fair
   d. never dangerous

2. A score in football is called
   a. a homerun
   b. a bingo
   c. a dunk
   d. a touchdown

3. The average length of the four-toed cremuth is
   a. one foot
   b. twelve inches
   c. three feet
   d. eighteen inches

4. The Argualan colonists fought the King because of
   a. land rights
   b. cruelty
   c. water rights
   d. unfair taxation of export products from their homeland

5. The Battle of Ares took place because of
   a. religion
   b. greed
   c. famine
   d. a and b

6. Which of the following is a tree that does not stay green all year?
   a. fir
   b. juniper
   c. oak
   d. pine

7. Couches and chairs are both
   a. used only inside the home
   b. easy to read
   c. very fast
   d. furniture for sitting

Section II. Match the term on the left with the word(s) on the right that means the same thing. Write the letter in the blank beside the number of the appropriate term.

   ______ 1. apple
   ______ 2. sethol
   ______ 3. train
   ______ 4. money

   a. small growth
   b. used to purchase goods
   c. red or green fruit
   d. form of transportation

PRETEST

Section III. Write a short essay below on the following topic: My Three Favorite Foods.

Section IV. Write “True” or “False” in the blank.

[True/False] 1. Low levels of monoplasm in the blood always indicate endemic infection.

[True/False] 2. January is a month in the spring.

[True/False] 3. Many of the countries in the lower peninsula region depend on irrigation for crop watering.

[True/False] 4. If sendium is added to phosphorous, it never fails to ignite.

[True/False] 5. Most cancerous cells contain a form of skotema.

[True/False] 6. The first day of the work week is Monday.

[True/False] 7. The greedy ARES always stockpiled their gold.

Section V. Write a word in the blank that makes the sentence correct.

1. The last centrium used in a laser was the __________.

2. Apples, oranges, and pears are all __________.

3. Reading, writing, and arithmetic are subjects taught in __________.

4. A variety of __________ are used in extol extraction.

APPENDIX B

POSTTEST 1

SECTION I. Put a circle around the letter next to the best choice.

1. During the neoplenic period, the weather was
   a. often unpredictable   c. always below freezing
   b. never cold           d. mostly temperate

2. In school, most students sit at
   a. a lounge chair       c. a desk
   b. a couch             d. a rocking chair

3. The early migratory settlers made most of their tools and utensils from
   a. wood                 c. stone
   b. iron                 d. trees

4. The author Aclostedes was imprisoned because he
   a. stole bread          c. was a rebel
   b. wrote a treatise on the economic   d. wrote without permission
      exploitation of the masses

5. All of the following animals is a common household pet except
   a. the dog              c. the cat
   b. the tiger           d. the parakeet

6. Two, four, and six are
   a. numbers             c. animals
   b. letters             d. even numbers

7. The Clotides made medicine out of
   a. potatoes            c. cat tails
   b. banana root         d. tranks

Section II. Write a word or letter in the blank that makes the sentence correct.

1. The letters a, e, ______o, and u are vowels.

2. In the United States, the elected leader of the country is called the
   ____________.

3. The black-tailed caribou usually mate during ____________.

4. In the formula, x-y, the Z stands for ____________.

Section III. In this space, write a short essay on the following topic: My three favorite recording artists.

Section IV. Circle the number next to true statements.

1. Smoking is hazardous to your health.
2. Ingestion of haylides is always fatal.
3. Many of the halicynthe hybrids are grown in Iowa.
4. All of the immigrants from eastern Carpathia went to the United States.
5. Only females get straight As in school.
6. The letters c, b, m, and n are all vowels.
7. The only fuel used in grills is charcoal.

Section V. Match the term on the left with the word(s) on the right that means the same thing. Write the letter in the blank beside the number of the appropriate term.

_____ 1. trank  a. a small vegetable used for medicine
_____ 2. bed  b. writing implement
_____ 3. pen  c. eating utensil
_____ 4. fork  d. sleeping furniture

APPENDIX C

CONTROLLED PRACTICE TEST #1

Section 1. In the blank provided, write the letter of the most appropriate response.

_____ 1. Christmas occurs in
   a. Spring            c. Winter
   b. Summer            d. Fall

_____ 2. Television and radio are
   a. used by animals   c. means of communication
   b. used by fish      d. means of visual communication

_____ 3. Architects stopped using argronium in construction because
   a. it was too expensive    c. it wasn’t strong enough
   b. it was too heavy        d. it weighed too much

_____ 4. Legs and arms are part of the body. Which of the following is not?
   a. branch               c. twig
   b. nose                 d. a and c

_____ 5. The most common use of bason solutions is
   a. fermentation         c. as a cleaning compound
   b. as the organic catalyst  d. pigmentation
       found in oil solvents

_____ 6. When the preservative monoglate is added to food
   a. the food rarely spoils  c. the food never changes color
   b. the food always changes color  d. the food never spoils

_____ 7. The Cadmos family fought with the Justins because they wanted
   a. their money back       c. their food back
   b. their land back        d. their clothes back

Section II. Write the letter in the blank next to the appropriate word.

_____ 1. boy             a. a young cow
_____ 2. minite           b. a young gerbil
_____ 3. calf             c. a young male
_____ 4. girl             d. a young female

Section III. Briefly describe three of your favorite television shows in the space below.

Section IV. Place a + in front of each sentence that is true. Place a - in front of each sentence that is false.

______ 1. Prisoners in Paduan prisons are usually allowed to use the library facilities.
______ 2. Only farmers who grew alfalfa made money during the drought of 1956.
______ 3. Radio thermography is seldom used to diagnose apranorma.
______ 4. It is important to learn to read.
______ 5. All doctors agree that aspirin is the best way to treat phrenitis.
______ 6. The Justins, who were land thieves, always got away with their thefts.
______ 7. Christmas always falls on December 24th.

Section V. Fill in the blanks with the appropriate word.

1. Red, green and blue are __________.

2. Ketomite is made up mainly of __________.

3. If sendium is added to phosphorous, it forms __________.

4. Two plus two equals __________.

## APPENDIX D

### TEST-TAKING STRATEGY

**VERBAL PRACTICE CHECKLIST**

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<thead>
<tr>
<th>Explaining Strategy In Own Words</th>
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<tr>
<td>Prepare to succeed</td>
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</tr>
</tbody>
</table>

| **Naming Substeps** |   |   |   |   |   |   |
| Put name and PIRATES on the test |   |   |   |   |   |   |
| Allot time and order |   |   |   |   |   |   |
| Say affirmation |   |   |   |   |   |   |
| Start within 2 minutes |   |   |   |   |   |   |

| Read |   |   |   |   |   |   |
| Underline “what” & “where” |   |   |   |   |   |   |
| Note special requirements |   |   |   |   |   |   |

| **Naming “ACE” Guessing Techniques** |   |   |   |   |   |   |
| Avoid absolutes |   |   |   |   |   |   |
| Choose the longest choice |   |   |   |   |   |   |
| Eliminate similar choices |   |   |   |   |   |   |

| **Questions** |   |   |   |   |   |   |
| 1. |   |   |   |   |   |   |
| 2. |   |   |   |   |   |   |
| 3. |   |   |   |   |   |   |
| **Total** |   |   |   |   |   |   |
| **Percentage correct** |   |   |   |   |   |   |
| **Date** |   |   |   |   |   |   |

APPENDIX E

STUDENT SATISFACTION SURVEY

Indicate your response by circling the number to indicate your level of agreement/disagreement with each statement. Please note that 1 indicates strong disagreement while 5 indicates strong agreement.

5 = strongly agree
4 = agree
3 = neither agree nor disagree
2 = disagree
1 = strongly disagree

1. The Test Taking Strategy was useful to me.  
   5 4 3 2 1
   SA A N D SD

2. I liked using the CD to learn The Test Taking Strategy.  
   5 4 3 2 1
   SA A N D SD

3. The Test Taking Strategy CD was difficult to use.  
   5 4 3 2 1
   SA A N D SD

4. I learned something new from The Test Taking Strategy instruction.  
   5 4 3 2 1
   SA A N D SD

5. Since participating in this study, I have used the strategies I learned from The Test Taking Strategy CD on other tests.  
   5 4 3 2 1
   SA A N D SD

6. I already used the strategies presented on The Test Taking Strategy CD before I participated in this study.  
   5 4 3 2 1
   SA A N D SD

7. Learning and using the strategies from The Test Taking Strategy CD made me feel more confident about taking tests.  
   5 4 3 2 1
   SA A N D SD

8. Learning and using the strategies from The Test Taking Strategy CD improved my test grades.  
   5 4 3 2 1
   SA A N D SD

9. Preparing to succeed helped me do well on on-line tests.  
   5 4 3 2 1
   SA A N D SD
10. Inspecting the instructions is a useful strategy for on-line tests.  5  4  3  2  1
SA  A  N  D  SD

11. The read, remember, reduce step of The Test Taking Strategy is effective for on-line tests.  5  4  3  2  1
SA  A  N  D  SD

12. The answer or abandon strategy was useful on-line tests.  5  4  3  2  1
SA  A  N  D  SD

13. Turning back to the items I skipped helped me do better on on-line tests.  5  4  3  2  1
SA  A  N  D  SD

14. Estimating answers by avoiding absolutes, choosing the longest or most complete answer, and eliminating similar choices helps me do well on on-line tests.  5  4  3  2  1
SA  A  N  D  SD

15. Surveying to be sure I’ve answered all items and only switching answers I am sure are incorrect are effective strategies for on-line tests.  5  4  3  2  1
SA  A  N  D  SD
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Education

2008 - present  Ph.D. candidate in Special Education, The Pennsylvania State University, University Park, PA

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