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AN INVESTIGATION OF THE EFFECTS OF USING DIGITAL FLASH
CARDS TO INCREASE BIOLOGY VOCABULARY KNOWLEDGE IN HIGH
SCHOOL STUDENTS WITH LEARNING DISABILITIES

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the College of Education
at the University of Central Florida
Orlando, Florida

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2011

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ABSTRACT

The field of science education, specifically biology, is becoming more challenging due to richer and more rigorous content demands. Along with new demands is the emergence of National Common Core Standards and End of Course Exams. Despite these changes, one factor remains consistent: As content knowledge increases, language demands also increase. For students with learning disabilities (LD), specifically those with language-based disabilities, the increasing vocabulary demand can lead to failure due not to a lack of understanding biology but the vocabulary associated with the content. In an attempt to impact high school students with learning disabilities' success in biology, a vocabulary intervention was investigated. Research suggests as more and more content is compressed into science courses, teachers are looking toward technology to assist with vocabulary mastery. The current research study examined the effects of a digital flash card intervention, Study Stack, versus a paper flash card intervention in biology for students with LD by measuring students' word knowledge and overall biology course achievement. Findings from repeated measures ANOVA showed a statistically significant increase on both the vocabulary assessment as well as the course grades in biology over time. However, the test of between effects considering card type yielded no differential change on vocabulary assessment and course grades in biology. Based on qualitative data, students interviewed liked the tool and found it to be helpful in learning biology terminology.

ACKNOWLEDGMENTS

The most eloquent words to honor those who inspire me to continually improve myself and the condition of teacher preparation in special education are those of James Baldwin, “There is never time in the future in which we will work out our salvation. The challenge is in the moment; the time is always now”. My sincere “thank you” goes to my committee: Dr. Lisa Dieker, Dr. Rebecca Hines, Dr. Wilfred Wienke and Dr. Michael Hynes. This committee has delivered my salvation in ways that I cannot count. Dr. Rebecca Hines and Dr. Lisa Dieker held a tag-team role in shaping me as an expert of special education and an expert of me. Dually, they have helped shape me and have supported me in learning the biggest lesson of my life; despite a learning disability I am valuable and strong. This is a lesson that my father, Peter Grillo, attempted to teach me years ago, but then I was too stubborn to learn. As liberal and idealistic as I may be, and though we might not always see eye to eye on policy, Kimberly Grillo-Mills deserves a huge thank you for not giving up on me and for trying to teach me to read, though the process was painful at best! Daily my husband, Duce Smith, and our son, Carver James Smith, provide me the will and desire to continually try to improve the human fabric. My greatest thanks go to Mrs. Finley, my high school biology teacher, who helped me to believe my dreams were worth dreaming.

“Not everything that is faced can be changed, but nothing can be changed until it is faced” (Baldwin in Dictionary of Proverbs, 2005).

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LIST OF ACRONYMS/ ABBREVIATIONS

AIPM	Automatic Information Processing Model
AYP	Annual Yearly Progress
CAI	Computer-Assisted-Instruction
CBA	Curriculum-Based-Assessment
df	Degrees of Freedom
ECS	Education Commission of the States
ECE	End of Course Exams
ESEA	Elementary and Secondary Education Act
IEP	Individualized Education Program
IRB	Institutional Review Board
LD	Learning Disabilities
LS	Learning Strategies
M	Mean
NAEP	National Assessment of Educational Progress
NCLB	No Child Left Behind
NLTS2	National Longitudinal Transition Study 2
PISA	Program for International Student Assessment
SD	Standard Deviation
SLD	Specific Learning Disability
TIMSS	Trends in International Mathematics and Science Study

CHAPTER 1:

INTRODUCTION

An essential element of science instruction is content literacy. In order to improve literacy specific to science, vocabulary must be addressed. Jitendra, Edwards, Sacks, and Jacobson (2004) specifically point out, “because learning vocabulary during independent reading is very inefficient for students with reading difficulties, vocabulary and word learning skills must be taught” (p. 300). The goal of this research study was to investigate the impact of a technology-based vocabulary intervention by measuring its effect on learning essentials, high frequency terms and course performance in high school biology.

Statement of the Problem

The Nation’s Report Card: Science 2005 reported only 29% of all eighth grade students performed at the proficient level in science (Grigg, Lauko, & Brockway, 2006). According to the National Assessment of Educational Progress (NAEP) data, from 1996 to 2005 students have shown a decline in 12th grade science performance with scores steadily declining from 150 to 147, where a score of 147-177 is basic, 178-209 is proficient and 210 and above is advanced.

While science achievement is continually a national concern, the national and international testing data (NAEP, TIMSS, and PISA) fail to show the disparity between students with learning disabilities (LD) and their typically developing peers. Testing often indicates that secondary students identified with LD are producing outcomes below their non-disabled peers in science (Wagner, Newman, Cameto, Levine, & Garza, 2006). The National Longitudinal Transition Study 2 (NLTS2) research summary reports, “... more than three-quarters of those with disabilities score below the mean across subtests” (Wagner et al., 2006, p. 26). Looking more closely at the NLTS2 findings, these data reveal:

Across the subtests, between 14 percent [science subtest] and 27 percent of youth with disabilities have scores in this [below the mean or score of 70] range. Compared with the 2 percent of youth in the general population who score below 70, 27 percent of youth with disabilities do so on the mathematics calculation subtest, as do 24 percent on the passage comprehension subtest, 15 percent on the applied problems and social studies subtests, 14 percent on the science subtest, and 13 percent on the synonyms/antonyms subtest ($p < .001$ for all comparisons) (Wagner et al., 2006, p. 15).

Furthermore, according to course grades, approximately 50-60 percent of students with disabilities have reported below average or failing grades in course work that is required for a standard diploma in grades 9-12 (Cawley, Kahn, & Tedesco, 1989). The NLTS2 findings show 8% of all students with disabilities in the general education curriculum have grades comprised mostly of D's and F's with 26% of all students with disabilities in the general education setting failing to meet teacher expectations (Wagner et al., 2006). Researchers speculate that students with LD lack the ability to "keep up" in biology courses because of the rigorous language (Groves, 1995; Taraban, Box, Myers, Pollard, & Bowen, 2007; Wandersee, 1985; Yager, 1983).

Many students with LD have language-based processing deficits impeding content specific language growth. Since science classes have a great deal of content specific language, secondary students with LD are at a disadvantage, especially in language-based science classes (Pamar, Deluca, & Janczak, 1994). Scruggs and Mastropieri (2007) conclude struggling readers in secondary settings basically lack critical science vocabulary knowledge.

Purpose of the Study

Based upon the need for critical vocabulary development in biology for students with LD, the purpose of this research study was to examine the effect of a technology-based vocabulary

intervention. The effect of this tool on students' ability to gain biology content specific word knowledge was assessed. The researcher presented high school students with LD a technology-based flash card system called Study Stack™ where students independently manipulated targeted Biology 1 vocabulary to determine if word learning increased.

Theoretical Framework

As stated, students who lack grade level reading ability and language processing skills often struggle in traditional language-based biology content area instruction (Pamar, Deluca, & Janczak, 1994). The theoretical concept that drove this research was the Automatic Information Processing Model (AIPM; LaBerge & Samuels, 1974). Attempting to fluidly read and process content specific vocabulary requires high levels of student processing, hampering both comprehension and new word knowledge construction for students with language deficits. The AIPM explains that, while students are engaged in a literacy task, they can only fully focus on one aspect of the task at a time. Students move from part-word recognition to whole-word recognition before moving to comprehension (LaBerge & Samuels, 1974). The AIPM clarifies that independent sounds construct words and that those words, until familiar, cannot become automatic at any discernible speed. Therefore, comprehension is prevented even at the word level for those who are not already fluent.

In high school biology, the AIPM directly relates to content literacy instruction because the language of learning science needs to become automatic before reaching higher levels of learning. The AIPM explains that spaces in the working memory of the brain cannot process the next level of literacy, which is comprehension, until the mind is freed from other tasks (LaBerge & Samuels, 1974). Therefore, this study attempted to free students from the cognitive load of

Biology 1 vocabulary by teaching the most essential, high frequency words using a web-based vocabulary study tool called Study Stack™.

Research Questions

The questions addressed in this research are as follows:

- (1) Is there a difference in vocabulary assessment scores between students with LD learning content Biology 1 terms using a digital flash card program compared to paper flash cards?
- (2) Is there a difference in Biology 1 course grades between students with LD learning content biology terms after using a digital flash card program compared to paper flash cards?

Research Design

The research methodology used for this study was a quasi-experimental design with analysis of variance for both word learning and Biology 1 course grades (Cook & Campbell, 1979). This study focused on the use of Study Stack™, vocabulary instructional technology tool, versus paper flash card users as the intervention. The investigation central on determining the effect of digital flash cards on a foundational word learning Curriculum-Based Measure and Biology 1 course grades of students with LD. Twenty five volunteers from an intact sample of students with LD enrolled in a Learning Strategies class were recruited to participate. As required by the Institutional Review Board (IRB) process, signed consent forms were first collected from guardians, and then the assent process was explained to teenage volunteers (Appendix A). The research was conducted over a 45 day instructional period, ending with interviews conducted to examine the impact of the study qualitatively, to better understand student perceptions of the overall research experience.

Significance of the Study

Beginning in the 2007-2008 school year, No Child Left Behind (NCLB, 2002) mandated all states and districts must test the achievement of not only reading and mathematics, but also science content at each level (elementary, middle, and high) of school. Although NCLB does not specify the intensity of the testing, 24 states have “high stakes” testing for all students in core subject areas (Johnson, Thurlow, & Stout, 2007).

The Education Commission of the States (Dounay, 2007) gathered data on standard diploma requirements of all 54 states and territories: 19 out of 54 states and territories require successful completion of one unit of either a life science or biological science to earn a standard diploma (see Appendix B). In the 35 states that allow individual governance to determine science course work in high school, a common practice is to offer general biology to all students seeking a standard diploma. The NAEP data indicates 32% of students scoring below the basic range report biology as the highest successfully completed science course versus 1% of students scoring in the advanced range also reporting biology as being the highest successfully completed science course. To aid students in meeting graduation requirements, biology must be successfully completed. This completion includes successfully passing a standardized measure in many states.

Standardized assessments drive the curriculum in science courses (Eylon & Linn, 1988) and are comprised of many terms faced by students with disabilities. All students, including those with LD, must meet the same accountability mandates as their non-disabled peers (Yovanoff, Duesbery, Alonzo, & Tindal, 2005). Although some researchers frown upon direct instruction in science literacy (Brown & Ryoo, 2008), students with language-based disabilities may not increase proficiency on standardized measures without specific content instruction in

vocabulary. Providing instruction to meet the demands of the current assessment reality makes sense for students with disabilities who also have reading and language processing deficits. Therefore, students with LD, whose primary deficit is language-based, must be taught content biology terms to increase the likelihood of passing high-stakes science exams typically required to earn a standard diploma.

Assumptions

Four major assumptions guided this research. The first assumption is that the selected participants required vocabulary supports for increasing biological literacy. This assumption was based on the limited available research suggesting students with language-based LD require content language learning supports. The second assumption was that the participating teacher would follow the prescription of the intervention schedule. Third, homogeneity of variance between the two conditions groups was assumed, so results could be interpreted. The final assumption and perhaps the most important assumption, was the novelty of the technology as opposed to paper flash cards, would engage the students in this study.

Definitions

Automatic Information Processing Model (AIPM):

The AIPM explains that while students are engaged in a literacy task, they can only fully focus on one aspect of the task at a time. Students move from part-word recognition to whole-word recognition before moving to comprehension (LaBerge & Samuels, 1974).

Biology 1:

Biology 1 is a course that is required for graduation requirements in the state of Florida (FLDOE, 2010). The course code for Biology 1 is 2000310 in the Florida Department of Education course registry (see www.floridastandards.org/Courses/PublicPreviewCourse69.aspx?ct=1).

Curriculum-based-assessment (CBA):

CBA is based on the assumption that teachers should measure what is being taught at a given point in the curriculum by counting or measuring the progress being made on the content engaged (Witt, Elliot, Daly, Gresham, & Kramer, 1998).

Delayed Post-test OR Test of Maintenance:

A delayed post-test is a data point taken after the intervention is withdrawn.

Intervention Phase:

An intervention phase is a time period when the independent variable is applied to the experimental group.

Learning Strategies (LS):

Learning Strategies is a course frequently offered to students with disabilities (FLDOE, 2010).

The purpose LS is to support students with disabilities in gaining independence in both the educational settings and community settings. The course code for LS is 7963080 (see [www.floridastandards.org/Courses/PublicPreviewCourse408.aspx?ct=1&kw=Learning Strategies](http://www.floridastandards.org/Courses/PublicPreviewCourse408.aspx?ct=1&kw=Learning%20Strategies)).

Specific Learning Disability (SLD)/Learning Disability (LD):

In general, the term “specific learning disability” means a disorder in 1 or more of the basic psychological processes involved in understanding or in using language, spoken, or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations (IDEA, 2004).

Mnemonic Device:

Mnemonics devices are associative memory boosting techniques using what Levin (1983) called the three R’s principle, (a) recoding, (b) relating and (c) retrieving. The example provided uses

the word “dahlia” to demonstrate this model. “Dahlia”, a perhaps unfamiliar word, is recoded into a more familiar word like “doll”. This word is the keyword. The keyword is then related semantically to the vocabulary meaning of the unfamiliar word (in this case flower for dahlia) such as in the example “doll sniffing a flower”. The retrieval happens by following the line “dahlia” to “doll” to “doll sniffing a flower” (Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1987). For the purpose of this study a mnemonic booster is paired with each of the 48 targeted vocabulary words.

Post-test:

A post-test is a data point taken after the intervention phase of a research study.

Pre-Test:

A pre-test is a data point taken prior to the intervention phase of a research study.

Precision Teaching:

Precision Teaching (PT) is a type of mastery teaching of factual knowledge (Lindsley, 1990).

Typically, PT contains frequent short drills over time. Drills in PT are predictable and are contained in manageable small chunks of time. Using a Standard Celeration Chart students are able to self-monitor by charting each drills outcome. Typically, the Standard Celeration Chart contains the date along the x axis (bottom) and numbers on the x axis (left) and represents the number of correct responses completed each day of intervention. By self-monitoring and graphing correct responses students are able to visually see their growth of a targeted skill.

Precision Teaching has been noted as a motivator for struggling learners who routinely graph because they are able to see their educational growth visually.

Study Stack™:

A web-based platform for manipulating vocabulary, Study Stack™ is one type of digital flash card. Study Stack™ is free for anyone to use. Ready-made lists from individuals in the network exist or custom word lists can be created. For the purpose of this study, the lists were customized.

The Knowledge of Science:

The Knowledge of Science, defined by Chiappetta, Sethna, and Fillman (1991), explains science learning on the factual, foundational level, where there is a high cognitive load to recall information and accounts for how students gather new science information.

Title I school:

The term Title I school is defined by the Department of Education in the No Child Left Behind, Parents Guide (2003) as "...those schools that receive funds under Title I of the *Elementary and Secondary Education Act (ESEA): Improving the Academic Achievement of the Disadvantaged*. Title I supports programs to improve the academic achievement of children of low-income families" (p. 7).

Word Knowledge:

According to Beck and McKeown (1991) there is a word knowledge hierarchy. The continuum of word knowledge starts from not having any knowledge of a particular word, to having some knowledge of the word, to having absolute knowledge of the word (Beck & McKeown, 1991). Absolute word knowledge is represented by demonstrating reading comprehension when the word is encountered within text, being able to fluently use the term within writing and accurately using the term in spoken language (Beck & McKeown, 1991).

Word knowledge in the content areas is an emergent research area and one that is complex (Harmon, & Wood, 2008). Harmon and Wood use a biology content example to show the word knowledge continuum and its complexity “the average tenth grader is likely to have a deeper and more sophisticated understanding of the term *atom* compared to the knowledge of an average fourth grader, who still has a more simplistic understanding of the term” (p.1). In the fourth grade, students are not required to know about the bonding of elements based on the atoms’ valence electrons. However, in high school biology, students often are required to know more about how matter is transformed and what types of bonds are made during the transformation. Word knowledge for this research is considered foundational or on the factual recall level. According to Harmon, Hedrick, and Wood (2005) if complete word knowledge is required for content processing, teachers require “extensive time and effort to explain” (p. 266), word meaning and processes. Assuming science content terms are acquired using the word knowledge continuum as described by Beck and McKeown (1991), for the purposes of this study, word knowledge is defined as students acquiring some foundational word knowledge on the factual recall level.

CHAPTER 2:

REVIEW OF THE LITERATURE

Introduction

The purpose of this chapter is to provide an overview of the relevant literature related to students with LD increasing fluency of science vocabulary in biology. First, a historical perspective of students with LD situated in the general science education setting will be discussed. Next, the current outcomes for students with LD in high school science as well as barriers to this population's success are presented. Then the author presents a summary of critical research studies, which were primarily conducted in the 1980's through the 1990's, examining the importance of vocabulary acquisition for students with LD. Finally, the chapter concludes with how embedding critical vocabulary knowledge in technology could influence the current negative outcomes in secondary biology.

Historical Perspective of LD

The concept of identifying students with LD and benchmarking their progress is seen in the literature as far back as 1877 as documented in the Proceedings of the Association of Medical Officers of American Institutions for Idiotic and Feeble-minded Persons. Professionals questioned if the solution to problematic learning could be assigning a label to the condition and testing students who present difficulties in learning:

Finally, do we not need some effective form of description of our cases [struggling students]; some generally recognized tests of physical and mental condition that will show, in the first place, the starting-point in the pupil's career, to which reference can be made from time to time to test their absolute or relative progress? Do we not need some mile-posts along in the educational path to the same end? This would be, in one sense, a

form of classification, namely, in relation to the growth and development of the pupils.
(p. 34).

Though the problem of identifying and providing specific instruction for students with learning difficulties was considered as early as the 19th century, the term “Learning Disability” was not defined until Dr. Samuel Kirk published his text *Educating Exceptional Children* in 1962, Learning Disability is defined as a “retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, spelling, writing, or arithmetic resulting from a possible cerebral dysfunction and not from mental retardation, sensory deprivation, or cultural or instructional factors” (p. 263). Diagnosticians and medical professionals believed in first creating a definition allowing them to identify a person with LD and, once identified, the student could then be supported in his or her learning. Thus, Kirk reiterates in 1962 what professionals were speaking about in 1877:

With such a scheme before us we should be able not only to define the position of our pupils, mentally, at the very start, but also to keep track of their progress in the intellectual way. Thus could we not only satisfy ourselves, but also record, for the benefit of others, the result of our labors (p. 35).

Legislation

This idea of first identifying students with LD and then supporting them was embraced as a national need in the late 1960’s with the passing of the Children with Specific LD Act of 1969 (P.L. 91-230). This landmark legislation led to 44 states receiving funding from the Bureau of Education for the Handicapped to establish Child Service Demonstration Centers (Kirk & Elkins, 1975). Although states receiving funds to develop practices for diagnosing, prescribing, and supporting learners identified with LD, had to follow the federal definition of Specific Learning

Disability (SLD), each state interpreted the statute differently. For example, Kirk and Elkins (1975) took the opportunity to analyze the types of children served under the term LD in 1975, they surveyed 21 projects and summarized basic characteristics from a student sample of 3000 that received services at Child Demonstration Centers and concluded the following:

(1) most of the children were in the lower elementary grades, (2) the sex ratio was three boys to one girl, (3) of the children enrolled, approximately two-thirds were rated as having reading problems, (4) the median educational retardation was one grade below the mental age reading expectancy, (5) the retardation in reading and spelling was one-half grade more than the retardation in arithmetic, (6) the distribution of IQs contained a larger proportion with below average ability than is found in the general population of children, and (7) the resource room was the most commonly used method for delivery of service. In general children with learning disabilities are defined at most Child Service Demonstration Centers to be those who are below grade in educational achievement especially in reading (p.31).

From these beginnings came the definitive modern federal definition of SLD, as presented in the revisions to and reauthorization of the Individuals with Disabilities Education Act (IDEA) of 2004:

(A) In general, the term “specific learning disability” means a disorder in 1 or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations.

(B) Disorders included

Such term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.

(C) Disorders not included

Such term does not include a learning problem that is primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage (20 U.S.C. §1401 [30]).

The criteria for determining the eligibility of services provided under IDEA further defined what a student with LD looks like:

A team may determine that a child has a specific learning disability if--

(1) The child does not achieve commensurate with his or her age and ability levels in one or more of the areas listed in paragraph (a)(2) of this section, if provided with learning experiences appropriate for the child's age and ability levels; and

(2) The team finds that a child has a severe discrepancy between achievement and intellectual ability in one or more of the following areas--

(i) oral expression

(ii) listening comprehension

(iii) written expression

(iv) basic reading skill

(v) reading fluency skills

(vi) reading comprehension

(vii) mathematics calculation

(viii) mathematics problem solving [34 CFR 300.309 (a)(1)]

The first piece of legislation to have a major impact not defining (S)LD, but learning for students with disabilities in the inclusive classroom, was the Elementary and Secondary Education Act of 1965 renamed in 2001 the No Child Left Behind Act (NCLB). Written as an attempt to streamline several educational initiatives, the goal of NCLB is summarized by the Department of Education as follows: “The major focus of No Child Left Behind (NCLB) 2001 (also known as ESEA) is to provide all children with a fair, equal, and significant opportunity to obtain a high-quality education.” (Department of Education Section 101: Statement of Purpose, 2010). The NCLB Act set performance standards for all students and was the first time professionals would be held responsible for the performance standards of all students. Now, teachers were required to show educational gains with annual yearly progress (AYP) reports to include students with special needs.

Although streamlining quality education where all students make progress is a focus of NCLB, IDEA provides students with disabilities increased protection by requiring an annual individual education plan (IEP). Under IDEA legislation, not only do students with disabilities have an annual review of educational progress, but the legislation requires students with an IEP are ensured of the following, (a) education by highly qualified teachers, (b) inclusion in statewide testing and (c) interventions that are research-based (Yell, Katsiyannas, & Shiner, 2000). As a result of IDEA (2004), classroom teachers are now expected to make instructional changes when students are reported as making insufficient progress toward IEP goals.

Outcomes

It might be assumed there are standard procedures in place to supplement instruction for students with LD in science. Unfortunately, this statement is not true. Although science instruction is legislatively mandated to provide research-based interventions to increase learning

gains for students with LD, the research currently does not include evidence that diagnostic-prescriptive instruction is occurring in the general education content setting for students with LD in high school (Swanson, 1999). In fact, when conducting an electronic search in ERIC, EBSCOhost and PsychInfo data bases with search terms “diagnostic-prescriptive instruction” AND “science instruction” AND “Learning disability”, only one document was produced (Johnson, 1981). A lack of evidence that high school science teachers of students with LD use prescriptive teaching methods to support science achievement is important to note in the literature.

General Outcomes for Students with LD

Exacerbating the difficulty of providing the necessary instruction to help students with LD succeed are the sheer numbers of students with LD being served. Approximately 2.5 million students identified as SLD are currently being served and supported in public schools in programs funded by IDEA (28th Annual Report to Congress, 2008). Thus, Weintraub (2005) suggests the goal of providing educational services for this underserved population has been met. However, the veneer of the services provided for students with LD begins to wear when exit data are examined. According to the National Center of Education Statistics, 236,135 students were served under the LD classification (2008). Nationally, 61.6% of those students received a standard diploma while 12.5% earned a certificate of attendance and 25.1% dropped out (Planty, et al., 2008). Looking specifically at the State of Florida data, Planty, et al. (2008) reported there were 22,964 students with LD who exited high school. Only 41.5% did so with a standard diploma which is 20% less than the national average. Approximately 30% of students with LD earned a certificate of attendance and 30% dropped out. These data suggests, that although many

students with LD are served, teachers still struggle to support this population to achieve minimum level of competency to earn a standard high school diploma.

Outcomes in Science Achievement for Students with LD

Despite overall struggles in learning outcomes for students with LD, science achievement especially continues to be a national concern. Although data collected on science performance fail to show the disparity between students with LD and their non-disabled peers, the NLTS2 research summary reports, "... more than three-quarters of those with disabilities score below the mean across subtests" (p. 26). Looking more closely at science NLTS2 data, Wagner et al. (2006) point out 14% of students with disabilities score below the mean while only two percent of their non-disabled peers score below the mean.

According to course grades of high school students with disabilities approximately 50-60% reported below average or failing in grades 9-12 (Cawley, Kahn, & Tedesco, 1989). The NLTS2 study reported 8% of all students with disabilities in the general education curriculum have grades of mostly D's and F's with 26% of students failing to meet teachers' expectations in general education settings (Wagner et al., 2006). Espin and Deno (1995) point out that a strong predictor of course task success and overall achievement in content areas is vocabulary knowledge.

Barriers to Learning Biology for Students with LD

Researchers speculate students with LD lack the ability to "keep up" in biology courses because of the rigorous language (Groves, 1995; Taraban, Box, Myers, Pollard, & Bowen, 2007; Wandersee, 1985; Yager, 1983). Students in high school who are struggling readers lack science vocabulary knowledge (Scruggs & Mastropieri, 2007) and many do not gain vocabulary from independent reading often cited as best practice (Blachowicz, Fisher, Ogle, & Watts-Taffe, 2006;

Bryant, Goodwin, Bryant, & Higgins, 2003; Ebbers & Denton, 2008; Jitendra et al., 2004).

However, the practice of independent reading is widely used in science classes (Cawley, Foley, & Miller, 2003), leaving struggling readers with potentially limited outcomes.

Textbook Based Science Curriculum as a Barrier

Hence, the primary source of knowledge dissemination in science classrooms is the textbook (Cawley, Foley & Miller, 2003; Cawley et al., 2002; Yager, 1983). As much as 85% of all districts employ text-based curriculums (Brownell & Thomas, 1998) and 90% of all science instruction is text-based (Yager, 1983). In a recent 2009 study of 54 science inclusive lessons, Moin, Magiera, and Zigmond found 72% of the lessons were language-based where students were expected to do some sort of reading and writing as the primary demonstration of science knowledge. Moats and Lyon (1993) point out that 80% of all students served under the LD category have reading and language-based deficits.

Language as a Barrier

Biology is laden with language and rigorous vocabulary (Groves, 1995; Kahveci, 2010; Lovitt & Horton, 1994; Wandersee, 1985; Yager, 1983). More importantly, for students who struggle with language processing, literacy skills specific to learning the language of biology must be addressed (Fisher, Grant, & Frey, 2009). Many researchers have compared the learning of scientific language to that of a foreign language (Groves, 1995; Wandersee, 1985; Yager, 1983). Yet, this comparison understates the difficulty of learning the terminology required of high school biology students, according to Wandersee (1985) and Groves (1995). The language of biology has been found to be more intensive by sheer volume than that of foreign language course. Lovitt and Horton (1994) suggested, “Even the most cursory inspection of secondary science textbooks reveals that they are brimming with idiosyncratic vocabulary” (p. 108).

Looking more scientifically at secondary science texts, Lloyd (1990) analyzed three biology texts for text elaborations. The books were intended for use with varying types of students: (a) general education non-college preparation, (b) general education, and (c) special education. Results indicated text designed for students with special needs presented the least amount of elaborative information, making the text more difficult because, “Unelaborated ideas become problematic in the learning process because they increase the content density of a text” (Lloyd, 1990, p. 17), requiring the user to extract meaning themselves or to access prior knowledge.

Unfortunately, students with LD often “require more support in the area of vocabulary development [in order] to achieve their academic potential than has been typically offered in mainstream classrooms” (Wannarka, 2010, p. 2). This support is especially needed in science classrooms. Lumpe and Beck (1996) reviewed seven high school science textbooks, they coded four major strands of science literacy and revealed the dominant strand as the ‘*knowledge of science*’. Within that strand, researchers have named vocabulary terms as the major foci (Chiappetta, Sethna, & Fillman, 1991; Lumpe & Beck, 1996). Most science teachers assume that basic vocabulary is understood by all students; however, this assumption often creates a learning barrier for students with LD (Miller, 2009).

Standardized Tests as a Barrier

Compounding the problems of assumed knowledge (Miller, 2009), text density (Lloyd, 1990), text-based curriculums (Cawley, Foley & Miller, 2003; Cawley, et al., 2002) and vocabulary amplification (Groves, 1995; Kahveci, 2010; Lovitt & Horton, 1994; Wandersee, 1985; Yager, 1983) is the pace of science instruction. Most science curriculums are designed to prepare students for standardized evaluations which impede deep processing and instead are

paced too rapidly, covering a range of tested materials (Eylon & Linn, 1988). Eylon and Linn (1988) summarize the current significance of the overall problem best:

Students need science topic knowledge to display abstract reasoning about scientific phenomena, yet such knowledge is not sufficient for abstract reasoning. Most achievement tests emphasize recall of science topic knowledge rather than the skills students really need to respond to new scientific problems. Furthermore, these tests encourage teachers to address a wide range of topics rather than covering fewer topics in greater depth. As a result, both the test and the curriculum become focused on recall of science facts from many science topics. This, in turn, encourages use of science curricula that fleetingly cover many topics. (p. 269)

This finding is significant for students with LD since the enactment of the No Child Left Behind Act (2001). No Child Left Behind does not specify what kind of tests are to be used to measure performance, but 24 states administer 'high stakes' testing for all students in core tested areas (Johnson, Thurlow, & Stout, 2007). To further complicate matters, standardized assessments that have driven the pacing in science courses are comprised of many terms that students with disabilities will face to meet accountability mandates (Yovanoff et al., 2005). For example, direct instruction in science literacy has been frowned upon by some researchers (Brown & Ryoo, 2008; Fisher, Grant, & Frey, 2009), but students with language-based LD cannot increase proficiency without vocabulary instruction (Pamar, Deluca, & Janczak, 1994). Providing instruction to meet the demands of the current assessment reality makes sense for students with reading and language processing deficits.

Vocabulary Instruction for Students with LD

Research is limited in the area of secondary students with disabilities and science content vocabulary instruction. This dearth of research was particularly evident when a Web of Science article database search yielded 10 possible articles when the search terms “science”, “learning disabilities” and “vocabulary” were entered. After social studies articles were omitted as well as five other articles for inappropriate grade level and disability type, merely three studies focused solely on students with learning disabilities and science education content. Two of the three remaining articles (Jitendra, et al., 2004; Lovitt & Horton, 1994) were meta-syntheses of prior research, spanning all grade levels and subject areas, and are used as an overview of the literature with the majority occurring in the 1990’s. The remaining study from Espin and Deno (1995) is then summarized.

Jitendra, et al., (2004) completed an extensive review of the literature highlighting 19 studies from 1978-2002 and found effective specific modes of vocabulary instruction for students with LD. These data show keyword method, mnemonics, cognitive strategies, direct instruction, time delay, and activity-based instruction are affective for students with LD while the computer-assisted-instruction (CAI) methods presented mixed results. Of the research reviewed by Jitendra, et al. (2004) two studies are closely examined that provide detailed research on CAI.

In an earlier review of the literature, Lovitt and Horton (1994) examined materials that enhanced textbooks in the content area. The research included examination of study guides, graphic organizers, vocabulary supports, and CAI. From the meta analysis Lovitt and Horton (1994) made suggestions for textbook modifications in the content areas, and suggested the following: (a) modify the most difficult materials, (b) collaborate with other professionals, (c)

use CBA before teaching, (d) use computerized modification options, (e) use co-teaching and divide workload, and (f) urge professionals who are on textbook adoption committees to only purchase texts if they come with modification tools including vocabulary exercises and graphic organizers.

One area where researchers are developing new understanding is the importance of memory in science vocabulary (Carlisle, 1999; Carlisle, Fleming, & Gudbrandsen, 2000; Koury, 1996). Carlisle (1999) found students with LD have greater trouble with free recall in comparison to their typically developing peers. Carlisle (1999) found that even when statistically controlling for vocabulary knowledge and comprehension by use of sentence verification, or checking for meaning with yes-no answers on read aloud sentences students with disabilities performed below same aged peers. Kramer, Knee, and Delis (2000) looked at verbal memory and the ability to encode and retrieve information and found students with dyslexia had impaired rehearsal which impeded encoding of new information. However, repeated-measures analysis of variance revealed no difference in the impaired student population and the control in recall and retention.

Working memory problems have been consistently identified as a cause of learning problems for students with learning disabilities, particularly in the areas of reading and mathematics (Carlisle, 1999; Swanson, 1999). This problem is perpetuated in science instruction at the high school level because to comprehend the content, students have to be proficient in reading and math, in essence forcing a student through these topics to get to the science (Ofiesh, 2007).

Mnemonic Instruction to Increase Word Knowledge in Science

The largest body of empirical research aimed at increasing memory and word knowledge for language success in science is mnemonics instruction, especially in the biological sciences (see Table 1). The following studies in Table 1 are all at the high school level with a focus on keyword mnemonics instruction with students who are labeled LD.

Table 1

Comparison of Mnemonics Studies in High School Science

Citation	Sample	Condition	Result
Mastropieri, Scruggs, & Fulk, 1990	N=25 LD	Students stratified by grade level and selected randomly for either the keyword/mnemonic picture or direct instruction condition	Keyword/mnemonically trained students outperformed those with Direct Instruction only
Johnson, Gersten, & Carnine, 1987	N=25 LD, grades 9-12	Students matched on pretest then randomly assigned to 1 of 2 CAI programs	Students in Small Teaching Set (CAI 1) mastered content earlier than those in Large Teaching Set (CAI 2) and also learned more efficiently

Citation	Sample	Condition	Result
Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1987	Exp. 1: N=24 LD Exp. 2: N=24 LD	Both experiments used a mnemonic and a control, randomly assigned and stratified by grade level	Positive effect for mnemonic condition
Mastropieri, Scruggs, & Levin, 1986	Exp. 1: N=56 LD, high school Exp. 2: N=8 educable mentally retarded (EMR) junior high students	Exp. 1: Students seen in normal instructional groups of 3-6 students 6 groups randomly assigned to mnemonic or direct instruction condition Exp. 2: 8 EMR students attending self-contained special education classes	Positive effect for mnemonic Instruction Condition for students in both experiments

Citation	Sample	Condition	Result
Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985	Exp. 1: N=32 LD, 10 in 7 th grade, 11 in 8 th and 11 in 9 th Exp. 2: N=30 LD, 14 in 7 th , 8 in 8 th and 8 in 9 th	Exp. 1: Students assigned to either mnemonic picture or direct instruction by stratified randomization Exp. 2: Students assigned randomly to either mnemonic imagery or direct instruction	Exp. 1: Recall of mnemonic picture subjects statistically higher than direct instruction subjects Exp. 2: Definition recall of mnemonic- imagery subjects was statistically higher than direct instruction subjects
Mastropieri, Scruggs, & Levin, 1985	Exp. 1: N=90 LD, 9 th grade, divided into 2 achievement groups of 45 each Exp. 2: Omitted: Subjects not LD	Exp. 1: 15 students randomly assigned to 1 of 3 conditions: mnemonic, questioning or free study	Mnemonic subjects statistically out recalled both questioning subjects and free study subjects

Note. Setting for all experiments was either specifically a resource room or “quiet” room reserved for the students outside the general education classroom.

The 25 students with LD participating in the first experiment (Mastropieri, Scruggs, & Fulk, 1990) received either index cards with a vocabulary word at the top, keyword in

parenthesis and definition, along with a picture in the center depicting the keyword interacting with the definition (keyword/mnemonic condition) or index cards similar to the mnemonic group, but with no references to a keyword and no keywords represented in the picture (rehearsal/direct instruction condition). Students received equal instruction time in both groups with the teaching method varying depending on the condition, either focusing on mnemonic keyword or drill-and-practice. After the instructional period was over for both groups, each was administered individually a recall test followed by a comprehension test. The answer sheets were scored by two experimenters, blind to experimental condition.

While the mnemonically instructed students outperformed the rehearsal condition students on both the production test, $F(1,23) = 47.69, p = .000$ and the comprehension test, $F(1,23) = 5.66, p = .026$, both groups performed higher on the concrete words in the production test than the abstract, $F(1,23) = 10.28, p = .004$. As for the comprehension test, no effect was found for item type, $F(1,23) = .01, p = .937$. Item type was not statistically significant by condition interaction on the production test, $F(1,23) = .25, p = .619$ or the comprehension test, $F(1,23) = .60, p = .448$.

In the third study mentioned in the Table 1 (Scruggs et al., 1987), two experiments were performed. The first experiment was on the recall of dichotomous attributes of minerals and the second experiment was on the recall of specific attributes of those minerals. For the first experiment, students were given two study booklets, one specific to their condition (mnemonic or free study) and one that both groups used. Students in both groups were instructed to focus on the dichotomous information presented, though specific attributes were listed in the text. The study booklet for the mnemonic condition specifically mentioned to students they would learn a new way of studying and presented mnemonic strategies. Students in the mnemonic group also

had booklets with mnemonics illustrating keywords, color and setting cues to help students learn the vocabulary. The free study students were given the same pictures without the keywords (color and setting cues were included).

After the same amount of time with the two interventions, the students were administered a dichotomous-attribute identification test and an unexpected test of specific-attribute recall. Students provided with the mnemonic pictures scored $M=22.33$ ($SD = 2.64$) out of 24 (or 93%) on the dichotomous-attribute identification test while those in the free study control averaged around $M= 13.25$ ($SD = 3.19$) (or 55%). The performance difference was statistically significant ($z = 4.01, p < .001$), and this outcome can be seen in that every mnemonic student, except one, exceeded every student in the free study control group. Neither group did well on the unexpected specific-attribute recall test; performance for both was low with a mean percentage of 3% for the mnemonic group and 5% for the control.

In Scruggs and colleagues (1987) second experiment, materials similar to those in experiment one were used, but only the specific mineral facts were presented instead of the dichotomous attributes. Students in the mnemonic condition were given a list of 10 rhyming peg words, instructions they would be using word or number clues as well as mnemonic illustrations to learn about color and hardness of eight minerals. Materials in the control group were similar to those used in the mnemonic group. However, students did not receive the list of peg words and mnemonic illustrations.

Students were given the specific-attribute recall test and an unexpected dichotomous-attribute test. One week later the same students were given another specific-attribute test as well as a specific-attribute identification test. On all four tests, mnemonic subjects outperformed control subjects. Mnemonic subjects initially remembered more, retained more of what they

learned and were able to infer dichotomous attributes based on their specific attribute knowledge. The mean for mnemonic students on the immediate specific-attribute test was 17.67 ($SD = 4.85$) and 10.50 ($SD = 8.02$) for the control. The mean on the immediate dichotomous test was 19.58 ($SD = 1.83$) for the mnemonic group and 15.41 ($SD = 4.87$) for the control. One week later, the mnemonic group's mean on the specific attribute test was 13.41 ($SD = 7.00$) and the control group's was 5.08 ($SD = 3.90$). The mean on the identification test was 16.50 for the mnemonic group ($SD = 6.56$) and 6.75 ($SD = 4.16$) for the control.

Mastropieri, Scruggs, and Levin (1986), examined two different groups of students. The students were divided into a mnemonic instruction group and a direct instruction group. The mnemonic groups were taught a keyword-peg word mnemonic technique using an index card showing the peg word, a picture of the peg word, and its rhyming number on one side with the corresponding peg word and picture on the other side. The direct instruction groups were led in keyword-based instruction where they were shown colored line drawings of the minerals being studied with the mineral name and number printed on the card. After being presented the intervention, students were asked to write the hardness level for each of 14 minerals presented by the experimenter in random order. The overall mean recall percentage for the mnemonic instruction groups was 80% while the overall mean recall percentage for the direct instruction group was 50%. "A two-sample permutation test indicated that the difference favoring the mnemonic condition was a reliable one, $p < .01$ " (p. 304).

The second experiment Mastropieri, Scruggs, and Levin, (1986) compared the mnemonic and direct instruction methods to see which would be better for students labeled EMR (Educable Mentally Retarded). Two groups of materials were used focusing on eight minerals, one set of mnemonic materials and one set of direct instruction materials. Subjects learned the material on

each list, one list at a time. All eight subjects performed better when given mnemonic instruction (average of 64% correct) than under direct instruction (average of 37.5% correct). The difference was determined to be statistically significant per “a correlated sample permutation t test” (p. 305).

In another study by Mastropieri, et al. (1985) two groups of students were involved in two experiments. In the first experiment, 16 students were assigned to the mnemonic picture condition and 16 to the direct instruction condition in the researchers’ first experiment. Sixteen low frequency English vocabulary words were selected (two for examples and fourteen as target items). The subjects in the mnemonic picture condition were given a mnemonic illustration with the keyword and meaning interacting. The same card also contained the vocabulary word, the keyword and the meaning of the vocabulary word on it. The direct instruction subjects also received vocabulary items and non-mnemonic illustrations that represented the meanings of the vocabulary items. Equal instruction time was given to both groups. The results indicated the mean recall of correct definitions in the mnemonic picture subjects (79.5%) was statistically higher than that of those in the direct instruction group (31.2%), $t(30) = 7.12$, $p < .001$.

For experiment two, Mastropieri, et al. (1985) divided the subjects into two groups, one a mnemonic imagery group in which subjects were provided keywords and prompted to generate their own images, and a direct instruction group, who received the same materials as that group in the first experiment. Overall, the mnemonic picture group once again had better definition recall (69.3%) than those in the direct instruction group (46.7%), $t(28) = 2.96$, $p < .01$.

Mastropieri, Scruggs, and Levin (1985) also conducted two experiments, one with students who were LD, the other without. In the first experiment, the 90 students were separated into two achievement groups of 45 based on their reading comprehension subtest scores on the

California Achievement Test (CAT). Students with scores at or above the 40th percentile were put into the “higher” achievement group and the rest were in the “lower” achievement group. Within each achievement group, 15 students were randomly assigned into each of the three experimental conditions: mnemonic, questioning, and free study. Seventeen minerals (14 target items and three examples) were included in the material to be learned.

The mnemonic group was given materials with both pictorial representations of the peg word, keyword, and combined keyword/peg word, as well as the written peg word, keyword, and keyword/peg word combination and hardness level of the material described. The questioning group was given randomized lists of the minerals and their hardness on flashcards with the name of the mineral on one side, the hardness level on the other coupled with a colored picture of the mineral on each card. The free study group received the same materials as the questioning group, but this group also received a blank sheet of paper. The questioning and free study groups both got a general lesson about minerals as well.

Instruction was provided to each group, at the end of each instructional session students were presented a verbal test of mineral hardness in random order. A parallel assessment was administered 24 hours later. The mean percentage of correct responses for lower achievers in the mnemonic group was 70%, with the questioning group of lower achievers only answering correctly 25.7% of the items and the free study group of lower achievers answering 27.6% correctly. The same results were seen in the higher achievers with the mnemonic group achieving 80.5% accuracy, the questioning group responding correctly on 30% of the items and the free study group getting 44.8% correct. Only the mnemonic students were able to recall virtually all learned materials on the 24-hour delayed recall tests.

The study in Table 1 carried out by Johnson, Gersten, and Carnine (1987) is of particular importance as it is the only one specifically utilizing CAI. The researchers in this study begin by stating that, “drill and practice computer programs are the most widely used CAI software” (p. 206). They stress the size of the learning set, or how many items presented during one lesson, is a topic requiring more research since it can impact a student’s ability to remember and master material.

Two different CAI programs were investigated in the Johnson, Gersten, and Carnine (1987) study, the Large Teaching Set (LTS) and the Small Teaching Set (STS). The computer programs differed in the volume of words to be learned and only the STS provided a cumulative review for the participants. The STS program included individualized lessons with only unfamiliar words as the target. Each practice set in the STS presented 7 words at a time. The STS also had mastery criterion which, when met in two consecutive lessons, indicated the word was learned. Cumulative reviews were also included in the STS program after words were learned.

In the LTS CAI program words were taught in sets of 25. The student could choose one of the following formats for review of the word list: (a) a teaching display with the word, (b) its definition and sample sentence, (c) a multiple choice quiz, (d) a fill-in-the-blank sentence completion with word definition, or (e) an arcade-type game in which the student matched words to definitions. The researchers did not provide a cumulative review in the Large Teaching Set program. Students in both conditions were given the same amount of instructional time.

The high school students with LD who participated in the Johnson, Gersten, and Carnine (1987) study were in grades 9-12. Participants consisted of a pool of 38 students, the final number of subjects participating in the study were 24. A pretest was used to randomly assign the

students to either the STS computer program or the LTS computer program. The setting for the study was a large special education resource room in a northwestern high school. Computers were set up in the back of the room so that study participants working on the computers would not distract other instructional groups.

As a part of the study protocol, 24 students (12 in each set) were given a pretest, posttest, and maintenance test (two weeks following the pretest). In the STS, 10 of the 12 subjects reached mastery, or 83% in an average of 7.6 sessions ($SD = 1.9$). In contrast, 8 of 12 reached mastery from the LTS, or 67% in an average of 9.1 sessions. Both groups did better on the posttest than the pretest but their scores decreased on the maintenance test. Both groups performed well on the posttest (84% correct on average for the STS and 87.8% correct on average for the LTS). The mean percentage of correct answers two weeks after the study treatment was removed demonstrated learning was maintained at a level of 84% for the LTS and 81% for the STS. Both CAI programs maintained mastery levels above 80%. The striking difference for both groups was not the mastery of the content, but the amount of time taken to achieve mastery. The participants in CAI STS achieved mastery more efficiently than the LTS participants.

Computer Assisted Instruction in Science Content Vocabulary

As noted in the cited studies, mastery of science vocabulary for students with LD can occur and the acceleration of mastery appears to be possible with CAI (Johnson, Gersten, & Carnine, 1987). The potential impacts of CAI accelerating learning in science vocabulary are outlined in this section. The section starts with a summary of why emerging technologies might impact learning and then progresses to how technology could support increasing science vocabulary knowledge for students with LD.

The Horizon Report (Johnson, Levine, Smith, & Stone, 2010) from the New Media Consortium, a group concerned with emerging technologies in education, pointed to five major trends in technology in schools for 2010 through 2015. These trends include (a) technology is increasingly the means for student empowerment, (b) technology dramatically impacts work and those with technology skills will have an educative and workforce advantage, (c) innovation is gaining acclaim and the importance for student creativity is resurfacing, (d) in-time engagement and mentoring online is increasing, and (e) technology is transforming learning space to include the virtual world and will not always be dependent on a physical building.

Interventions incorporating the computer as a means to provide vocabulary instruction to engage and help with free recall for students in biological science classrooms have been in use since the classroom computer was introduced (Staples, 1985). Additionally, Stewart (2005) suggested programming in science should aim to increase student literacy of terms as the field of sciences is evolving at such a rapid pace. Yet to date, little empirical research has emerged using CAI for increased vocabulary development in the biological science classroom for students with disabilities.

To address vocabulary development for students with LD Lovitt and Horton (1994) and ten years later, Jitendra, et al (2004) examined the literature, both citing Horton, Lovitt, and Givens, (1988) as being the only study focused on CAI of vocabulary in the sciences for secondary learners with LD. Horton, Lovitt, and Givens (1988) investigated environmental word learning through the use of media center computers using a pre-test, intervention, post-test design in an attempt to measure environmental science word learning. Findings indicated students with LD required two sessions to make significant word learning gains while non-disabled peers only required one session to make significant word learning gains. Yet, both

groups showed positive learning gains in language development using the computer for word learning in biological sciences.

Two years later, Reinking and Richman (1990) discerned that computer assisted instruction for language acquisition has positive results on vocabulary learning and comprehension. Reinking and Rickman (1990) used text enhanced displays for students in middle grades who struggled in reading while engaged with text-based science reading. Four comparison groups were considered: (a) paper copy reading with a dictionary as support, (b) paper copy reading with targeted words defined and provided as support, (c) computer reading with optional supports, and (d) computer reading with mandatory supports of targeted words. Computer users outscored all paper copy readers, most importantly, computer users without option for support of targeted vocabulary terms scored the highest on vocabulary and comprehension measures (Reinking & Richman, 1990).

The Role of Technology for Students with LD

Currently, technology is gaining momentum for use with students identified with LD. Blackhurst (2005) reported online learning innovations like web-tutoring are easily accessed by students with LD. Previously discussed research supports moving towards CAI for language acquisition. In the study conducted and summarized previously by Johnson, Gersten, and Carnine (1987) an attitude survey was administered to both groups of students with LD involved with the experiment. Twenty-three of the 24 subjects “felt the computer helped them learn new words”, while one indicated that “maybe” the computer helped (Johnson, Gersten, & Carnine, 1987, p. 210). On a scale of 1-4 with 4 being “very much”, the mean score for the answer to “Did you enjoy working on the computer?” was 3.4 for subjects in one group, the STS group, and 2.8 for subjects in the other group, the LTS group (Johnson, Gersten, & Carnine, 1987, p.

210). Nineteen students indicated they would like to learn more on the computer, with three indicating “maybe” (Johnson, Gersten, & Carnine, 1987, p. 211).

Although students with LD might easily access, engage in, and enjoy technology to support learning, research is scarce in the area of technology’s use in the inclusive science classroom. The National Center for Education Statistics (2006) reported nearly all public K-12 schools in the United States are connected to the internet. However, the dilemma of teacher adoption of new technology is seen in Kebritchi’s (2010) technology research which presents a case study of an educational computer game called *Dimenxian*. Although the teachers in the study were interested in using technology, barriers included (a) alignment of the curriculum to the technology tool, (b) convincing teachers that time spent using the technology was beneficial for instruction, and (c) doubts about whether the concepts learned using technology would be transferable to other contexts. On the other hand, the teachers in the study commented that combining learning with technology motivated student engagement and was reason enough to consider the technology in the future. Even though teachers had concerns, they were still willing to adopt the technology especially because of the level of student engagement and outcomes (Kebritchi, 2010).

Conclusion

From the past to the present students with LD need support to ensure their success in learning (Lloyd & Hallahan 2005; Tissington, 2006). As early as 1877 (Proceedings of the Association of Medical Officers of American Institutions for Idiotic and Feeble-minded Persons), researchers used the diagnostic-prescriptive method to assess a student’s abilities and weaknesses and prescribe a course of action to address the weaknesses. Though some services emerged for students with LD, via the Children with Specific LD Act of 1969 (P.L. 91-230) and

the emergence of a formal definition of SLD specified in the Individuals with Disabilities Education Act (IDEA) 1975, arguably the legislation that led to high stakes assessment and expected outcomes for this population was No Child Left Behind Act of 2001. After this act, students with LD were evaluated on the same criteria as their peers and were expected to be part of an inclusive classroom. This movement became even more significant when 24 states chose to have ‘high stakes’ testing for all students in core tested areas (Johnson, Thurlow, & Stout, 2007).

Unfortunately, despite the intention of having high standards, many students with LD have fallen behind their peers (Planty et al., 2008), especially in science performance (Wagner et al., 2006). One of the primary barriers to students with LD’s success has to do directly with reading difficulties (Scruggs & Mastropieri, 2007). Hence, the struggle for students with LD in science is not surprising when 90% of all science instruction is text-based (Yager, 1983) with 72% of inclusion class lessons requiring language proficiency to demonstrate learning (Moin, Magiera, & Zigmond, 2009). Science instruction often requires the mastery of vocabulary as the major focus for demonstrating the knowledge of science (Lumpe & Beck, 1996) and simultaneously the rise of the standardized test focuses predominantly on the recall of science facts (Eylon & Linn, 1988). Consequently, students with language disabilities have more difficulty succeeding than their nondisabled peers (Wagner et al., 2006) in science instruction.

A technique to address this issue is emerging in the literature. Researchers suggest that memory plays a vital role in science education (Carlisle, 1999; Carlisle, Fleming, & Gudbrandsen, 2000; Koury, 1996). Strategies have emerged that teachers can use to increase the understanding and retention of vocabulary knowledge and recall. These strategies include mnemonics, keyword method, cognitive, direct instruction, time delay and activity-based

instruction (Jitendra et al, 2004). While some researchers see direct instruction as a tool not to be used in science literacy (Brown & Ryoo, 2008; Fisher, Grant, & Frey, 2009), students with LD in language cannot increase proficiency without some direct science vocabulary instruction (Pamar, Deluca, & Janczak, 1994).

The literature reviewed shows that direct instruction of science vocabulary through CAI does result in positive vocabulary acquisition for students with LD (Reinking & Rickman, 1990). When computer facilitated graphic displays were used, both students with and without LD produced positive learning outcomes (Wilkie, 1994). In the study conducted by Johnson, Gersten, and Carnine (1987), students with LD using two different computer programs both improved and retained their knowledge of critical science vocabulary from pretest to posttest. In the same study an attitude survey was given to the subjects regarding technology use, 23 of 24 students felt the computer assisted them in learning words and 19 of 24 said they would like to receive more computer-based instruction.

NCLB mandates standardized testing to meet Annual Yearly Progress (AYP), including in the area of science (Johnson, Thurlow, & Stout, 2007). Because of paper-based assessment, students with LD must know science vocabulary to meet minimum standards or else they fail (Planty et al., 2008). Research indicates that direct instruction along with other strategies (Jitendra et al., 2004) can help improve vocabulary knowledge and fluency of recall for students with LD. Pairing direct instruction of critical vocabulary in biology with CAI could enhance student vocabulary and improve overall outcomes on state mandated assessments for students with LD (Reinking & Rickman, 1990).

CHAPTER 3:

METHODOLOGY

Introduction

The purpose of this study was to increase students with LD understanding of key Biology 1 vocabulary using a web-based instructional tool. This chapter opens with an introduction of the research questions that guided the study, followed by introduction summary of participants and setting. Next, the methodological details are presented and include: (a) research design, (b) research timeline, (c) research procedures, (d) dependent and independent variables, (e) data collection, and (f) data analysis. The chapter concludes with a discussion of the limitations of the study.

Research Questions

The questions addressed in this research are as follows:

- (1) Is there a difference in vocabulary assessment scores between students with LD learning content Biology 1 terms using a digital flash card program compared to paper flash cards?
- (2) Is there a difference in Biology 1 course grades between students with LD learning content Biology 1 terms after using a digital flash card program compared to paper flash cards?

Participants

The researcher recruited an intact student sample of convenience at a large urban high school in the Southeast. The student sample was drawn from the total population of students enrolled in Learning Strategies (LS) classes across three class periods. A total of 36 possible students with identified disabilities were targeted. To participate in the current research study,

students in the LS course had to meet the following criteria: (a) be identified as LD; (b) be eligible to receive specialized instruction in language development, as evidenced by having an Individual Education Program (IEP) goal in the area of reading development in one or more of the following areas: phonological awareness, spelling, comprehension or fluency; (c) be dually enrolled in a 9th grade Biology 1 course; (d) be assigned to 9th grade for the first time; and (e) have completed parental consent forms to participate in the research study.

Twenty eight students from three class periods of LS were identified and invited to participate in the research study. Out of the 28 students who fit the participant criteria, 25 students returned the signed consent form to participate in the research study. Three nearly equal groups across periods 1 through 3 including 9 students from period 1, 7 students from period 2 and 9 students from period 3 participated. The participant demographic information is presented in Table 2.

Table 2

Participant Demographics by LS Class Period

LS Period	N	Gender	Race
1	9	4 Female	2 Caucasian, 2 Hispanic
		5 Male	1 Caucasian*, 3 Hispanic, 1 Biracial
2	7	2 Female	1 Caucasian, 1 Hispanic
		5 Male	2 Caucasian*, 3 Hispanic
3	9	2 Female	2 Caucasian
		7 Male	3 Caucasian, 4 Hispanic

LS Period	N	Gender	Race
Total	25	8 Female	5 Caucasian, 3 Hispanic
		17 Male	6 Caucasian, 10 Hispanic, 1 Biracial

*Receiving Speech-Language Services as the Primary Disability

Using the guidelines as described by Cohen (1977), the researcher was cognizant to balance, or make the two group conditions (paper or digital) equal, by random assignment of participants into condition. Table 3 is the participant demographics by card type that were randomly assigned while making sure the assignment to the two conditions remained about equal.

Table 3

Demographics based on Card Type

Condition	N	Gender	Race
Paper	13	2 Female	2 Caucasian
		10 Male	5 Caucasian, 5 Hispanic
Digital	12	6 Female	3 Caucasian, 3 Hispanic
		7 Male	1 Caucasian, 5 Hispanic, 1 Biracial
Total	25	8 Female	5 Caucasian, 3 Hispanic
		17 Male	6 Caucasian, 10 Hispanic, 1 Biracial

Settings

The study took place at a large urban high school in the Southeast. The school population consisted of 2,242 students and served over 438 students in the special education program. The school consisted of 1,058 female students and 1,184 male students. However, in

the special education population students were 146 females and 292 males, a 1:2 ratio of females to males being served in the special education program funded under the IDEA. Table 4 is the demographic, linguistic and student diversity of the school site.

Table 4

Student Demographics

2008 Student Enrollment		
	Female	Male
Disadvantaged ^a	477	477
ELL ^b	31	45
ESE ^c	146	292
Black	128	159
Hispanic	344	332
White	527	628
Asian	11	17
Am. Indian	0	6
Multiracial	48	42
Female Total	1058	
Male Total		1184
Total Students Served	2242	

^aEconomically Disadvantaged based on the number of students receiving free or reduced lunch.

^bEnglish Language Learners (ELL)

^cStudents identified and receiving services in Exceptional Student Education programs.

The school employed 138 teachers, of which 29 are Special Education teachers (see Table 5). In addition, there are seven school-based administrators, with one dedicated to special education and related services. Of the 131 instructional positions at the school, 51 teachers have received advanced degrees.

Table 5

Staffing

2008 Staffing	
	Number
Instruct Reg ^a	101
Instruct ESE ^b	30
	131
Admin ^c	6
Admin ESE ^d	1
	7
Master's	45
Specialist's	3
Doctorate	3
	51

^aGeneral Education Teacher

^bSpecial Education Teacher

^cGeneral Education School-based Administrator

^dSpecial Education School-based Administrator

Ninety percent of the instructional staff were assigned to instructional positions “in field” or teaching a subject in which they are fully credentialed.

The current research took place in a LS classroom during the first three periods of the day. There were four classroom computers that had access to the internet. The classroom contained numerous work spaces including a long table for group work, student work tables, and four computer centers (see figure 1). The teacher assigned to the classroom also had access to a Interactive White Board to model the use of computer tools.

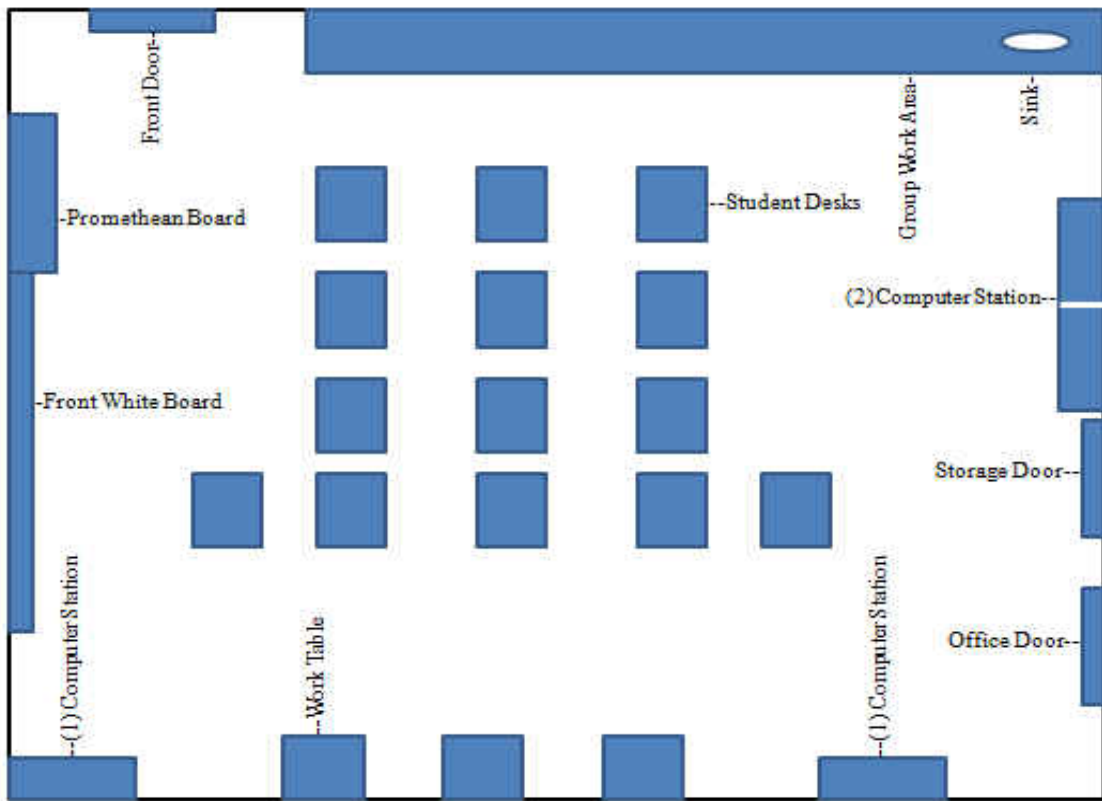


Figure 1

LS Classroom Design

The LS teacher was a Caucasian, middle-class female, with a Master’s Degree in Special Education, in her ninth year of teaching. The LS teacher’s experience included inclusive instruction in Algebra, History and Biology courses. The LS teacher was responsible for a

caseload of 27 students and maintained IEP progress reports and records along with teaching each of the LS courses periods 1 through 3. Learning Strategies was a course the LS teacher developed and instructed for three years. Using data-driven instruction, her curriculum was guided by the State Standards and addressed study skills that the students required for mastering the state's high stakes exit exam. The LS teacher was provided school-based professional development in literacy and accommodations for students with special needs aligning with skills that are addressed in LS curriculum.

Design Methodology

The research methodology used for this study was a quasi-experimental group design with repeated measures analysis of variance of scores for both the vocabulary assessment and Biology 1 course grades (Cook & Campbell, 1979). A quasi-experimental design was chosen because students' placement in the LS classrooms were pre-determined from school personnel and had been influenced from the master schedule so true randomization was not feasible. However, homogeneity of variance between the two treatment conditions was assumed based upon the availability of participants, selection criteria standard, and randomization of the participants into condition type and using a random number generator.

This study focused on Study Stack™, as an intervention tool, which was used to investigate the effect of digital flash cards on a vocabulary measure of foundational word learning and Biology 1 course grades of students with LD. An intact convenience sample of students identified as having a LD placed in LS classes was recruited for the study to examine the ability to gain Biology 1 content specific vocabulary, or high frequency words, considered essential to the understanding of key biology concepts. Analysis of variance of gain scores on

pre-post test measures and Biology 1 course grades were used to gain understanding of students' ability to acquire new content specific word meaning. Lastly, interviews were conducted to examine the impact of the study qualitatively to better understand student perceptions of the overall research experience.

Research Timeline

The current research study occurred over the entire third, 9 week, grading period. A typical grading period is 45 instructional days in the district where the research was conducted. Students with LD who received 30 days of Study Stack™, digital flash card program, were compared to students with LD who received 30 days of paper flash card intervention. Both of the treatment conditions participated in a pre-test on day 1. During the intervention phase (days 2-31) both groups interacted with small word sets to more efficiently learn 48 targeted biology terms. Every ten days a third of the words to be learned (16) were targeted. Both groups completed a data probe on days 11, 21, and 31 to monitor word learning and study engagement. The intervention phase (days 2 through 31) ended with a post-test given on day 32 to both groups. On days 33- through 42 both groups had the intervention withdrawn. On day 43, a test of maintenance or delayed post-test was given to both the treatments groups. A voluntary interview completed the research on day 45 (see Figure 2).

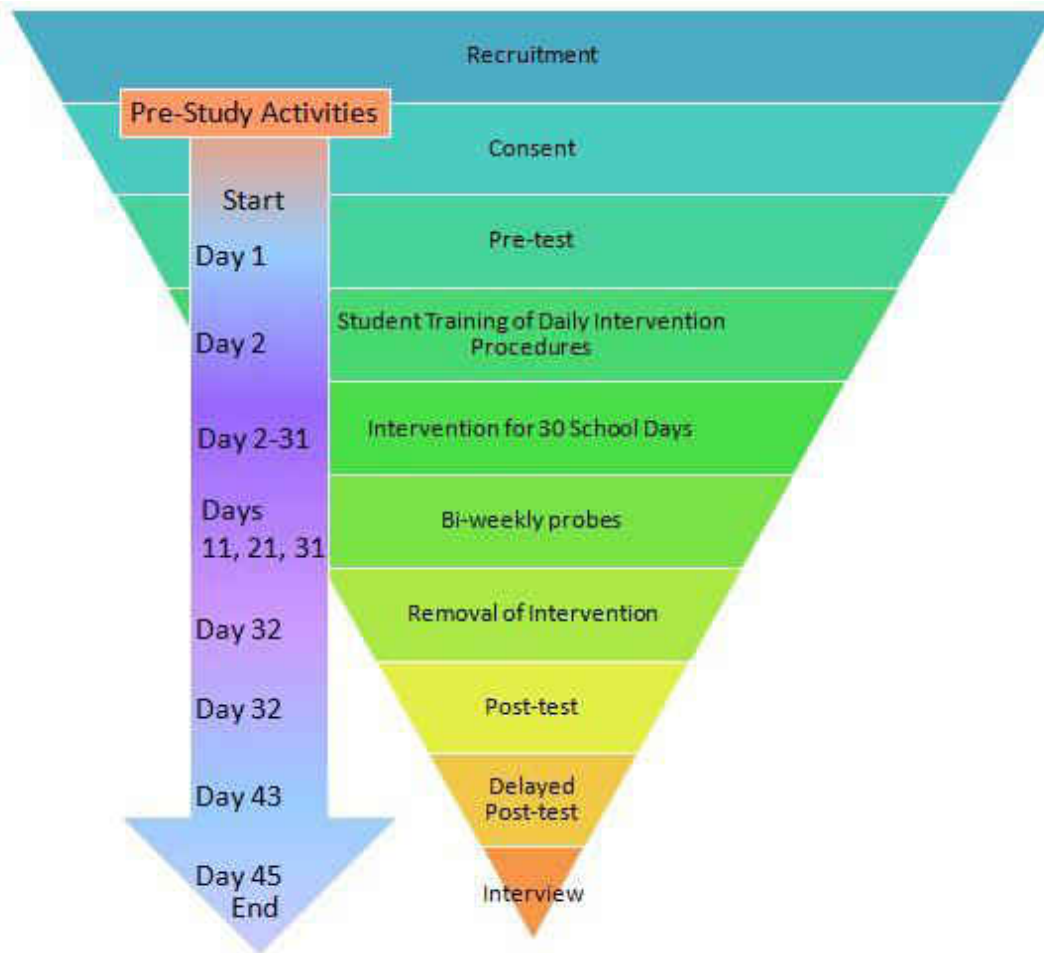


Figure 2

Study Time Line

Research Procedures

Students with LD in a LS class taking 9th grade Biology were recruited by a study invitation. The students were asked to participate in Biology word learning through the use of flash cards in their assigned LS course for the entire third grading period. Accompanying the invitation, the students received consent forms that were approved by the Institution Review Board at University of Central Florida (UCF). Guardians and students volunteering for the study were asked to provide the researcher with the birth dates, last four digits of the students' social security number and the students' first and last names to access the private UCF server. This

collection of student data allowed students to access a website with a secure login and passwords each day and to secure intervention data.

While students were recruited the researcher invested time to develop materials for the research intervention. Two weeks, for 8 hours a day, materials were prepared for the study. Material preparation included, creating and printing of study protocols and procedures that were laminated for students use during the study. Digital flash cards were programmed and paper flash cards printed on manila cardstock, cut and sorted into stacks to be placed in paper card users folders. It is important to note that for the production of the paper flash cards, manila cardstock was used to ensure that the color of the flash cards remained the same for both the digital and paper flash card conditions. Thirty student study folders were then constructed. Fifteen for each card type (paper and digital) were constructed by placing all of the card specific study protocols and materials into folders. Folders for the students were then labeled and materials were placed in a study bin to be delivered to the school site.

After consent had been documented, all students participating in the study were assigned a non-name identifier. The non-name identifier was used to label study materials and study instruments. Also, by using a random number generator, each student was assigned to either the paper or the digital group using the non-name identifier so the researcher was able to keep the students' identities private and secure throughout the study.

After the students received their non-name identification code, students were asked to take a pre-test. The LS teacher received explicit instructions for the administration of the pre-test protocol. On day one, the pre-test was administered using the Day One Pre-Test protocol. The LS teacher had the students write their non-name identifier code on the name line of their pre-tests. After the identification codes were checked by the LS teacher, the student's instructions

were read verbatim, by the teacher, from the Day One Pre-Test protocol. After the students completed the pre-test the LS teacher placed all of the completed pre-tests in the folder provided by the researcher for pick-up that day (see Day One Pre-testing Procedures Appendix C).

Once students who were assigned a non-name identifier participated in a pre-test and were randomly assigned to a study conditions, they were then able to receive study materials created specifically for them. The study materials were labeled using the non-name identifier and placed in a research folder. The folders were used day two through day thirty-one of the study. Each folder contained daily procedures that were laminated and attached to the right side of the folder. The digital groups' procedures included instructions for logging into the computer and flipping through the digital flash cards (see Appendix C) while the control groups' procedures include instructions for flipping through paper flash cards (see Appendix C). Both groups received graph paper in the left pocket with instruction on how to self-monitor and graph the daily number of correct biology terms (see Figure 4). Students not participating in the study also received a folder containing study materials as the LS teacher made the intervention a part of the regular routine. However, the non-participating students' data were eliminated by the LS teacher. Since the LS teacher provided instruction in graphing skills, at her request, graph paper was also placed in each of the non-participating students' folders to allow this group to also practice graphing. The graphing data of non-participating students were removed before the researcher collected research data. All the student folders with study materials were housed in a locked file cabinet located in the teacher work room which also has a locking door.

16										
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1										
	day 1	day 2	day 3	day 4	day 5	day 6	day 7	day 8	day 9	day 10
Date:										
Teacher Initials:										

Figure 3

Self-Monitoring Graph Paper

On the second day of the study (see Day Two Procedures, Appendix C) the LS teacher provided trainings to both the groups participating in the intervention phase of the study. Using the Day Two Procedures, the LS teacher distributed the student study materials using their non-name identification code. This coding made the distribution orderly and also helped remind each student of their non-name identifier code that they used for the entire study. The two groups were then divided into condition type (paper or digital) for the second part of the training using the students' non-name identification code.

Using the Biology Word Learning Training Manual (see Appendix C), the LS teacher first modeled the instructions for the paper flash card group and the non-participating student group. Alternatively, the digital group was completing a learning task with the Media Center teacher. After the daily procedures were modeled for the paper group, and the students completed guided practice, the LS teacher walked the paper group down to the Media Center and

instruction was completed with the digital group (see Appendix C). Each groups' intervention training was modeled using the Biology Word Learning Training Manual (see Appendix C). Students were instructed in all of the intervention procedures including: (a) folder retrieval, (b) timer protocol, (c) flash card engagement, (d) graphing, and (e) folder storage. During the modeling of the flash card engagement, the LS teacher used either the paper flash card protocol or the digital flash card protocol. After the two student groups had completed guided practice using the protocols, they were instructed that the next day they would complete the flash card intervention independently during center time. However, the LS teacher explained the visual instructions were available in the individual student research folders for student groups, paper or digital, and these instructions were specific and would remain in their folders for the entire study.

Dependent Variable

There are two dependent variables being used in the data collection of the research. The first is student pre-post scores on vocabulary assessment. A 48 item pretest/posttest exam generated using the SkeVa™ © system in part and items not contained in SkeVa™ © were constructed using the vocabulary terms that are targeted in the study with the common definition and expert review. All 48 terms used throughout the entire research study using SkeVa™ © in part, (6 items out of 48) and 42 items taking the vocabulary from the curriculum map and paring the term with the basic definition. Both the pre-test and post-test was constructed by clicking on a selection of targeted State Standards Biology terms. In essence these assessments are considered Curriculum Based Assessments (CBA) that mirror the target intervention vocabulary terms for the study.

SKeVA™ © is a computer-based science key word vocabulary assessment system. Texas State Department of Education supports both the assessment system and continued

research development through Texas A&M. Vannest, Adiguzel, and Parker (2006) beta tested the first 1500 key vocabulary words for fifth grade and found a strong positive relationship to the standardized Texas Science Statewide Assessment. The items at the fifth grade level not only are reliable in predicting student assessment outcomes, but the items are internally validated. Individual word knowledge is internally validated by items being presented multiple times and by items being presented in the inverse. SKeVA™ ©, which is now in its 5th full year has been expanded to include 8th grade Texas Science key words. The assessment system has been analyzed as a valid and reliable tool over the last 5 years. The research team continues to test individual items while expanding the system to include targeted key words from the evolving Texas State assessment in science. Adiguzel and Vannest (2008) looked at the SKeVA™ © web-based formative assessment made up of 1,813 key word science vocabulary terms and found the pre-post measures created a large and valid effect size. SKeVA™ © was validated by experts in the field and beta tested by using individual assessment items (Vannest et al., 2007). Vocabulary in the SKeVA™ © system is reliable and valid as a measure of word knowledge in science (Adiguzel & Vannest, 2008). Six of the items for this study were used in the assessment of vocabulary foundational word knowledge.

Espin, Shin, and Busch (2005) suggested vocabulary matching exams validly measure students' word knowledge. To ensure mathematical relationship from the research findings were linked to the assessment matching exams were used to measure foundational word knowledge. Experts from the field reviewed the matching vocabulary assessment. Experts included two Science Education Faculty, two practicing biology teachers, and two pre-service science education teachers who have already earned 18 credit hours in science, which included biology course work.

The second dependent variable was Biology course grades. The LS teacher provided the researcher with the Biology 1 course grades of the participants. As suggested from the research of Espin and Deno (1995), vocabulary knowledge in the content area is a strong predictor of course grades. Tracking course grades in Biology allowed the researcher to investigate if a word learning intervention for students with language-based LD impacts individual student grades.

Independent Variable

Study Stack™ digital flash card program is the intervention being used for the current research study. Students volunteering to be participants in this study will engage with one of two types of flashcards.

[Home](#) | [Science](#) | [Biology](#) | [Phase I Terms](#)



Phase I Terms

Description: [Biology Vocabulary Terms](#)

Category: [Biology](#)

Created by: ksmithathome@hotmail.com on 2010-03-31

[Add Notes](#)



Figure 4


Study Stack™ Program Interface

As shown above, the Study Stack™ program allows users to choose the format in which they want to engage to practice learning vocabulary terms. Students independently studying with the Study Stack™ program can use flash cards, study stack, study tables, matching, type in the

answer, bug match, and hungry bug, but they can also play word games like hangman, crossword, and unscramble. Additionally, the Study Stack™ program also provides an option to print paper flash cards and to export the terms to a mobile device.

Index Cards for perforated stock

Print cards on standard index card stock which puts three cards per page. Print the document double sided so that questions can be on one side and answers on the others. The question will be on the odd pages and the answers on the even pages.



Since the "Phase I Terms" data contains 3 columns, you need to specify what to print as the question and what to print as the answer.. Please confirm what will be printed.

Font Size

Question: (odd pages)

Answer: (even pages)

Figure 5

Screen Capture of Study Stack™ Printable Flash Cards

Participants either used the printable paper flash cards produced by Study Stack™ or the digital flashcard option. The paper flash cards were generated by the Study Stack™ program, to ensure exact words and like definitions were presented to the students in the control group (see Figure 6). The helper words or mnemonics also appeared on the paper flash cards to standardize the treatment for both groups. All of the paper flash cards were placed in a zip lock bag and assigned to each individual student by placing the non-name identifier on the back of each set.

The researcher embedded the digital flashcard option into a Webcourse@UCF to standardize the treatment for the experimental group (see Figure 7).

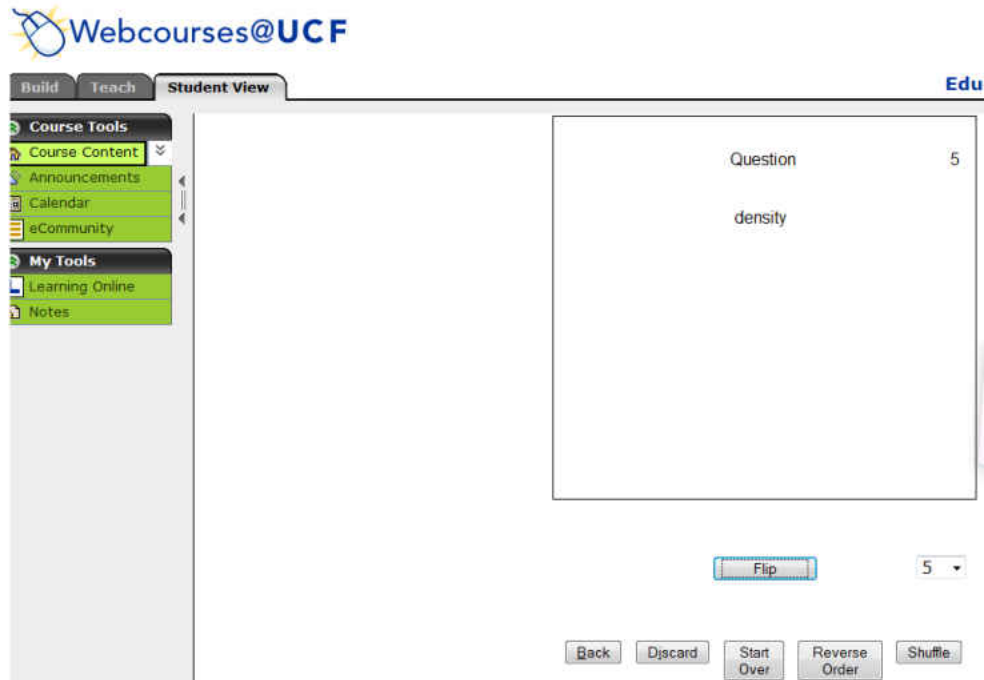


Figure 6

Webcourse@UCF with Study Stack™ Flash Cards Imbedded

Within the flashcard option the targeted word appears as a question, the definition as the answer and an additional column was programmed for a helpful hint or to anchor the term by a memory device such as a mnemonic or peg word. Once the intervention started, on day three, the students were blocked from accessing the intervention at the district level. The Webcourse@UCF was disabled from the student computers. A decision was made to create a short cut from the targeted study intervention to the desktop of the classroom computers. Each day after the intervention was completed, the classroom computers were turned off until the next day during intervention assignment. As suggested by the literature, a mnemonic device was programmed into the Study Stack™ program serving as a memory enhancement.

Data Collection

Data collection of the research occurred over the entire third grading period, which is 45 instructional days. To account for time spent in intervention, the data collection was spoken

about in terms of days. Each day during the intervention phase, students spent a total of five minutes interacting with the targeted terms in this research. Due to teacher duty days and holidays occurring naturally in the school calendar, data collection was specifically described in terms of the day data were collected. Table 6 provides a summary of data collection.

Table 6

Details Each Week of Data Collection.

Prior to Intervention	Intervention Phase			After Withdraw of Intervention		
Day 1	Day 2-11	Day 12- 21	Day 22-31	Day 32	Day 43	Day 45
	Phase I	Phase II	Phase III			
Pre-test	Probe	Probe	Probe	Post-test	Delayed	Interview
48 terms	Phase I (16 terms)	Phase II (16 terms)	Phase III (16 terms)	48 terms	Post-test 48 terms	

Validity

Three important types of validity were analyzed in the current research: (a) representational/content validity, (b) internal validity, and (c) external validity. Representational validity is not often considered, especially in school studies. According to the curriculum map provided to all district teachers of biology (see <http://blackboard.volusia.k12.fl.us>), and driven from the Florida State Standards, vocabulary terms have been identified and are suggested as key terms for teachers to focus upon in each subject. For the current study, the biology curriculum map was used to generate a list of 48 vocabulary terms that students are required to learn and master in Biology 1 in Florida (see Table 7). These 48 terms were targeted for instruction and learning during the timeframe of the study and provided overall study content validity.

Table 7

Targeted Biology Terms

Volusia County Targeted Biology Vocabulary		
Jan-3-Feb 4th (19)	Feb-7-April 22 (29)	
ATP	Allele	Inheritance Patterns
Chlorophyll	Codon	Pedigree
Chloroplasts	DNA	Phenotype
Photosynthesis	Genetic Code	Punnett Square
Product	Protein Synthesis	Biotechnology
Reactants	Ribosomes	Crossing Over
Stomata	RNA	Genetic Recombination
Transpiration	Transcription	Haploid
Activation Energy	Translation	Independent Assortment
Carbohydrates	Cell Cycle	Meiosis
Enzymes	Chromosome	
Lipids	Diploid	
Nucleic Acids	Mitosis	
pH	Mutation	
Proteins	Gamete	
Aerobic	Genotype	
Anaerobic	Heredity	
Cellular Respiration	Heterozygous	
Fermentation	Homozygous	

In reference to internal validity, Campbell and Stanley (1963) suggested researchers ask, “Did in fact the experimental treatments make a difference in this specific experimental instance?” (p. 5). Internal validity is then the confirmation of an experimental affect. Threats to internal validity relevant to this research were summarized by Patten (2004) in the literature and included: (a) possible changes in the instrumentation from pretest to posttest; (b) the testing itself, or “the

effects of the pretest on the performance exhibited on the posttest”; (c) a statistical regression, “which occurs if the participants are selected on the basis of their extreme scores”; (d) intact groups which “can occur when we have two comparison groups that are not formed at random” (p. 88).

Special attention was made to address internal validity within the given study. Considering intact participants were used due to the conditions of educational research, a way to control for an overall lack of randomization was by analyzing mean growth scores (Fitzmaurice, Laird, & Ware, 2004). For both research questions in this study, Repeated-measures ANOVA was used to examine how the two conditions, paper and digital, differ in pre-posttest scores for vocabulary assessment and semester Biology course grades. Descriptive statistics, the tests of within subject effects, differential effects and mean plot representations of the data are reported for the paper and digital flash card users over time.

An attempt to maintain homogeneity of participants in this study was made by randomly assigning subjects into the two study conditions (paper or digital) using a random number generator. Post-hoc analyses were also conducted to investigate homogeneity.

External validity is also an important factor that was considered for the current research. Patten (2004) suggests researchers ask, “To whom and under what circumstances can the results be generalized?” (p.89). Generalization of the experiment is the object in external validity. However, the more internal threats a researcher has the less the external generalizing becomes. Since wide generalizations will not be made from this research, this research is more of an exploratory (hypothesis-generating) research investigation (Cook & Campbell, 1979).

Treatment Fidelity

A senior research associate assisted in the data collection of this study. A doctoral candidate, who completed qualitative research for his dissertation research, assisted in the collection of data. After being trained with the Biology Word Learning Manual (Appendix C) and the Inter-Rater Form (Appendix D), the senior research associate and the researcher held two practice rating sessions. Both the researcher and the associate used the inter-rater forms to evaluate two practice sessions with the teacher and a mock student recruited from the research site to practice gathering data. This practice not only helped the team review all the procedures, but it allowed the researcher and associate to check inter-rater agreement. The practice session was recorded for later use if more practice was deemed necessary by the researcher.

An apriori decision was made to set the agreement of the ratings at 80% or above. The Inter-Rater-Form was developed as a verification tool to indicate if each of the study protocols were being following. In a yes-no fashion the researcher and senior research associate indicated if in fact the protocols were completed. In each category a “yes” was required. These procedures were critical to the study and had to be followed so that data collected could be interruptible. Of the 30 days of intervention 25% were observed, making 8 total days of observation for treatment fidelity. The researcher was aiming for compliance at 100%. However, if one of the six categories were not responded to in a yes fashion the overall rating was reduced to 83%. In addition, to ensure treatment fidelity the LS teacher completed a daily observation checklist (Appendix C).

Reliability

Suen (1988) defined reliability of research data in two ways, as the “general trustworthiness of obtained data” and the “mathematical relationship between an ‘observed’ test

score and the test-taker's 'true' score on that test”(p. 265). To ensure the accuracy of data collected in this study, treatment fidelity procedures were employed during data collection. Two research associates supported the collection and analysis of data for accuracy. When data were collected, 25% of the scored vocabulary assessments were re-assessed by the junior research assistant. The junior research associate was IRB trained, enrolled in a communications disorder course, participated in a research internship, and participated in the “honors in the major” thesis completion. The junior research assistant also checked for reliability of 25% of the data entered into SPSS.

To ensure a mathematical relationship is linked to the assessment, Espin, Shin, and Busch (2005) suggest vocabulary matching exams should validly measuring students' word knowledge. All statistical examinations were completed using SPSS. Furthermore, a professor in statistics scrutinized the data analysis for accuracy and appropriate statistically procedures in SPSS. Additionally, and perhaps most importantly, post-hoc analysis of data was conducted to ensure statistical reliability of reported outcome measures.

Data Analysis

Mean difference calculated from the post-test outcomes were analyzed to investigate the effects of the Study Stack™ intervention versus paper flash cards. To determine changes that occurred in the digital and flashcard groups, an analysis of variance of group mean scores for both word learning and Biology 1 course grades were examined using a Repeated-Measures ANOVA conducted on pre-posttest scores for vocabulary assessment and semester grades.

Semester grade differences were also examined. The mean differences in Biology 1 course grades were analyzed. The LS teacher provided all student participants' Biology 1 course grades from grading periods one through three. Mean grade differences were calculated using the

standard 4.0 scale. All grade calculations were examined using a 4.0 grading scale converting each A to four points, B to three points, C to two points, D to one point and each F were converted to zero points. Grade averages for semester I & II course grades were computed. Each student's grading period one and two Biology 1 course grades were added together and divided by two producing an average grade for semesters I and II. Then, mean semester I and II course grades were used as the pre-measure, while the post-measure was the mean semester III biology course grades.

CHAPTER 4:

RESULTS

The purpose of this research study was to examine the effect of a technology-based vocabulary intervention versus a paper flash card intervention on students with Learning Disabilities acquiring foundational vocabulary. The research questions examined were:

- (1) Is there a difference in scores on a vocabulary assessment between students with LD learning content Biology 1 terms using a digital flash card program compared to paper flash cards?
- (2) Is there a difference in Biology 1 course grades between students with LD learning content Biology terms after using a digital flash card program compared to paper flash cards?

Multiple measures were used in evaluating the differences in students randomly assigned to a paper or digital flashcard group. Both quantitative and qualitative data were gathered. The quantitative measures included a pre-test, three biweekly probes, a posttest, a delayed posttest, and semester grades prior to and after the intervention. The qualitative measures included voluntary interviews conducted with students from the digital and paper flashcard groups and field notes completed by the teacher and researcher.

This chapter is organized into four sections. First, the quantitative data are presented addressing the two research questions. Next, fidelity of treatment measures is addressed. Third, reliability of vocabulary assessment scores and course grades are shared. The chapter concludes with an examination of the qualitative data describing students' perceptions of the use of flash cards.

Overview of Quantitative Data Analysis

To determine changes occurring in both the digital and paper flashcard groups, an analysis of variance of mean group scores for both word learning and Biology 1 course grades were examined. A Repeated-measures ANOVA was conducted on pre-posttest scores for vocabulary assessment and semester grades (Average Sem I & Sem II, versus Sem III). The mean number of vocabulary words on the pretest and posttest and mean biology semester grade calculated on a 4-point grading scale were examined. All grade calculations were executed using a 4.0 grading scale converting each A to four points, B to three points, C to two points, D to one point and each was F converted to zero points. Mean grade differences were calculated using the standard 4.0 scale. The pre-measure of Biology 1 course grades were computed by taking each grade earned by the students and computing an average of semester I and semester II grades. Semester III was used as the post-measure. Descriptive statistics, the tests of within subject effects, differential effects and mean plot representations of the data are reported for the paper and digital flash card users over time.

Data Analysis for Research Question 1

Is there a difference in vocabulary assessment scores between students with LD learning content Biology 1 terms using a digital flash card program compared to paper flash cards?

A repeated-measures ANOVA was conducted to analyze change over time in vocabulary assessment. The dependent variable was the number correct on the vocabulary assessment. Time was the within-subjects factor, and card type served as the between-subject factor. In the following section descriptive statistics, the tests of within subject effects, differential effects, and mean plot representations of the data are reported.

Descriptive Statistics

The descriptive statistics of students at the pretest, and posttest scores based on card type are presented in Table 8.

Table 8

Descriptive Statistics Vocabulary Assessment

Condition	Card Type	M	SD	N
Pretest	Paper	6.77	4.126	13
	Digital	9.25	4.202	12
	Total	7.96	4.267	25
Posttest	Paper	13.69	9.578	13
	Digital	14.33	5.805	12
	Total	14.00	7.837	25
Delay Post	Paper	14.00	10.206	13
	Digital	14.25	7.375	12
	Total	14.12	8.776	25

Mauchly's test of Sphericity results showed the assumption of homogeneity of error covariance was met. The interaction between time (pretest to posttest) and card type was not statistically significant [$F(1,23)=16.58$ $p=0.000$]. The effect of time from pretest to posttest was statistically significant [$F(1,23)=.389$ $p=0.539$].

The effect of the card type from pretest to posttest was not statistically significant [$F(1,23)=0.561$ $p=0.461$]. The between subject effect yielded no differential change on vocabulary assessment from pretest to posttest by card type.

In Figure 8 the blue diamond represents the mean scores of the paper card group at the pretest (time 1) and posttest (time 2), the red square represents the mean scores of the digital card group at the pretest (time 1) and posttest (time 2). Posttest mean scores between paper and digital were more similar after the treatment was administered for six weeks. For both paper and digital groups, the mean scores of the vocabulary assessment demonstrated an increase over time.

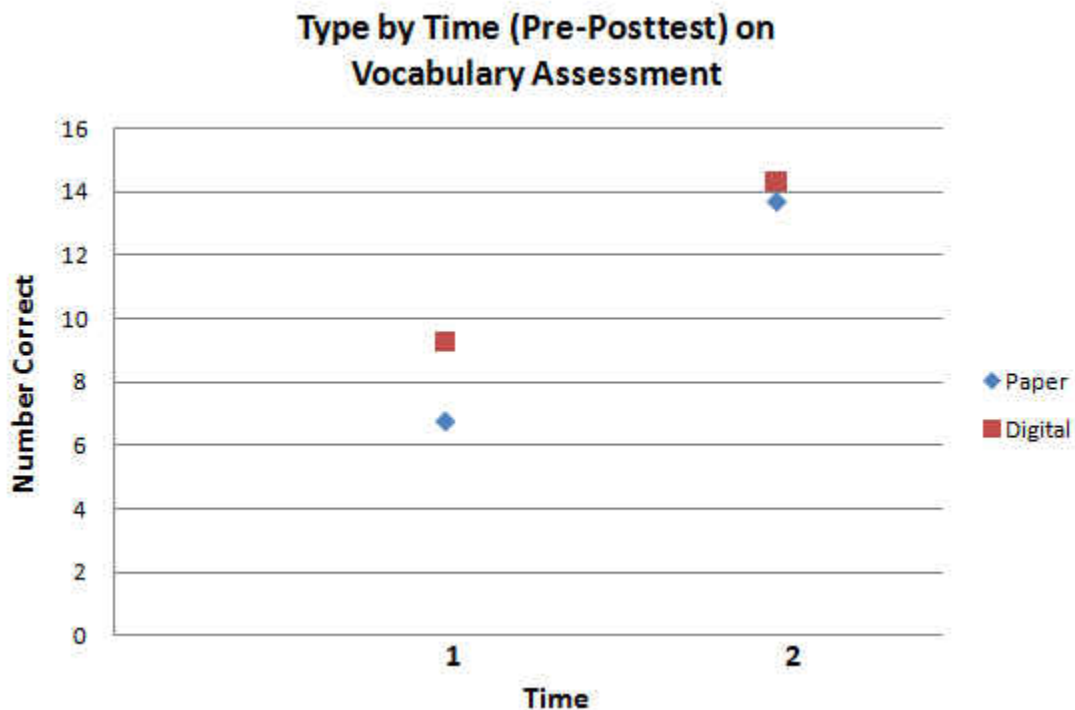


Figure 7

Card Type by Time (Pre-Posttest) on Vocabulary Assessment

Additionally, the delayed posttest effects were examined. The interaction between time (pretest to delayed posttest) and card type was not statistically significant [$F(1,23)=17.31$

$p=0.000$]. The effect of time from pretest to posttest was statistically significant [$F(1,23)=0.576$ $p=0.456$]. Figure 9 shows the mean scores of the paper card group (blue diamond) at the pretest (time 1) and delayed posttest (time 2), and the mean scores of the digital group (red square) at the pretest (time 1) and delayed posttest (time 2). Mean delayed posttest scores between paper and digital were continually more similar even after the treatment was removed for three weeks. An increase over time for both conditions was noted, even after the treatment was removed (pretest to delayed posttest).

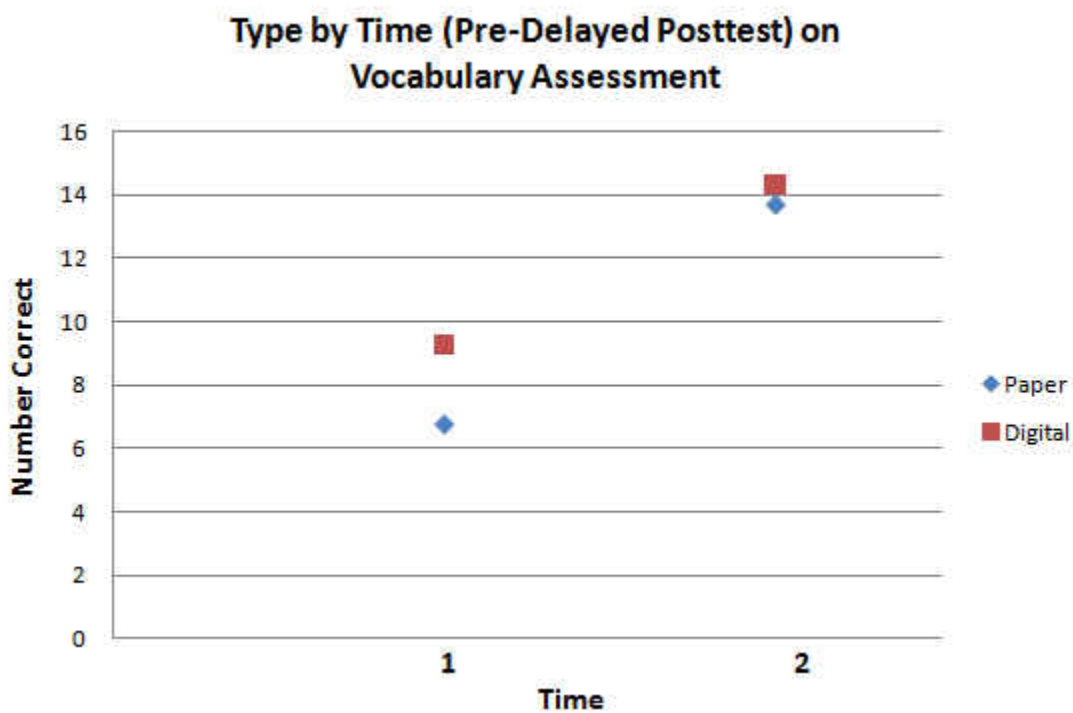


Figure 8

Card Type by Time (Pre-delayed Posttest) on Vocabulary Assessment

Overall, a statically significant differential effect on vocabulary assessment over time was measured.

Data Analysis for Research Question 2

Is there a difference in Biology 1 course grades between students with LD learning content

Biology 1 terms after using a digital flash card program compared to paper flash cards?

A repeated-measures ANOVA was conducted to analyze change over time in biology course grades. The dependent variable was the semester course grades. Time was the within-subjects factor, and card type served as the between-subject factor. The tests of within subject effects, differential effects and mean plot representations of the data are reported.

The descriptive statistics of students at the pre measure (Average semester I & II grade) and post measure (semester III grade) based on digital or flashcard group are presented in Table 9.

Table 9

Descriptive Statistics Semester Course Grade

Condition	Card Type	M	SD	N
Pre Sem I_ Sem II Avg	Paper	0.731	0.9707	13
	Digital	1.125	0.7724	12
	Total	0.920	0.8860	25
Post Sem III	Paper	1.54	1.450	13
	Digital	1.75	1.215	12
	Total	1.64	1.319	25

Mauchly's test of Sphericity results showed the assumption of homogeneity of error covariance was met. The interaction between semester grade over time and card type was not

statistically significant [$F(1,23)=11.863$ $p=0.002$]. The effect of semester grade over time was statistically significant [$F(1,23)=0.193$ $p=0.665$].

The effect of the card type was not statistically significant [$F(1,23)=0.561$ $p=0.461$].

The between subject effect yielded no differential change on Biology 1 course grades from pre-measure to post-measure by card type.

As presented in Table 9 the effect size (partial eta squared= 0.340) suggested 34% of the variance in semester grades of third grading period might be attributed to the intervention. Observed power = 0.909. The effect size (partial eta squared= 0.008) suggests .8% of the variance in semester grades of third grading period might be attributed to the interaction of the semester and the card type (see Table 10).

Table 10

Tests of Within-Subjects Contrasts

Source	Semester	Type III		Mean Square	F	Sig.	Partial		
		Sum of Squares	df				Eta Squared	Noncent. Parameter	Observed Power ^a
Semester	Linear	6.404	1	6.404	11.863	0.002	0.340	11.863	0.909
Semester *	Linear	0.104	1	0.104	0.193	0.665	0.008	0.193	0.071
Card_Type									
Error(Semester)	Linear	12.416	23	0.540					

a. Computed using alpha = 0.05

Semester grades over time are shown in Figure 10. The blue diamond represents the mean semester course grade of the paper card group at the pre measure (Semester 1: Avg Sem I & Sem II) and post measure (Semester 2: Sem III), the red square represents the mean scores of the digital card group at the pre measure (Semester 1: Avg Sem I & Sem II) and post measure

(Semester 2: Sem III). At the post measure the mean scores between paper and digital were more similar than the pre measure. For both paper and digital groups the mean course grades showed an increase over time.

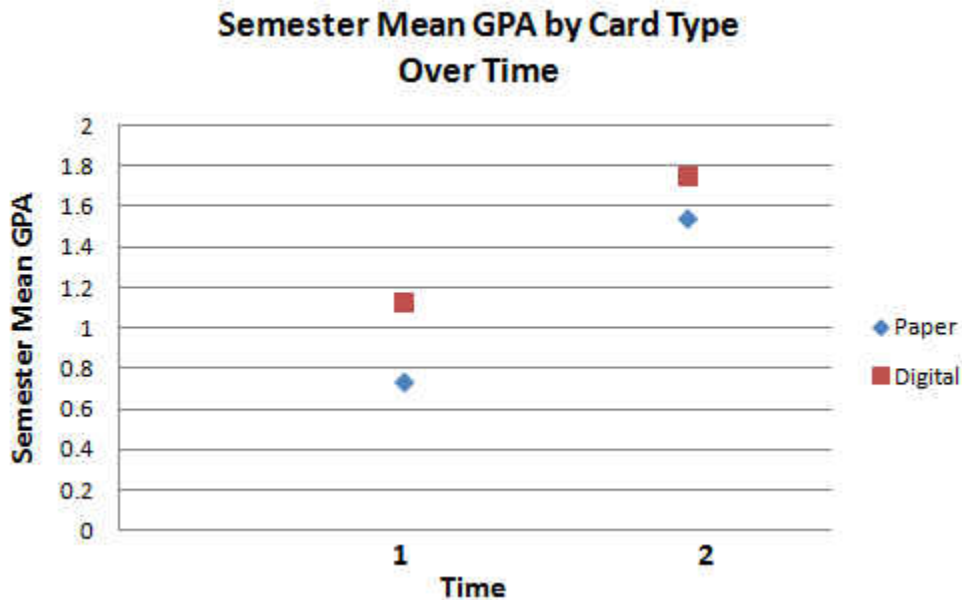


Figure 9

Card Type by Time (1: Avg Sem I & Sem II, 2: Sem III)

Fidelity of Treatment

The researcher executed multiple measures of fidelity of treatment in this research. Fidelity checks included analysis of teacher lesson plans, a daily teacher checklist and eight inter-rater evaluations.

Analysis of teacher lesson plans

Teacher lesson plans were obtained and reviewed for any strategy interventions that addressed biology vocabulary. Noted was the vocabulary column in the teacher lesson plans (see Appendix E). The vocabulary column from the teacher lesson plans were cross examined with the targeted intervention biology terms. After examination, it was determined that the teacher

did not address any of the targeted vocabulary in the learning strategies class throughout the intervention.

Daily teacher observation check list

The teacher in this study completed a daily check list consisting of yes-no questions (see Appendix C). Through this checklist, the teacher was able to verify intervention use across five categories, (a) folder retrieval, (b) timer use, (c) flash cards use, (d) graphing, and (e) folder storage. If a “no” was recorded, anomalies that had occurred were noted. Anomalies included an office referral, an assistive technology support teacher conferencing with a student about some necessary equipment, and students being redirected for text messaging during the five minute intervention. The teacher’s notes also included her personal reflections on the students’ ability to engage in the intervention that day. During week two of the intervention a student was called to the office. However, the teacher asked the student to finish his flash cards. Despite the student finishing, the teacher noted she felt the student had been, “distracted from intervention” due to the office call. The teacher also noted the student using assistive technology may have on day four of the intervention “participated more fully” because the assistive technology support service provider was present. In the past the teacher reported that this student tended to work harder when the technology specialist was present. Lastly, on two different days, day 16 and day 22, students were redirected for due to text-messaging during the intervention. The teacher included a note stating students, “resumed work thereafter.” Overall, 26 out of 30 days were spent in intervention without any teacher notes related to interruptions or impact on the daily intervention.

Observation Inter-rater Instrument

An apriori decision was made to set inter-rater agreement at 80% or above. The Inter-Rater-Form was used as a verification tool to indicate student engagement of study protocols. In a yes-no fashion the researcher and associates were able to verify intervention use at or above 80%. Indicators were grouped into five categories, (a) folder retrieval, (b) timer use, (c) flash cards use, (d) graphing, and (e) folder storage. Seven of the eight observations during the 30 days of intervention yielded 100% verification for treatment fidelity. One observation yielded an 80% agreement due to the research assistant reporting not being able to see students in the far corner of the room completing the paper flash card protocol. Overall, fidelity of treatment was established at or above 80% for 25% of the days observed.

Reliability

The researcher executed multiple procedures to determine reliability of the research data collected. Steps included independent review of the assessment of foundation vocabulary word knowledge and random evaluation of quantitative data. Qualitative data were evaluated for accuracy of transcription and independently coded. The researcher completed member checking with the interview participants to ensure student voices were represented with precision.

Assessment of Foundational Word Knowledge

Espin, Shin, and Busch (2005) suggested vocabulary matching exams validly measure students' word knowledge. Matching exams that went through expert review were used in the current research. In addition to expert review, two students from an advanced placement biology course at a local high school and two university pre-service teachers completed the assessment to determine that all procedures were accurate and easy to follow. All examinees were able to score 48 out of 48 items correct.

Reliability of Instrument Scoring

When data were collected, 25% of the instruments were independently scored by the research associates. Additionally, post-hoc analysis of data was conducted and verified by a UCF professor from the Statistics Department. The statistical procedures were checked for accuracy in terms of correct procedural steps being entered in SPSS.

Validity

Internal, external and practical validity were evaluated in this study. Fitzmaurice, Laird, and Ware (2004) suggest using gain score analysis for mean growth change when true randomization of participants cannot be achieved. For both of the research questions in this study, mean change scores were examined to investigate the two groups' change over time. Homogeneity of participants in this study was met. Thus, in reference to internal validity, Campbell and Stanley (1963) suggested researchers ask, "Did in fact the experimental treatments make a difference in this specific experimental instance?" (p. 5). The data trends show both paper and digital flash card users made statistically significant gains in their scores (vocabulary assessment and semester course grades); however, no statistically significant interaction effect of between factors (card type) was found. Since a control group was not obtained for the current research, generalized outcomes could not be made. However, the data show that students' mean Biology 1 course grades did increase. Beyond learning foundational biology vocabulary, earning a high school diploma requires passing course grades in Biology 1 for students with LD who participated in this study. The intervention may have contributed to students receiving passing course grades.

Students' Perceptions of Intervention

Perceptions on the use of a flash card intervention were measured through interviews. A voluntary sample of students participated in the interviews. Participants were provided the consent protocols in accordance with the University's Institutional Review Board (IRB) process. Student assent to participate was acknowledged by students who indicated their understanding and agreement to participate in the interview portion of study both before recordings started and again while the recordings were running. Student who participated did so during lunch to ensure no interruption in learning time. The semi-structured interviews took no longer than 8 minutes per student. The interview protocol in Appendix F was designed to measure the social validity of use of the flash cards in general.

Description of Interview Participants

Forty percent of the students who participated in the overall research were interviewed. Five of the students interviewed were in the paper flash card group; the other five were in the digital flash card group (Table 11). Each student was assigned an interview research code, 01 through 10 to protect student identify in relation to their responses.

Table 11

Descriptive Statistics of Interview Participants by Card Type

Condition	Gender	Race
Paper	1 Female	Hispanic
	4 Male	3 Caucasian*, 1 Hispanic
Digital	1 Female	Caucasian
	4 Male	1 Biracial, 3 Hispanic

Note. 1 Student Interviewed Received Speech-Language Services as the Primary Disability

Qualitative Data Analysis

All 10 interviews consisted of eight questions that focused on the use and utility of the flash card intervention. Interviews were recorded for later transcription and analysis. Verbatim transcripts were drafted after interviews were conducted (see Appendix G). Transcription was time consuming due to students Speech-Language deficits. Though only one student (P06) interviewed was identified as having a primary language disability, data on past language services was not available nor was the secondary classifications. Transcriptions were then checked by a junior research assistant for any discrepancies and adjustments were made by both the researcher and junior research assistant. Then 20% of the transcripts were independently reviewed by the senior research assistant for accuracy. A random selection of 2 full interviews yielded 99.8% accuracy, noting only 3 errors in the transcriptions.

The transcriptions were coded by the researcher and junior research assistant independently. After the independent review the researcher, junior research assistant, and senior research assistant discussed the codes and any noted discrepancies. A second review of the coded transcripts was completed by the researcher and junior research assistant. The codes found in Appendix H were used for the final qualitative analysis. These codes were then synthesized into 7 major themes: (a) difficulty of the task, (b) helpfulness, (c) supportive of learning, (d) time, (e) reusability, (f) organizational support, and (g) perceptions of technology use.

A summary statement was developed for each of the themes. These statements were then presented to the student participants for member checking, agreement or disagreement. The students reported 100% agreement with the statements as written.

Theme Analysis

The 7 themes found in the transcriptions were regrouped and sorted into broader, conceptual categories of; (a) learning, (b) structure, and (c) technology (see Figure 11).

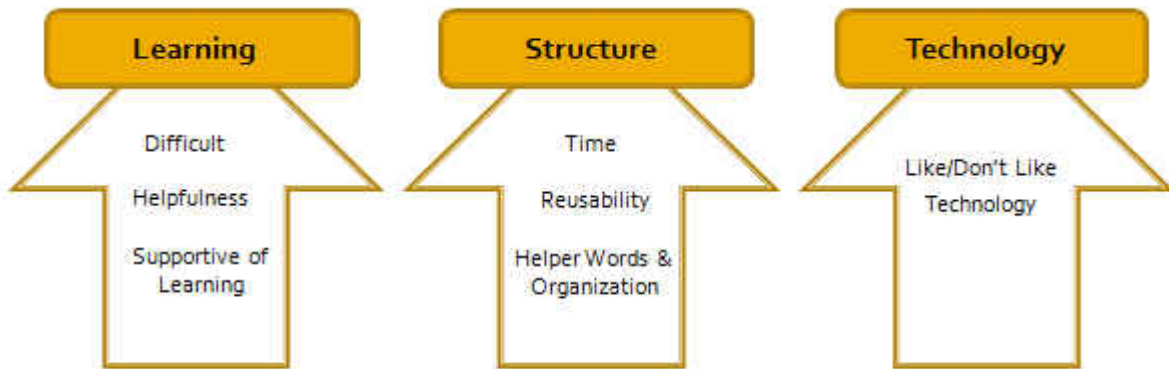


Figure 10

Themes based on Conceptual Category

Learning

In this theme the students talked about the difficulty or ease of the task, if they saw it as helpful and supportive of their learning both the vocabulary words and biology content. The level of difficulty with the vocabulary was coded as “hard” by two different students (P05 and P06) who were interviewed. One of the students (P05) expressed, “Some of the words were hard to pronounce and it’s hard to understand.” Another student (D03) mentioned the computer version of the cards as being “hard” by saying, “It was kinda of difficult on the computer.” Another student (D09) mentioned, “It was hard, but like, I get used to it.” The researcher noted the utility of the computer version was difficult for one of the student participants (D03) who specifically stated, “I would feel more comfortable using the flash cards then the computer.” A preference for paper cards was noted by only this student participant.

All of the students interviewed mentioned flash card use as supporting their learning of the biology vocabulary. For instance, one student (P08) said, “Well I didn’t know what Mitosis was before, but since you gave me the flash cards about it, it helped me more. And there were some other words I did not know either, but since I had some vocab words for that, it helped me a little bit with the tests that I took that had something to do with it.” This student goes on to share that he learned more than he had expected, “It worked out better than I thought.” Another student (P02) replied, “I thought it worked, I learned a little.” Another student (D04) stated, “I liked it, I liked the whole, the whole words thing, I think I learned a lot from it,” and yet another (P07) expressed, “Personally, I think they were just helpful all the way around, because it was just easier to remember.”

Structure

This category contained responses from students related to time, reusability and organization of the flash card activity related to their learning. The researcher probed for reasons as to why students felt the cards were supportive of learning and many felt that the mnemonics increased memory. For instance a student (P08) suggested, “If I was stuck I would just look at the helper words and I would probably get it more.” Another (D01) said, “The way they were organized and displayed really helped. The word and the definition and then the way for you to remember the definition really helped.”

The amount of time spent on the task also emerged as a theme. One student (P07) stated, “We could’ve done about 6 minutes, but I don’t care.” Another student mentioned (P08) if they had paper cards, he would carry them to remember to look at the cards more often, again indicating time spent in intervention could have increased from the students’ perceptions.

All of the students interviewed agreed that it would be a good idea to use flash cards for studying biology vocabulary in the future. One student (P02) stated the reason for continued use was, “Because they [cards] helped me learn my vocabulary words better than I do now.”

Another student (P06) said, “Cause it’s just, I, I did better than like studying from a book, and then taking a test on them [vocabulary], so I got like the more interactive words studying, studying them cards then just looking every [word] up.”

Technology

With regards to the category of technology students mainly focused on whether they liked or did not like the technology used for the digital flashcards. Students who were assigned to the digital group reported they liked the technology. Specifically, one student (D01) said, “Well I think it helps because, with all the current technology teenagers these days have short attention spans, so unless they have like you know electronic stimulation they lose focus”, another student (D04) mentioned that technology is, “fun.” Moreover, one student (P05) in the paper flash card group mentioned she would have rather been assigned to the digital flash cards. “I would rather have the computer though”.

In conclusion, students viewed the flash card intervention favorably and felt that the cards supported their learning of biology vocabulary. Figure 12 represents the themes by individual student response by interview code.

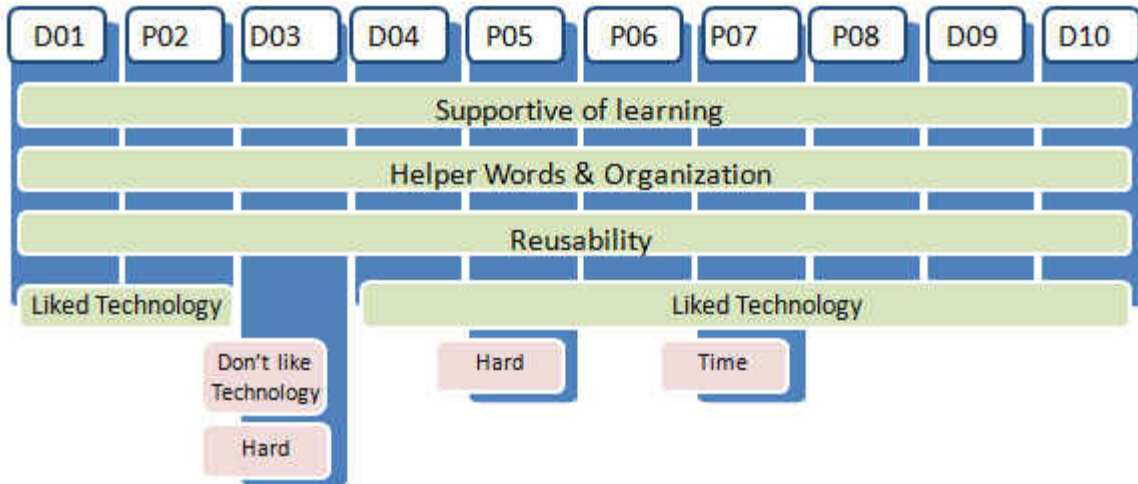


Figure 11:

Individual Participant Responses by Theme

Furthermore, students gave voice to the future use of flash cards with mnemonics to learn biology vocabulary. Although one student (D03) reported disliking the digital flash cards, the remaining 9 students responded favorably to technology's use in learning.

Summary of Analysis

The reported data in this chapter were reflective of the outcomes for students with language-based LD engaged with flash cards learning Biology 1 vocabulary. Repeated measures ANOVA results showed a statically significant increase on both the vocabulary assessment, as well as the course grades in biology, while the intervention was employed. However, the test of between effects, when considering card type, yielded no differential change on vocabulary assessment and course grades in biology. Based on qualitative measurement, students liked the intervention overall and would reuse the tool to learn biology vocabulary. Two participants noted that they would prefer a choice in card type.

CHAPTER 5:

DISCUSSION

The overarching categories used to frame the discussion reflect the voices of the students, gathered from the interviews, in the study. Their voices are used to present the outcomes of the study as derived from the data gathered, the process used throughout the study, and how these findings reflect the current literature. The chapter opens with a summary of the purpose of the research study followed by a summary of findings. The chapter concludes with implications of the research, limitations, and future research.

Purpose of the Study

The purpose of this study was to examine the effect of a technology-based vocabulary intervention for foundational vocabulary development for Biology students with LD. The research explicitly examined students with LD use of Study Stack™, digital flash cards, versus paper flash cards to acquire foundational vocabulary in Biology. The research questions examined were:

- (1) Is there a difference in scores on a vocabulary assessment between students with LD learning content Biology 1 terms using a digital flash card program compared to paper flash cards?
- (2) Is there a difference in Biology 1 course grades between students with LD learning content Biology 1 terms after using a digital flash card program compared to paper flash cards?

To determine the difference between student groups randomly to each of the conditions (paper and digital) a curriculum-based biology vocabulary assessment as well as semester course grades

were collected and analyzed. Qualitative data were also gathered to examine student perceptions of the intervention.

Summary of Findings

A Repeated measures ANOVA was conducted to determine if there were differences in scores on a vocabulary assessment between students with LD learning content Biology terms using a digital flash card program compared to paper flash cards. The results from the study showed no interaction effect between time (pretest to posttest) and card type [$F(1,23)=16.58$ $p=.000$]. However, the effect of time from pretest to posttest was statistically significant [$F(1,23)=.389$ $p=.539$]. Even after the treatment was withdrawn for three weeks, a delayed posttest showed the effect of time from pretest to delayed posttest was statistically significant [$F(1,23)=.576$ $p=.456$]. The interaction between time (pretest to delayed posttest) and card type however did not show a statistically significant difference [$F(1,23)=17.31$ $p=.000$]. These findings indicate the vocabulary intervention may have impacted student achievement on the vocabulary assessment over time.

A Repeated measures ANOVA was also conducted with the dependent variable defined as biology course grades, time was determined to be the within-subjects factor, as card type was defined as the between-subject factor to answer research question two. The interaction between semester grades over time and card type was not statistically significant [$F(1,23)=11.863$ $p=.002$]. The effect of semester grades over time was statistically significant [$F(1,23)=.193$ $p=.665$].

Based on student interviews Learning, Structure, and Technology emerged as conceptual themes. Students indicated they liked the intervention and would reuse the study tool to learn

biology vocabulary. The research also indicated that some participants would prefer a choice in card type for word study.

Implication of Findings

As a result of IDEA (2004), classroom teachers are expected to make instructional changes when students are reported as making insufficient progress toward IEP goals, this includes science instruction. However, there is lack of evidence that diagnostic-prescriptive instruction takes place in general biology classrooms for students with LD in high school (Swanson, 1999). Furthermore, current research indicates a lack of evidence of high school science teachers using prescriptive teaching methods to support science achievement of students with LD. When conducting an electronic search in ERIC, EBSCOhost and PsychInfo data bases with search terms “diagnostic-prescriptive instruction” AND “science instruction” AND “Learning disability”, only one document was produced (Johnson, 1981). Although many students with LD are served in general education biology classrooms, teachers struggle to support this population in positive learning outcomes. Findings from this study are framed in past literature and current themes from student interviews including, Learning, Structure and Technology.

Learning

Direct instruction in science literacy has been frowned upon by some researchers (Brown & Ryoo, 2008; Fisher, Grant & Frey 2009), but students with language-based LD cannot increase proficiency without vocabulary instruction (Pamar, Deluca, & Janczak, 1994). The current research study compliments the work of Pamar, Deluca, and Janczak (1994) with students gaining Biology 1 word knowledge over time in both Parmer and colleague’s work and this current study. Using direct instruction of content vocabulary positively impacted the

participants in the current research study learning Biology 1 vocabulary. Although the literature (Everett & Moyer, 2004; Maroney, Finson, Beaver, & Jensen, 2003; Melber, 2004) indicates and the author of this dissertation believes strongly in inquiry-based learning, some students with LD might benefit from some level of direct instruction of the intensive vocabulary found in biology.

Particularly, direct instruction of Biology 1 content vocabulary may benefit students identified as having a language-based LD in sub-populations. The current study had 13 students from Hispanic backgrounds. Though all students in the study showed a statistically significant increase on the Vocabulary Assessment, it is interesting to note, that students from Hispanic backgrounds outperformed Caucasian students in mean gain scores on the Vocabulary Assessment (see Table 12).

Table 12

Student Mean Gain Scores on the Vocabulary Assessment based on Race

Race	Mean	N	SD
White	4.64	11	7.978
Hispanic	6.62	13	6.727
Biracial	14.00	1	
Total	6.04	25	7.271

Finding a way for students who are LD to be successful in biology is critical, when Cawley, Kahn, and Tedesco (1989) noted that 50-60% of students with disabilities reported below average or failing in grades 9-12 it was apparent. The NLTS2 research reported 8% of all students with disabilities in the general education curriculum have grades of mostly D's and F's (Wagner et al., 2006). The current study affirms these findings with mean Biology 1 course

grades of students in the study being primarily F's prior to intervention ($M_{total}=0.920$), to an increase in mean Biology 1 course grades to rising to nearly C's ($M=1.64$). Students validated the results by accounting for the use of the flash card intervention as being helpful and supportive of learning. One student (D10) directly stated, "It was helpful and it really help me a lot". All of the students interviewed conferred that the intervention positively supported and impacted learning from their point of view.

Espin and Deno (1995) found vocabulary knowledge to be the strongest predictor of student performance on content-study tasks. Unfortunately, students with LD often "require more support in the area of vocabulary development [in order] to achieve their academic potential than has been typically offered in mainstream classrooms" (Wannarka, 2010, p. 2). The reason for needed support has been largely attributed to memory deficits for students with language-based LD (Carlisle, 1999; Carlisle, Fleming, & Gudbrandsen, 2000; Koury, 1996). The largest body of empirical research aimed at increasing memory and word knowledge for language success in science is mnemonics instruction, especially in the biological sciences. The current findings from this study show content area learning is impacted when vocabulary supports are structured and paired with mnemonics.

In order for language development coupled with mnemonics to be effective, the language that is critical for comprehension of the subject matter must first be isolated. Once the language is identified, targeted vocabulary must be assessed. Measuring students' ability to identify words and their meanings are critical to learning content must drive instruction. Furthermore, identifying the language that is most difficult to learn then creating learning episodes that allow for frequent, regular exposures of the vocabulary with a memory anchor may impact student learning of new content language.

For many students with LD, their ability to learn vocabulary is impaired. With high stakes testing, in Florida – End of Course Exams (ECE), this lack of ability to master vocabulary can make it very difficult for students with LD to even pass courses like biology. For many students with LD, the impairment is largely attributed to memory deficits and reading difficulties. For students to learn biology, teachers must move away from text-based curriculums, yet many teachers struggle with the parallels of text-based learning and ECEs. To bridge the gap for students with LD who have language impairments, they must be able to access the content of biology and increase their recall levels to that of automaticity. Students with language-based LD must have strategic, frequent, episodic, independent learning rituals to increase long-term memory storage and retrieval of content language (Wallach, 2010). Students with LD are capable of learning biology equal to their non-LD peers. Research clearly (Jitendra, et al., 2004; Lovitt & Horton, 1994; Pamar, Deluca, & Janczak, 1994; Wannarka, 2010) shows however, that vocabulary can be a barrier for students with LD. In order to impact students with language-based LD assessment scores and courses grades, structured, frequent brief opportunities to rehearse and recall vocabulary is critical.

In this study, students were provided with just that, an opportunity to put key vocabulary words into their memory storage. The need for students to put vocabulary into storage is so that with content language recall students are fully engaging in learning biology content at a deeper level instead of just factual knowledge.

Structure

Empirical biological science research using mnemonics also utilizes highly structured procedures for learning efficiency. The use of structure including frequency, replication, rehearsal, and monitoring have value in the learning routines of students with LD directly

translating to increased language growth. The current research supports the use of structure in the learning of Biology 1 vocabulary and is further validated by student interviews. One student stated, “If I was stuck, I would just look at the helper words and I would probably get it more.” Another student directly mentioned the organization of the routine supporting vocabulary growth. “The way they were organized and displayed really helped, the word and the definition, uh and then the way for you to remember the definition really helped.”

When examining the conceptual category of structure, three sub categories emerge, (a) replication, (b) usability, and (c) time engaged on the task of learning biology vocabulary. All of the students interviewed in the current research consented to the ideas of a) using the flash cards in the future, b) using the flash cards was easy, and c) spending time on the intervention was helpful learning biology vocabulary. The current findings are similar to the findings reported by Johnson, Gersten, and Carnine (1987) students with LD increased learning outcomes from pretest to posttest and reported satisfaction ratings overall. In the Johnson, Gersten, and Carnine (1987) study, students were randomly assigned to one of two conditions, a large learning set or a small learning set, each group achieved and retained positive learning outcomes.

Time spent on vocabulary instruction is noted as being important within the available research (Blachowicz, Fisher, Ogle, & Watts-Taffe, 2006; Stahl & Fairbanks, 1986). Stahl and Fairbanks (1986) found data from a meta-analysis supported the theory that instructional time spent on vocabulary teaching correlates with positive student learning and reading comprehension and learning outcomes. Learning, in this study, was positively impacted by spending only five minutes daily on vocabulary flashcard intervention.

Johnson, Gersten, and Carnine (1987) not only supported vocabulary learning, but student rating scales indicated enjoyment in learning through CAI. Current findings parallel the

work by students noting the study environment being better than typical study routines. One student exemplifies, “Cause it’s just, I, I did better than like studying from a book, and then taking a test on them, so I got like the more interactive words studying, studying them cards then just looking every [word] up”. Many students interviewed noted typical vocabulary instruction as reviewing the terms in the book. This mention of simply looking at book terms parallels the comments by researchers suggesting that the primary source of knowledge dissemination in science classrooms is the textbook (Cawley, Foley, & Miller, 2003; Cawley, et al., 2002; Yager, 1983). Moats and Lyon (1993) remind the field that 80% of all students served under the LD category have reading and language-based deficits, thus making book study an unfavorable choice for language growth. However, in a recent 2009 study of 54 science inclusive lessons, Moin, Magiera, and Zigmond found 72% of the lessons were language-based where students were expected to do some sort of reading and writing as the primary demonstration of science knowledge. Students in this study described typical study routines as being monotonous, lacking engagement and in many instances the students explained vocabulary listing was the primary mode of instruction. Lovitt and Horton’s 1994 meta synthesis suggested the field make instructional changes including textbook modifications in the content areas, structuring content by modifying the most difficult materials, and utilizing computerized modification options for students with disabilities in the content areas enabling them to master targeted content.

So how should teachers structure learning vocabulary for students with LD? In this study the LS teacher was given one of two tools that were short and yet practical interventions, she could use in a resource room or even as an alternative teach model in a co-taught setting. From this research, it is suggested that teachers identify the most difficult content to access and provide a way that is frequent, short, clear, and ritualistic for students to have the opportunity to practice

and recall the language associated with content. Incorporated into that structure should be a way to learn that is fun, frequent, and engaging. This short activity should occur daily and incorporate a way for students to see their learning gains (e.g., graphing). This type of intervention at the high school level needs to be easily managed for both the teacher and the student. For the teacher, this ease of use might be in terms of managing paperwork, timers, and materials. For the students, this process might be in terms of volume of words to master and time spent in intervention. Teachers should keep targeted learning lists short, not to exceed two terms to learn per day, thus 10 words per week as a maximum. They also should allow for brief learning sessions. About five minutes is seemingly reasonable for both the teacher to allow for in the learning environment and for the students to spend completing simplistic learning rituals.

Technology

Programming in science should aim to increase student literacy as the field of sciences is evolving at such a rapid pace (Stewart, 2005). To date there is little empirical research using technology tools for increased vocabulary development in the biological science classroom for students with disabilities. Moreover, The Horizon Report details emerging technologies in education reporting technology is increasingly the means for student empowerment and technology dramatically impacts workforce outcomes (Johnson, Levine, Smith, & Stone, 2010). The authors of the report stress that students with technology skills will have an educative and workforce advantage (Johnson, Levine, Smith, & Stone, 2010). With such dismal outcomes for students with disabilities in both science and workforce outcomes, the field needs to embrace new technologies and ground these skills in high level content areas.

Technology may in fact engage students in the M-generation (Kebritchi, 2010) while supporting students with disabilities in the content areas. It was assumed that the M-generation

would naturally desire the use of digital flash cards over paper flash cards. However, that assumption was not true for 100% of the students interviewed as one mentioned he would have preferred the paper cards. This concept introduces the argument for Universal Design for Learning, where students are empowered in the learning environment by being provided choice in learning (Hall, Strangman & Meyer, 2003). Now that we have discovered that paper and digital flash cards paired with a mnemonic device produces positive statistically significant outcomes that are similar, next steps may in fact include students being provided a choice of flash card type in which to engage. Study Stack™ has had no existing research to support engagement of learning biology vocabulary for students with LD. Students who were assigned to the digital flash card group reported they liked the technology. Specifically, “Well I think it helps because, with all the current technology teenagers these days have short attention spans, so unless they have like you know electronic stimulation they lose focus.” Another student mentioned the enjoyment that technology brings, “It was fun”. Moreover, one student mentioned she would have rather been assigned to the digital flash cards, “I would rather have the computer though”.

Any technology tools used to teach content vocabulary should enhance the learning. The fact that the technology tools are replicable, easily accessed, and addresses the standards thus the foundational content vocabulary are ideal. The technology tools should also be easily managed and prepared well in advanced of actually needing the tools for student support. Having already prepared intervention tools with vocabulary that is targeted in the content area using resources such as Brain Pop™ (www.brainpop.com), Flash Card Exchange™ (www.flashcardexchange.com), Flash Card Machine™ (www.flashcardmachine.com), Study

Stack™ (www.studystack.com), Quia™ (www.quia.com), or Quizlet™ (www.quizlet.com) are a few examples.

After the teacher has isolated the content, measured students' knowledge of the words, and provided time to independently interact with the vocabulary - then moving to more traditional exams may have a different outcome for students. Better yet though, why not use technology to move away from traditional exams and allow students to demonstrate their knowledge of concepts or vocabulary using technological tools such as video cameras, wikis, PowerPoint presentations, skits or any other method that demonstrates their learning? The current trend seems to be that if the ECE are paper/pencil then learning can only occur from a book or be assessed via paper/pencil. Yet for many students with LD this way of learning of this measure of an outcome may not demonstrate their true understanding of biology, which is really the goal of any type of assessment. Technology has the potential to allow students greater success in demonstrating and learning knowledge but only if these tools are used in a way that empower the student and provide a new way of engagement and encoding of their knowledge.

Limitations

The current research study has four major limitations. First, when conducting research using quasi-experimental designs, generalizability is always a concern (Cook & Campbell, 1979). However, accounting for the lack of true randomization, Cook and Campbell (1979) suggest randomizing the participants that are recruited for the study and this procedure was completed in the research. For the purpose of interpreting the data, an a priori decision of assuming homogeneity of variance between the two conditions, paper and digital, since they have been randomly assigned to conditions of the study. However, post-hoc evaluations showed that homogeneity of variance conditions were met. Second, high school students participating in

research increases mortality risk, especially with students with LD who may dropout or move. Considering that Florida has above the national average dropout rates for students with LD, the current research study was at an extreme risk of losing subjects due to these factors. When considering these factors, the students that were targeted for this research participated in a transition to high school program aimed at increasing retention, grade outcomes and attendance. The LS teacher had added language that specifically focused on the students' participation in this research study and included student specific behaviors like, following through with commitments, attending school, and participating in activities to focus on increased school grades. Finally, technology as a novelty, as opposed to paper flash cards, was assumed. Technology may in fact engage students in the M-generation; however Study Stack™ has had no existing research to support engagement learning Biology vocabulary for students with LD, this was perhaps the greatest limitation of the study.

Implications for Practice

Technology may hold promise for the motivation of students and can be the tool the M-generation uses to overcome language-based disabilities. Although technological environments are a familiar learning platform for students with LD (Blackhurst, 2005), the technology alone will not provide students the opportunity to critically impact science achievement data. Providing students with research-based solutions to improve their performance with language-based tasks should be the focus of instruction in biology. Organizations such as The National Joint Committee on LD (2010) support the focus of content area language monitoring, “Developmental data should be collected on older students on a variety of complex skills, such as subsystems of language, literacy, and academic content areas” (p. 11).

Teachers need to then structure learning environments around formative data outcomes. Students with LD in high biology school should be able to independently interact with content, specifically vocabulary, with high frequency allowing for rehearsal. Students' practice sessions should be monitored ensuring student growth, comprehension, retention, and progress in content area language development. Teachers must use content progress indicators like foundational vocabulary knowledge to determine when more intense interventions targeted to boost memory are required. Use of mnemonic memory devices are suggested for continued language growth in the sciences for students with LD, which means the educator must understand the language that most requires support in the content areas for students with disabilities in higher level content areas like biology and chemistry. The educators' role is to modify, when needed, based on student data, curriculum language that presents the greatest challenges.

Future Study

Simply stated, a strong need exists for continued research in language development for all students with LD. Special attention particularly in acquiring foundation biology language in high school for students with language-based LD is warranted. Aside from further research with a control group design to investigate the use of flash cards to support students with LD, more sophisticated systems of language progress monitoring for students in high school with LD is needed. Furthermore, what role does student motivation have in the willingness to engage in a basic study rituals like using flash cards? Teachers may want to couple learning rituals with Universal Design for Learning by providing choices of engagement between paper or digital flash cards to investigate if providing a choice impacts learning outcomes. Kebritchi's (2010) research leads to this thought in that teachers' commented technology is a tool to motivate students being reason enough to consider technology embedded learning in the future. As

technology becomes an everyday tool in the lives of students, the question remains, will it continue to be a motivating factor? In addition emerging technologies are transforming education and work, while increasing student empowerment for self-paced learning and individualized learning (Johnson, Levine, Smith, & Stone, 2010). This study exemplifies that technology alone may not motivate 100% of generation-M students. Researchers must take into consideration the complexity of the technologies, student exposure to the technologies, and if there is a natural, programmed reward attached to the system being studied.

Conclusions

Unfortunately, despite the intention of having high standards in science (Wagner et al., 2006), many students with LD have fallen behind their peers (Planty et al., 2008). One of the primary barriers to students with LD's success in science has to do directly with reading difficulties (Scruggs & Mastropieri, 2007). Science instruction often requires the mastery of vocabulary as the major focus for demonstrating the knowledge of science (Lumpe & Beck, 1996) and simultaneously most standardized science tests focus predominantly on the recall of facts and vocabulary (Eylon & Linn, 1988). Consequently, students with language disabilities have more difficulty succeeding than their nondisabled peers (Wagner et al., 2006) in science instruction. From the current research, evidence shows a) a strong need for continued examination of instructional practices focusing on content language development, and b) research in language development for all students with language-based LD, in critical content areas in high school. The greatest outcome of the current research is the focus on instructional tools that students enjoy while providing maximum positive impact in the least amount of time allowing student centered engagement and success in secondary science classes.

APPENDIX A: INSTITUTIONAL REVIEW BOARD



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1
FWA00000351, IRB00001138**
To: **Kelly J. Grillo**
Date: **January 04, 2011**

Dear Researcher:

On January 4, 2011, the IRB approved the following human participant research until 1/3/2012 inclusive:

Type of Review: UCF Initial Review Submission Form
Project Title: An investigation of the effects of using digital flash cards to increase biology vocabulary knowledge in high school students with learning disabilities.
Investigator: Kelly J Grillo
IRB Number: SBE-10-07323
Funding Agency: None

The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

If continuing review approval is not granted before the expiration date of January 3, 2012, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 01/04/2011 03:05:42 PM EST

IRB Coordinator



December 14, 2010

Ms. Kelly Grillo
500 Temko Terrace
Daytona Beach, FL 32118

Dear Ms. Grillo:

I have received your request to conduct research within [REDACTED]. I have approved your topic of "An Investigation of the Effects of Using Digital Flash Cards to Increase Biology Vocabulary Knowledge in High School Students with Disabilities." As with all requests to do research; participation is at the sole discretion of the principals, teachers and parents of all students involved. Parent Consent Forms will be necessary for all data gathered from the students of [REDACTED].

By copy of this letter, you may contact the school principals who allow this research to be conducted with their faculty and students. We request that you conduct your survey with as little disruption to the instruction day as possible.

I would appreciate receiving a copy of your project at the completion of your study.

Sincerely,

[REDACTED]
[REDACTED]
[REDACTED]

APPENDIX B: STANDARD DIPLOMA SCIENCE REQUIREMENTS

Standard Diploma Science Requirements for all Fifty States and Four Territories of the United States of America. © 2010 by the Education Commission of the States (ECS).

State	Science Course Requirement
Alabama	4, including 1 unit each of biology and a physical science
Alaska	2
American Samoa	Unable to locate any course requirements.
Arizona	<p>2</p> <p>Eff. Class of 2012: 2 units "in preparation for proficiency at the high school level on the AIMS test."</p> <p>Eff. Class of 2013: 3 units "in preparation for proficiency at the high school level on the AIMS test."</p>
Arkansas	<p>3 (1 unit each of biology and a physical science)</p> <p>Eff. Class of 2010: 3 (see notes)</p> <p>Notes/Citation: Eff. Class of 2010: 3 units of lab sciences chosen from physical science, biology or applied biology/chemistry, chemistry, or physics or Principles of Technology I and II or PIC Physics.</p> <p>Student who receives waiver from these requirements must complete 3 units, including 1 unit biology or its equivalent and 1 unit of a physical science.</p>

State	Science Course Requirement
California	2 Notes/Citation: Must include "biological and physical sciences."
Colorado	--
Connecticut	2
Delaware	3 Eff. Class of 2011: 3 lab
District of Columbia	3, incl. 1 unit lab science Eff. Class of 2011: 4, incl. 3 units lab science
Florida	3, incl. 2 lab science units

State	Science Course Requirement
Georgia	<p>3</p> <p>Eff. Class of 2012: 4, incl. 1 unit biology, 1 unit physical science or physics, 1 unit either chemistry, earth systems, environmental science or an AP/IB science course, and 4th unit that may be used to meet both the science and elective requirements.</p> <p>Notes/Citation: Pre-Class of 2012: College Prep: Must include "a physical science, a life science, and one additional science course. Students earning the Technology-Career-preparatory (TC) or Technology/Career-preparatory with Distinction (TC+) seal shall meet the requirements for the College Preparatory (CP) or College Preparatory with Distinction (CP+) seal or shall pass any three units of science including one physical science, one life science or two units of applied biology/chemistry." All must be lab-based.</p>
Hawaii	3
Idaho	<p>2, including 1 unit lab science</p> <p>Eff. Class of 2012: 3, including 2 lab science</p>
Illinois	<p>1</p> <p>Eff. Class of 2011: 2</p>

State	Science Course Requirement
Indiana	<p>2 lab science</p> <p>Core 40: 3 lab science</p> <p>Eff. Class of 2010: 2, incl. Biology I</p> <p>Core 40 Eff. Class of 2010: 3</p> <p>Eff. Class of 2011: All students must meet Core 40 reqts.</p> <p>Notes/Citation: "All approved high school science courses are laboratory courses and must be taught as laboratory courses." Core 40 Eff. Class of 2010: Must include 1 unit biology, 1 unit chemistry, physics or integrated chemistry-physics and 1 unit additional credits in Core 40 science courses.</p>
Iowa	<p>--</p> <p>Eff. Class of 2011: 3</p>
Kansas	<p>2, including 1 unit lab science</p> <p>Eff. Class of 2009: 3, including 1 unit lab science (see notes)</p>

State	Science Course Requirement
Kentucky	<p>3</p> <p>Eff. Class of 2012: 3 lab</p> <p>Notes/Citation: Must include "life science, physical science, and earth and space science as provided in the program of studies, 704 KAR 3:303." Eff.</p> <p>Class of 2012: Must include biological science, physical science, earth and space science, and unifying concepts.</p>
Louisiana	<p>3, incl. 1 unit biology</p> <p>Eff. Class of 2012:</p> <p>LA Core 4: 4 units, incl. 1 unit each biology and chemistry</p> <p>LA Core: 3 units, incl. 1 unit biology</p>
Maine	<p>2 (incl. 1 unit lab)</p> <p>Eff. Classes of 2007 and 2010: See notes</p> <p>Notes/Citation: Eff. Class of 2007: Graduation "determined by student achievement of the standards of the system of learning results in ... science and technology" and 4 other subject areas.</p> <p>Eff. Class of 2010: Students must achieve "standards of the system of learning results" in all 8 content areas.</p>

State	Science Course Requirement
Maryland	3, incl. 1 unit biology and 2 labs Notes/Citation: 2 lab units must be chosen from earth, life, and/or physical sciences
Massachusetts	--
Michigan	-- Eff. Class of 2011: 3 lab, incl. biology and chemistry or physics Notes/Citation: 4th unit science strongly encouraged but not required
Minnesota	3, incl. 1 unit biology Eff. Class of 2015: Must also incl. 1 unit chemistry or physics
Mississippi	3, incl. Biology I Eff. Class of 2012: 4, incl. 1 lab, Biology I Notes/Citation: Eff. Class of 2012: Lab unit may be satisfied by course selected from physical sciences (physical sciences, chemistry, physics).
Missouri	2 Eff. Class of 2010: 3
Montana	2
Nebraska	--
Nevada	2

State	Science Course Requirement
New Hampshire	2 Notes/Citation: 1 unit each of physical sciences and biological sciences.
New Jersey	15 credits (3 Carnegie units)
New Mexico	2, incl. 1 unit lab Eff. Class of 2009: 3, incl. 1 unit lab Eff. Class of 2013: 3, incl. 2 units lab
New York	3 (incl. min. 1 unit lab) Notes/Citation: 3 units of "commencement level science," including 1 unit life sciences, 1 unit physical sciences and 1 unit either life sciences or physical sciences.
North Carolina	3, incl. biology Notes/Citation: Must include biology, a physical science, and earth/environmental science.
North Dakota	--
Ohio	3, incl. 1 unit each biological sciences and physical sciences Eff. Class of 2014: 3 lab, incl. 1 unit biology, 1 unit physical sciences, 1 unit advanced science chosen from: (a) chemistry, physics or other physical science; (b) advanced biology or other life science; (c) astronomy, physical geology, or other earth or space science.

State	Science Course Requirement
Oklahoma	<p>3, incl. Biology 1</p> <p>Eff. Class of 2010: 3 units lab science</p> <p>Notes/Citation: Eff. Class of 2010: "Three units of laboratory science, limited to Biology, Chemistry, Physics, or any laboratory science course with content and/or rigor equal to or above Biology and approved for college admission requirements."</p>
Oregon	<p>2</p> <p>Eff. Class of 2012: 3, incl. 2 lab units</p>
Pennsylvania	--
Puerto Rico	<p>Statute requires department to give diploma to any student who passes "the examinations pertaining to the secondary school courses" or their equivalents.</p> <p>Students who take tests must be 18 and upon passage, receive diploma equivalent to a high school diploma.</p>
Rhode Island	3
South Carolina	3
South Dakota	<p>2 units lab science</p> <p>Eff. Class of 2010: Advanced program: 3 units lab science, incl. biology and chemistry or physics.</p> <p>Standard: 2 units lab science</p>

State	Science Course Requirement
Tennessee	3 Notes/Citation: Must include 1 unit Biology I, Biology for Technology or the equivalent in an integrated curriculum. 1 unit must be "drawn from the physical sciences" and all sciences courses must "include laboratory experiences."

State	Science Course Requirement
Texas	<p>Recommended program: 3, incl. biology. Two add'l credits must be chosen from the areas of</p> <ul style="list-style-type: none"> (i) integrated physics and chemistry; (ii) chemistry; and (iii) physics or Principles of Technology I. <p>Recommended program, eff. Class of 2011: 4, incl. biology. Two add'l credits must be chosen from</p> <ul style="list-style-type: none"> (i) integrated physics and chemistry; (ii) chemistry; and (iii) physics or Principles of Technology I. Fourth unit to be chosen from state-approved lab science courses. <p>Recommended program, eff. Class of 2016: 4 units, with 3 selected from one of each category: (i) biology; (ii) chemistry; (iii) physics or Principles of Technology I. Fourth unit to be chosen from state-approved lab science courses.</p> <p>Minimum program (pre- and eff. 2011): 2, incl. biology and Integrated Physics and Chemistry (IPC)</p> <p>Notes/Citation: Recommended: Biology credit must be taken in biology, Advanced Placement Biology or International Baccalaureate Biology.</p> <p>The other two units must be chosen from (a) Integrated Physics and Chemistry (IPC); (b) Chemistry, AP Chemistry or IB Chemistry; and (c) Physics, Principles of Technology I, AP Physics or IB Physics.</p>

State	Science Course Requirement
Utah	<p>2</p> <p>Eff. Class of 2011: 3</p> <p>Notes/Citation: Pre- and eff. Class of 2011: Two units must be chosen from the four science areas: earth systems science, biological science, chemistry and physics. Up to one unit may be earned in any of the four disciplines.</p>
Vermont	3
Virgin Islands	Unable to locate
Virginia	<p>3 lab science</p> <p>Notes/Citation: 3 units laboratory science.</p> <p>"Courses completed to satisfy this requirement shall include course selections from at least two different science disciplines: earth sciences, biology, chemistry, or physics."</p>
Washington	2, incl. 1 lab science

State	Science Course Requirement
West Virginia	<p data-bbox="824 264 883 289">3 lab</p> <p data-bbox="824 331 1370 428">Eff. Class of 2012: 3 lab, incl. 1 unit physical science, 1 unit biology and 1 unit chemistry</p> <p data-bbox="824 470 1430 1297">Notes/Citation: 3 lab courses are Coordinated and Thematic Science (CATS) 9 and 10 and a course above the CATS 10 level. Eff. Class of 2008: Students in professional pathway must complete 1 of the 4 career concentration units in science (unit must be above CATS 10). Eff. Class of 2009: 3 units must be completed in CATS 9 and 2 courses above the CATS 9 level. For professional pathway, 4th unit of science must be above CATS 9. Eff. Class of 2012: All students must take physical science, biology and chemistry in consecutive order. Professional pathway must complete 4th unit science, which must be above physical science.</p>
Wisconsin	<p data-bbox="824 1339 841 1365">2</p> <p data-bbox="824 1407 1382 1499">Notes/Citation: Must include "instruction in the biological sciences and physical sciences."</p>

State	Science Course Requirement
Wyoming	<p data-bbox="824 264 984 289">3 + See notes</p> <p data-bbox="824 331 1409 697">Notes/Citation: Diplomas must indicate a level of endorsement. Comprehensive endorsement: Standard reqts. + proficient performance on common core of knowledge and skills in science. General endorsement: Proficient performance in a majority of 9 subject areas which include science.</p>

**Note.* Reprinted with Permission, see Appendix K.

APPENDIX C: BIOLOGY WORD LEARNING MANUAL

Biology Word Learning

Teacher

Training Manual

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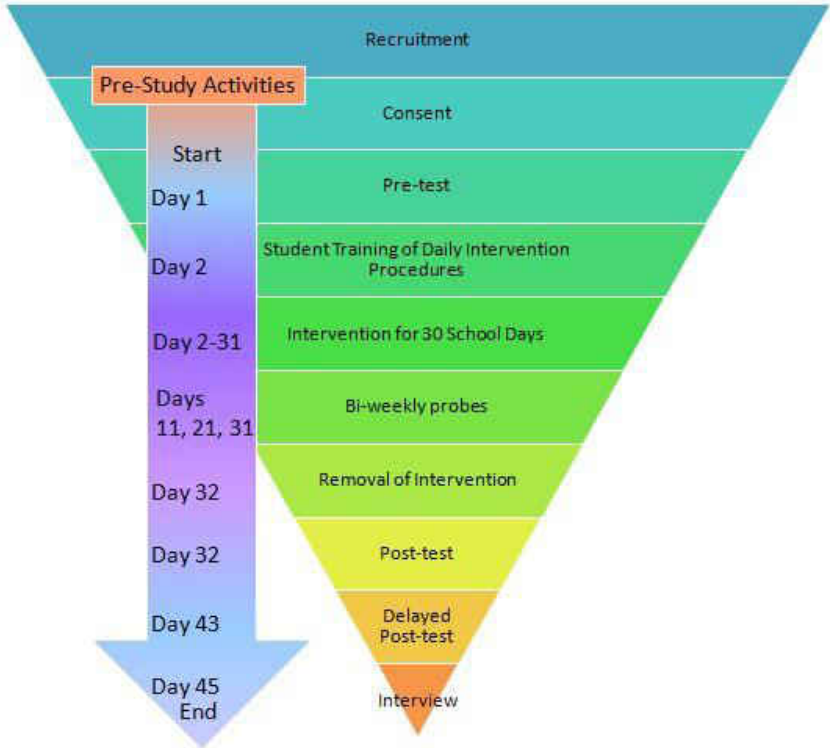
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INTRODUCTION

Thank you for choosing to participate in the Biology Word Learning Research Study. This research training Manual will detail all of the procedures to follow during the 45 days of participation. In order to have your class participate you are first required to read the entire manual for this research and receive one-on-one training by the researcher walking through each of the protocols. At the end of the training session, the last page in the training manual requires an acknowledgment by signing the voluntarily agreement of study.

During each part of the research study, the researcher will deliver all of the required study materials in a bin marked “Biology Word Learning”. Also accompanying the materials will be the protocols necessary for the portion of the study.

Here is a graphic of the study timeline. In the next section of the training manual there are instructions for each part of the study.



Study Time Line

PRE-STUDY ACTIVITIES

For the recruitment of the study, the researcher will bring a packet of materials that has a study invitation letter for parents and students to read at home. Accompanying the invitation are Institutional Review Board forms that include a letter of consent and child assent forms. There are two letters being sent home with students, one to be signed if the guardian (consent) and the other to be signed by the student (assent) for students who are volunteering to participate, in the research. An additional copy for both the guardian and student to keep will also be included. In order to participate in the research students are required to have a guardian sign a consent form and the students will need to also provide child assent, confirming they will volunteer for the research. After the consent and assent are returned by (enter date here), place the completed forms in the envelope for pick up on (enter date here) from the researcher.

GETTING READY FOR RESEARCH

Getting started! For each of the procedures in this manual, you will encounter sections that state, “Read this aloud to the students”. When you are prompted to read aloud, please read the instructions verbatim the instructions while modeling the instructions. Each of the study protocols will also be printed and placed in student folders. Please have students follow along as you read the protocols. The student protocols will remain in the student folders and will be individually assigned to each student for the entire study. The researcher will monitor student materials weekly and will ask that you monitor student folders nightly using a checklist. Student folders will be specific as to the assigned group the student is in, control or experimental. Research protocols are also specific to control or experimental as well. Please read instructions carefully and ask the researcher any questions that you may have prior to the research study beginning and feel free to contact the researcher via [REDACTED] or [REDACTED] [REDACTED] at any point in the study.

DAY 1/DAY 32/DAY 43 PRE/POST/DELAYED-TESTING PROTOCOLS

A testing bin will be provided by the researcher on the morning of each test day, marked “Biology Word Learning Data”. You will find your testing materials in a sealed envelope. Each of the tests, pre/post/delayed post will use the provided testing protocol. In the bin you will have (a) a copy of the test, (b) pencils to use for the test, (c) two new envelopes in which to seal completed tests and incomplete tests, (d) a form to fill out verifying the students who received and participated in the testing and (e) testing protocol.

Distributing Assessment Materials

Distribute the assessment to each student. On the back of each assessment, the students’ non-name identifier is preprinted. Each student will receive a specific assessment with their unique non-name identifier. Please be certain to distribute the assessment belonging to that student. Keep the assessment face down with the non-name identification code face up and distribute a pencil to each student walking desk to desk. Please initial next to the student code as this step indicates you have double checked that the exam belongs to the student taking the assessment.

Read this aloud to the students.

Please keep your assessment face down until I say “begin”. Each assessment will be individually distributed and verified. Please wait patiently and quietly while assessment materials are distributed.

Read this aloud to the students

Welcome to the Biology Word Learning Research assessment ([enter date assessment title here](#)). Please keep your assessment face down until I say begin. Please try your best and work individually on this assessment. Before we begin I will read aloud the instructions for the

assessment. Does everyone who is participating in the research study have an assessment and pencil?

Wait for response.

If no, provide a blank assessment and pencil.

If yes, continue reading aloud:

1. For this assessment you will be asked to read each word and choose the best definition for each term.
2. Each term will only be used once.
3. You may write on the assessment but make sure your final answer is marked clearly.
4. You will only have one class period to take this assessment.
5. Do you have any questions?

Wait for response:

If no, continue to #6.

If yes, answer question.

6. Once you have completed the assessment turn your paper face down and raise your hand so that I can collect your test materials.
7. Please turn your test face side up, you may begin.

DAY TWO INSTRUCTIONS

On the second day of the study you will be asked to provide both the control and experimental groups training to participants in the intervention phase of the study. Using the Day Two Procedures, distribute the student study materials using students' non-name identification codes. This will remind each student of their non-name identifier code that they will use for the entire study. The two groups will then be divided into control and experimental for the second part of the training.

Student codes from ([enter data here](#)) will be control.

Student codes from ([enter data here](#)) will be experimental.

Using the students' non-name identification code the teacher will divide the two groups. The control group will be trained first. The experimental group students will be provided a hall pass with the non-participating students to go to the Media Center.

Next, the control group will be provided training.

Each groups' intervention training will be modeled. Control group students will be instructed in all of the intervention procedures including, (a) folder retrieval, (b) timer protocol, (c) Using Paper Flash Cards (d) graphing , and (e) clean up.

During the modeling of the paper flash card engagement, you will be provided materials in a folder that is exactly the same as the control group marked, Using Paper Flash Cards Training Folder. During the modeling of the flash card engagement, you will model for students with the learning mat and paper cards provided in the Using Paper Flash Cards Training Folder. After, you have modeled the procedures for the students have them complete guided practice using the protocols as needed. Once students have completed guided practice using the protocols

they will be instructed that their study folders will contain these visual supports for the entire study.

Alternatively, the non-participating students and the experimental group will be completing a learning task with the Media Center teacher. After the daily procedures have been modeled for the control group and you have provided guided practice to the students, you will walk the control group down to the Media Center and switch groups. Non-participating students will remain with the Media Center Teacher. You will then complete the training with the experimental group using the Using Digital Flash Cards

Next, the experimental group will be provided training. Read this aloud to the students: Using Paper Flash Cards. Model the directions for control group students using the paper flash cards. Each groups' intervention training will be modeled. Experimental group students will be instructed in all of the intervention procedures including, (a) folder retrieval, (b) timer protocol, (c) Using Digital Flash Cards Protocol, (d) graphing, and (e) folder storage. During the modeling of the paper flash card engagement, you will be provided materials in a folder that are exactly the same as the control group marked, Using Digital Flash Cards Training Folder.

During the modeling of the flash card engagement, you will model the login and digital flash card procedures on the Promethean white board for students. After you have modeled using digital flash cards using the protocols, students will complete guided practice using the protocols as needed. Once students have completed guided practice using the protocols, they will be instructed that they are to assume the responsibility of entering intervention with support from the visual procedures found in their study folders.

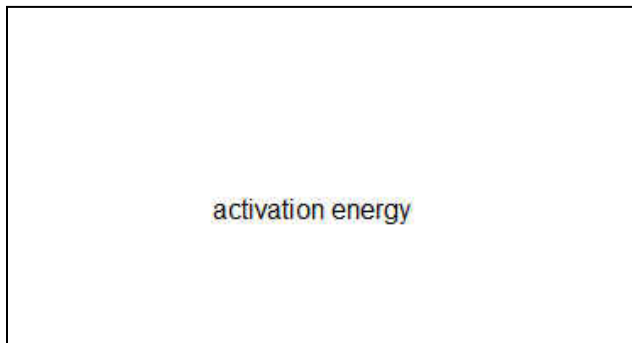
The visual instructions are control or experimental specific only differing in how participants engage with the flash cards, paper or digital, and will be placed in the students' personal folder for the entire study.

RETRIEVING STUDY FOLDERS DAILY

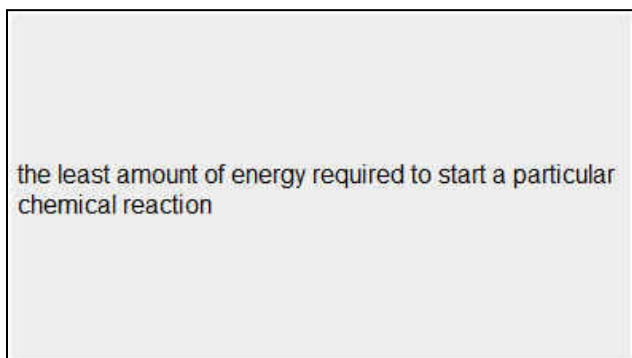
1. In the Right Pocket, place the daily procedures to include:
 - a. Daily Folder Retrieval Protocol
 - b. Timer Use Protocol
 - c. Flash Card Protocol
2. In the Left Pocket, place the self-monitoring materials to include:
 - a. Graph paper with teacher's daily initials completed for the day.
 - b. Graphing Protocol
 - c. Pencil
3. Close the folder
4. Place the folder in the bin labeled "Biology Word Learning".

FLASH CARD PROTOCOL: USING PAPER FLASH CARDS:

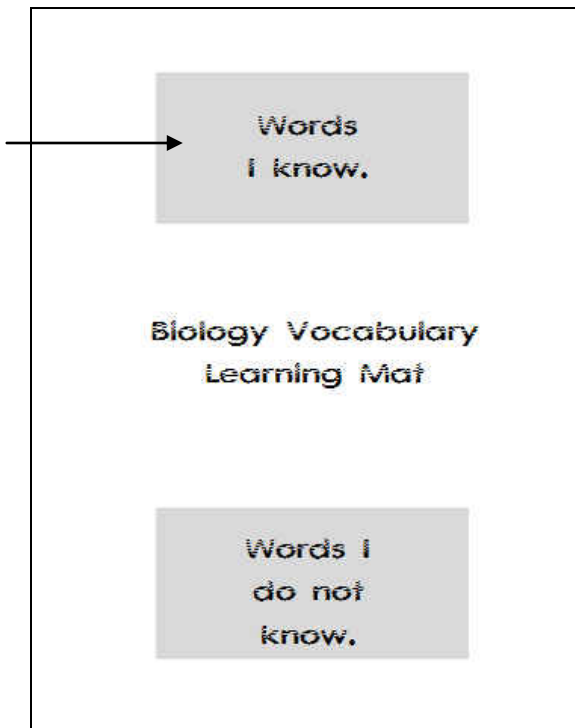
1. To study the deck of paper flashcards, read the data currently displayed and think about what is on the other side of the card.



2. Then "Flip" the card to see if you were right.



3. If you were correct, "Discard" the card for today into the "words I know" pile on your learning mat.



4. Move to the Next Card in the deck.
5. Read the data currently displayed and think about what is on the other side of the card.
6. Then “Flip” the card to see if you were right.
7. If you were not correct, keep the card in your pile of cards to learn.
8. If you don't need to study the current card in the deck, “Discard” to remove it for today by placing the card into the “words I know pile” on your learning mat.
9. Once you reach have tried each of the 16 terms in the deck, shuffle the deck remaining in your hand, and repeat steps 1-8.
10. Continue with steps 1-9 with any remaining cards you have not discarded in the “words I know pile” until you have reached five minutes.
11. After you have completed the 5 minute session, count the number correct in the “words I know” pile.
1. Move to the graphing instructions.

FLASH CARD PROTOCOL: USING DIGITAL FLASH CARDS:

Step I: Logging into WebCouses@UCF

1. Go to <https://webcourses.ucf.edu/webct/entryPageIns.dowebct>
2. Click the hyperkink “login to Webcourses@UCF”.



3. Enter your assigned Username and Password.

Your teacher will provide you your user name and password.

If you forget either your username or password, please raise your hand and the teacher will provide them to you. Please keep your username and password private.

Login

A screenshot of a login form. It contains two input fields: the first is labeled "Username / NID:" and the second is labeled "Password:". Below the password field is an "OK" button. The entire form is enclosed in a rectangular border.

4. Click the hyperlink labeled Education-Biology Digital Flash Cards

[Education - Biology Digital Flash Cards](#)
Section Instructor: Grillo Kelly

5. Once you are in the correct Webcourse page you will see the below Home page.



Researcher
[Kelly Grillo](#)

6. Click the hyperlink that has the green arrow pointing to the Flash Cards.

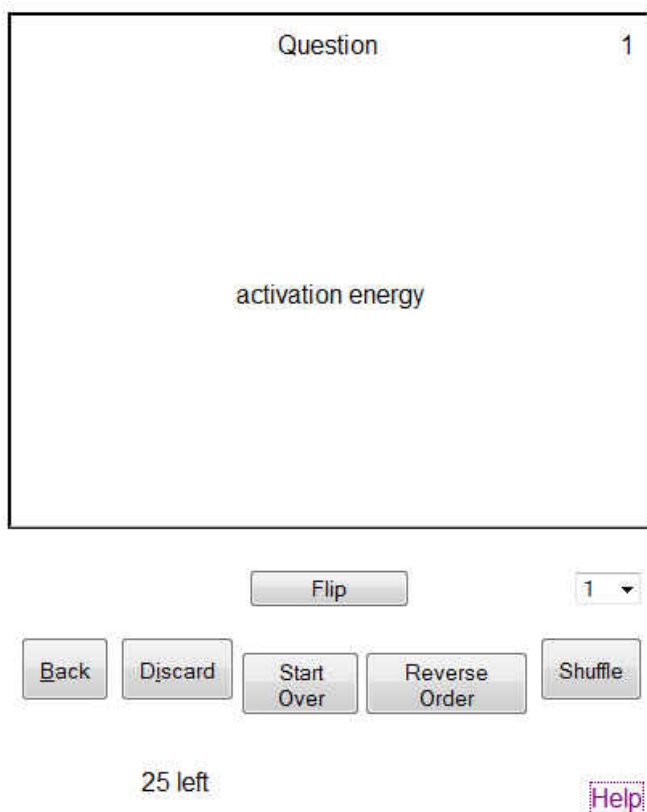


[Flash Cards](#)

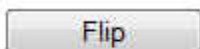
Click here to interact with the digital flash cards each day of the study.

Step II: Flash Card Protocol: Using Digital Flash Cards:

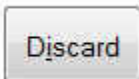
1. To study the deck of flashcards, read the data currently displayed and think about what is on the other side of the card.



2. Then press [click with your mouse] the "Flip" button to see if you were right.

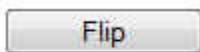


3. If you were correct Press "Discard"

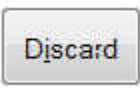


And the Stack will move to the Next Card

4. If you were incorrect press [click with your mouse] the "Flip" button to see Help.



5. If you don't need to study the currently displayed card any more, click the "Discard" button (or press the D key) to temporarily remove it from the deck.



6. Once you have tried each of the 16 terms in the deck, shuffle the deck.
7. Press [click with your mouse] the "Shuffle" button to mix up the order in which the cards get displayed.



8. Continue with steps 1-7 with any remaining words you have not discarded until you have reached five minutes.
9. As you flip through the cards, the cards that you take longer to flip over will get displayed more frequently.
10. After you have completed the 5 minute session, move to the graphing instructions.

GRAPHING PROTOCOL

1. After you have finished using the flash cards for five minutes take out the graph paper in your research folder.

18										
17										
16										
15										
14										
13										
12										
11										
10										
9										
8										
7										
6										
5										
4										
3										
2										
1										
	Jan 3rd	Jan 4th	Jan 5th	Jan 6th	Jan 7th	Jan 10th	Jan 11th	Jan 12th	Jan 13th	Jan 14th

→ X

2. At the base of the column where the data is located, place an X this means you have completed the drill today.
3. Using a pencil, color in the bar graph one box at a time to indicate the number of words you have gotten correct. One box should be colored in for each correct word.
*If you did not get any correct, please leave the graph blank.
4. Once you have completed coloring in the bar graph, your teacher will initial the graph paper next to the X.
5. After you have received an initial next to the X, place your graph paper in the research folder.
6. Move to the Clean Up instructions.

CLEAN UP PROTOCOL

1. In the Right Pocket, place the daily procedures to include:
 - a. Daily Folder Retrieval Protocol
 - b. Timer Use Protocol
 - c. Flash Card Protocol
2. In the Left Pocket, place the self-monitoring materials to include:
 - a. Graph paper with teacher's daily initials completed for the day.
 - b. Graphing Protocol
 - c. Pencil
3. Close the folder
4. Place the folder in the bin labeled "Biology Word Learning".

TEACHER DAILY CHECKLIST

Category	Question	Circle YES or NO									
Day Observed		1	2	3	4	5	6	7	8	9	10
Folder Retrieval Verification	Did students retrieve research folder during Center Time in LS?	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
<i>If No, within 2 minutes verbally prompt students to retrieve research folder during Center Time in LS</i>											
Research Folder Verification	Did students check non-name identification code belongs to them?	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Did you check 100% of students' non-name identification code											
Y/N											
Timer Verification	Did students use timers set for 5 minutes?	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
<i>If No, within 2 minutes verbally prompt students to use timer for 5 min</i>											

Flash Card Use Verification Students use flash cards. Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N

If No, within 2 minutes verbally prompt students to use flash cards

Graphing Verification Students graph number and has teacher initial graph. Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N

If No, within in 2 minutes verbally prompt students to graph number correct.

Did you check 100% of students' graph?
Y/N

Folder Collection Verification Students place folders in study bin Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N Y/N

If No, within 2 minutes verbally prompt students to place folder in study bin.

Did you check 100% of students placed folders in bin?
Y/N.

STUDY ACKNOWLEDGMENT PAGE

Dear Participating Teacher,

Thank you for reading and participating in the training for this Biology Word Learning research study. This study is completely voluntary and the researcher will provide assistance at your request. Please feel free to contact the researcher at the provided contact information. By completing this training and signing the acknowledgment page you are agreeing to follow study protocols to the best of your ability.

Thank you again for supporting this research study in your classroom,

Sincerely

Kelly J. Grillo

Researcher

Please sign and return the below portion of the form to the researcher.

Biology Word Learning

By completing this training and signing the acknowledgment page you are agreeing to follow study protocols to the best of your ability.

I, _____, agree to follow all of the training protocols of the Biology Word Learning research study as provided by the researcher.

APPENDIX D: INTER-RATER FORM

INTER-RATER FORM

Category	Student Behaviors Observed	Circle YES or NO	Teacher Behaviors Observed	Circle YES or NO
Folder Retrieval Verification	Students retrieves research folder during Center Time in LS	YES		
		NO		
		<i>If No move to Teacher Behavior</i>		
Research Folder Verification	Students check non-name identification code belongs to them.	YES	Teacher checks 100% of students' non-name identification code.	YES
		NO		NO
		<i>If No move to Teacher Behavior</i>		NO
Timer Verification	Students use timers set for 5 minutes	YES		
		NO		
		<i>If No move to Teacher Behavior</i>		
Flash Card Use Verification	Students use flash cards.	YES		
		NO		
		<i>If No move to Teacher Behavior</i>		
Graphing Verification	Students graph number and has teacher initial graph.	YES		
		NO		
		<i>If No move to Teacher Behavior</i>		
Folder Collection Verification	Students place folders in study bin	YES		
		NO		
		<i>If No move to Teacher Behavior</i>		
			Within 2 minutes teacher verbally prompts students to place folder in study bin AND teacher checks students have placed folders in bin.	NO

APPENDIX E: TEACHER LESSONS

Unit: (2nd 9 weeks) Course: Personal, Career, and School Development Skills I - 0500500

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
<ol style="list-style-type: none"> 1. What strategies can be used to understand and remember vocabulary? 2. What strategies can be used to help me understand what I read? 3. How does goal setting benefit me? 4. How can I handle anger in appropriate ways? 				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Anger Management Goal Setting	Students will set academic and career goals. Students will apply vocabulary strategies.	Monday 1. Journal Entry – Tutoring 2. Goal Setting – Notes 3. Goal Setting – Reading or Video 4. Vocabulary Tuesday	NEED TO LOCATE GOAL SETTING MATERIAL	

	<p>Students will apply reading strategies to comprehend what they read.</p> <p>Students will work collaboratively with a peer tutor.</p> <p>Students will learn and apply anger management techniques.</p>	<ol style="list-style-type: none"> 1. Continue Goal Setting 2. Application of Goal Setting 3. Vocabulary 4. Reading <p>Wednesday</p> <ol style="list-style-type: none"> 1. Revisit Tutoring Journal Entry 2. Tutoring <p>Thursday</p> <ol style="list-style-type: none"> 1. Anger Management Notes 2. Vocabulary Strategy of choice with vocabulary on Anger Management 3. Reading strategy of choice with 	<p>ANGER Management</p>	
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		<p>article on Anger Management</p> <p>4.</p> <p>Friday</p> <p>Journal Entry – What techniques to you use to manager anger?</p> <p>2. Anger Management Role Plays</p> <p>3. Quiz, Quiz Trade on all Vocabulary Cards for entire semester.</p> <p>4.</p>		
<p>SSS/State Benchmarks:</p> <p>0500500.2 Assess personal behavior in terms of personal, academic, and career goals.</p> <p>0500500.3 Demonstrate Effective Study Skills.</p> <p>0500500.5 Demonstrate use of effective communication skills.</p>				
<p>Teacher Reflection:</p>				

Unit: (2nd 9 weeks, week 2) **Course:** Personal, Career, and School Development Skills I - 0500500

Concept: Test taking		Pacing: 1week	Date Developed:	
Essential Questions:				
1. How do I prepare to pass a test?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
All Terminology presented in the	Students will apply reading strategies to comprehend what	Monday Test taking Strategies Tuesday	SIM KU Test taking Strategy	

past 18 weeks	they read. Students will apply test taking strategies.	Test taking Strategies Wednesday Test taking Strategies Thursday Test taking Strategies Friday Test taking Strategies		
<p>SSS/State Benchmarks:</p> <p>0500500.2 Assess personal behavior in terms of personal, academic, and career goals.</p> <p>0500500.3 Demonstrate Effective Study Skills.</p> <p>0500500.5 Demonstrate use of effective communication skills.</p>				
<p>Teacher Reflection:</p>				

Unit: Unit (3rd 9 weeks, week 3) Course: Personal, Career, and School Development Skills I - 0500500

Concept: Self Advocacy Skills		Pacing: 1 week		Date
Date Developed:				
Essential Questions:				
How can I demonstrate self-advocacy?				
How can self-advocacy benefit me?				
3. How can I build and maintain successful relationships with others?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Self Advocacy Goal Setting Paradigm Principle Proactive Reactive	Students will identify personal goals.	Monday Tuesday Clean out notebook- Keep	Goal Setting sheet?	Circle Map

	<p>Students will understand self paradigms and the paradigms of others.</p>	<p>Tutoring Journal Entry Circle Map - Self Goal Setting Sheet School Friends Family Review Final</p> <p>Wednesday Peer Tutoring</p> <p>Thursday Intro to Self Paradigm CE Frames of Reading Strategies Paradigm of Others-</p>	<p>The 7 Habits of Highly Effective Teens</p>	<p>Student</p>
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	Students will learn relationship principles.	Word Search of Vocabulary words Friday Relationship Principles Wheel Collage of Principles	The 7 Habits of Highly Effective Teens	collage
<p>SSS/State Benchmarks:</p> <p>0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.</p> <p>0500500.3 Demonstrate Effective Study Skills.</p> <p>0500500.5 Demonstrate use of effective communication skills.</p>				
<p>Teacher Reflection:</p>				

Unit (3rd 9 weeks, week 4) Course: Personal, Career, and School Development Skills I - 0500500

Concept: Self Esteem, Role Models, IEP Process		Pacing: 1week	Date Developed:	
Essential Questions:				
How is self esteem developed?				
How does self esteem impact your life?				
What should I know about the IEP process?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Self Advocacy Goal Setting Paradigm Principle Proactive Reactive IEP	Students will learn how to build positive self-esteem.	Monday Journal – advantages and disadvantages of growing up Steps for Positive self esteem Self Advocacy – pre-test Role playing scenarios of self advocacy	The 7 Habits of Highly Effective Teens Strategies Book	

	<p>Students will understand the IEP process.</p>	<p>Tuesday</p> <p>Tutoring Journal Entry</p> <p>Who are you?</p> <p>Mnemonic of name</p> <p>IEP Notes</p> <p>What is it? Why? Who attends?</p> <p>Students' roles?</p> <p>Note-taking Strategy: Chunking</p> <p>Wednesday</p> <p>Tutoring – Peer Tutoring</p> <p>Links Crew?</p> <p>Thursday</p>	<p>Internet site – Self</p> <p>LD Advocacy manual</p>	<p>Notebooks</p>
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	Students will make oral presentations.	Review Paradigms College Project (Wheel) Friday Presented Project Orally Choose Reading Strategy for Newspaper	The 7 Habits of Highly Effective Teens Newspaper	Rubric for oral presentation
SSS/State Benchmarks: 0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner. 0500500.3 Demonstrate Effective Study Skills. . 0500500.5 Demonstrate use of effective communication skills.				
Teacher Reflection:				

Unit: Unit (3rd 9 weeks, week 5) Course: Personal, Career, and School Development Skills I - 0500500

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
What is a personal bank account?				
What is the IEP process and why should I understand it?				
How is disability awareness important to me?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Self Esteem		Monday		Writing sample
Deposit		Tutoring Journal Entry		
Withdrawal		Video on surviving High School		
Relationship		Compare and Contrast writing – high school versus middle school		
Disability	Students will learn how to build	Tuesday Journal: What do you see when		

		<p>Bank Account</p> <p>Review IEP and Purpose</p> <p>Umbrella of disabilities and definitions of disabilities</p> <p>Friday</p> <p>Report out on Random Act of Kindness</p> <p>Open notes quiz on Personal Bank Accounts</p> <p>More notes on Personal Bank Account</p>		<p>Quiz</p>
<p>SSS/State Benchmarks:</p> <p>0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.</p> <p>0500500.3 Demonstrate Effective Study Skills. .</p> <p>0500500.5 Demonstrate use of effective communication skills.</p>				

Teacher Reflection:

Unit: Unit (3rd 9 weeks, week 6) Course: Personal, Career, and School Development Skills I - 0500500

Concept:		Pacing: 1 week	Date Developed:	
Essential Questions:				
What are the habits of successful teens?				
How can I plan to be proactive instead of reactive?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Circle of control Circle of non control Independent will Conscious Imagination Self awareness Proactive	Students will understand proactive responses.	Monday Tutoring Journal Note card or Notebook Vocabulary Strategy Cornell notes on proactive and reactive Group activity on proactive/ reactive scenarios	The 7 Habits of Highly Effective Teens Pages 49-50	Cornell notes Teacher observation of role play

<p>reactive</p>	<p>Students will compare and contrast proactive and reactive responses.</p>	<p>Tuesday FCAT Writing</p> <p>Wednesday Peer Tutoring Random Act of Kindness assignment</p> <p>Thursday Proactive/Reactive engagement activity Double Bubble (Circle) Reactive/Proactive Notes on control/ non control Visualize the Future</p>	<p>The 7 Habits of Highly Effective Teens Pages 49-50. Workbook for habits The 7 Habits of Highly</p>	<p>Circle Map</p>
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		<p>Control/ not control</p> <p>Friday</p> <p>Report Acts of Kindness</p> <p>Review game from notebook</p> <p>Turning setbacks into triumphs</p> <p>Mitchell Video from internet</p> <p>Discuss student setbacks</p>	Effective Teens	
<p>SSS/State Benchmarks:</p> <p>0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.</p> <p>0500500.3 Demonstrate Effective Study Skills. .</p> <p>0500500.5 Demonstrate use of effective communication skills.</p>				
<p>Teacher Reflection:</p>				

Unit (3rd 9 weeks, week 7) Course: Personal, Career, and School Development Skills I - 0500500

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
What are the habits of successful teens?				
How do role models impact positive and negative actions?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Role Model Change agent Influence Independent clause Simple sentence		<p>Monday</p> <p>Presidents’ Day Holiday</p> <p>Tuesday</p> <p>Video: Secret Garden</p> <p>What does this video have to do with the 7 effective habits of Teens?</p>	Charlene will send out email to Bio, Eng,	Writing sample

	<p>Students will learn components of a simple sentence.</p> <p>Students will explain the positive and negative influences of role models.</p>	<p>Wednesday</p> <p>Peer Tutoring</p> <p>Thursday</p> <p><i>Sentence Writing:</i></p> <p>Sentence Writing Pre-test</p> <p>Describe #7-13 – Students take Cornell notes</p> <p><i>7 Effective Habits:</i></p> <p>Circle Map: Who are your role models? Discussion on positive/negative influence.</p> <p>Friday</p> <p>Report Acts of Kindness</p>	<p>and Algebra teachers to utilize the Circle Map next week 1</p> <p>SIM Sentence</p> <p>Writing Strategy (PENS)</p> <p>The 7 Habits of Highly Effective Teens</p> <p>Microsoft word for writing sentences</p> <p>SIM PENS Strategy</p> <p>SIM Sentence</p>	<p>PENS Pre-test</p> <p>Circle Map</p> <p>Habit #1: Proactive Quiz</p> <p>PENS Practice sheets</p>
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		<i>Sentence Writing:</i> Describe Steps #14-17 – Student Guided Practice Sheets <i>7 Effective Habits:</i> Habit #1: Proactive Quiz	Writing Strategy (PENS) The 7 Habits of Highly Effective Teens	
SSS/State Benchmarks: 0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner. 0500500.3 Demonstrate Effective Study Skills. . 0500500.5 Demonstrate use of effective communication skills.				
Teacher Reflection:				

Unit: Unit (3rd 9 weeks, week 8) Course: Personal, Career, and School Development Skills I - 0500500

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
What is the purpose of the circle thinking map?				
What are the components of a simple sentence?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Independent clause	Students will develop circle maps for defining and brainstorming.	Monday Tutoring Journal	Thinking Maps	Circle Map Student Writing
Simple sentence		<i>Thinking Maps</i> TM Note-making TM guide p1-16/17	Copies of TM – note pg 1-16.17	
Subject Verb	Students will write a paragraph using 4 types of simple sentences.	Re-teach Circle Map – Stress purpose of Circle Review IEP Process	Overhead TM pg 1-18	
Noun phrase		<i>Sentence Writing:</i> Describe steps 18-23 – 4 sentence types	Reference: Steps pg 2-7	
Verb Phrase		Closure: Write paragraph using 4 sentence types with info from IEP circle	SIM Sentence	
Infinitives				
Personal				

<p>Mission Statement Destiny Inspiring</p>		<p>Map</p> <p>Tuesday</p> <p>Vocabulary Linking: Infinitive, Personal Mission Statement, Destiny, Inspiring</p> <p><i>Sentence Writing:</i></p> <p>Describe steps 24 – 26 PENS Steps</p> <p><i>7 Effective Habits:</i></p> <p>Habit 2 – Begin with the end in Mind</p> <p>Intro</p> <p>Read Examples pg 75-76</p> <p>Outside Activity pg 75</p> <p>Wednesday</p> <p>Disability Awareness notes EBD/ OHI</p> <p>Random Acts of Kindness</p> <p>Peer Tutoring - Develop a circle map</p> <p>Thursday</p>	<p>Writing Strategy (PENS)</p> <p>The 7 Habits of Highly Effective Teens</p> <p>The 7 Habits of Highly Effective Teens</p> <p>Copies of LINCS Table</p> <p>SIM PENS pg 35-36</p>	<p>Vocabulary Linking Table</p>
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		<p><i>7 Effective Habits:</i></p> <p>Crossroads p 76 -80, Student notes</p> <p><i>Sentence Writing:</i> Modeling Simple Sentence</p> <p>Friday</p> <p>Report Acts of Kindness</p> <p>Assessing Circle Map – TM 5-5</p> <p><i>7 Effective Habits:</i> Mission Statement</p> <p>Reading and discussing, Question Activity</p> <p><i>Sentence Writing:</i> Simple Sentence Quiz</p>	<p>Teacher created notes</p> <p>SIM PENS - Model Stage pg 38, Verbal Practice p42</p> <p>7 Habits: pg 86-89</p> <p>PENS St book /g 507</p>	<p>Circle Map</p> <p>Quiz</p>
SSS/State Benchmarks:				

0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.

0500500.3 Demonstrate Effective Study Skills. .

0500500.5 Demonstrate use of effective communication skills.

Unit: Unit (3rd 9 weeks, week 9) Course: Personal, Career, and School Development Skills I - 0500500

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
How does using all 4 simple sentence type improve my writing?				
How can I graphically display descriptions?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Adjective	Students will develop bubble maps to describe.	<p>Monday</p> <p>Tutor Journaling</p> <p>Teach Bubble Map and the purpose</p> <p>Bubble Map: Feeling toward FCAT</p> <p>–</p> <p>Write paragraph with info on</p> <p>Bubble Map</p> <p><i>Sentence Writing:</i></p> <p>Student WB Practice 1A</p> <p>Tuesday</p>	<p>Thinking Maps</p> <p>SIM Sentence</p> <p>Writing Strategy</p> <p>(PENS)</p>	<p>Bubble Map</p> <p>Student writing</p> <p>PENS student w/s</p> <p>PENS student w/s</p>

	<p>Students will develop personal mission statement.</p>	<p>Warm Up: Student PENS WB Practice</p> <p>Frame around Bubble Map - What influenced those feelings?</p> <p>How to overcome negative feelings? Group conversation.</p> <p>Talking about the consequences.</p> <p>Develop a personal mission statement</p> <p>Wednesday</p>	<p>SIM Sentence</p> <p>Writing Strategy</p> <p>(PENS)</p> <p>The 7 Habits of Highly Effective</p> <p>Teens</p> <p>Page 91</p>	<p>Mission statement</p>
	<p>Students will practice FCAT skills by applying them to a formal Midterm exam.</p>	<p>Random Acts of Kindness</p> <p>Peer Tutoring - Develop a Bubble Map with info being tutored in.</p> <p>Thursday</p> <p>Warm Up: Student PENS WB</p>	<p>SIM Sentence</p> <p>Writing Strategy</p>	<p>PENS student w/s</p>

		<p>Practice</p> <p>Accommodations available on FCAT – encourage to take advantage.</p> <p>Station Teaching:</p> <ol style="list-style-type: none"> 1.FCAT Explorer 2. Teacher led paper /pencil FCAT practice <p>Friday</p> <ol style="list-style-type: none"> 1. Teacher led paper /pencil FCAT practice 2. Midterm Exam 	<p>(PENS)</p> <p>FLDOE FCAT</p> <p>Materials</p> <p>FCAT Explorer</p>	<p>Midterm Exam</p>
<p>SSS/State Benchmarks:</p> <p>0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.</p> <p>0500500.3 Demonstrate Effective Study Skills. .</p>				

0500500.5 Demonstrate use of effective communication skills.

Teacher Reflection:

Unit: Unit (4th 9 weeks) Course: Personal, Career, and School Development Skills I - 0500500

FCAT

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Analyze		Monday Sentence Writing WB Practice FCAT Station Teaching: 1.FCAT Explorer 2. Teacher led paper /pencil FCAT practice De-Stressing Activity: Present Mission statement Posters	FDLOE FCAT Practice materials FCAT Explorer	PENS student w/s

	<p>Students will take FCAT.</p> <p>Students will learn the 5 keys to</p>	<p>Tuesday FCAT Testing</p> <p>Wednesday FCAT Testing</p> <p>Thursday FCAT Testing Make Ups Sentence Writing WB Practice Random Acts of Kindness Peer Tutoring</p>	<p>SIM Sentence</p>	<p>FCAT</p> <p>FCAT</p> <p>PENS student w/s</p>
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	<p>goal setting.</p> <p>Students will analyze previously written goals according to 5 keys and personal mission statement</p>	<p>Friday</p> <p>Sentence Writing WB Practice</p> <p>Share Random Acts of Kindness</p> <p>Notes on Goal Setting</p> <p>Lecture and note-taking on 5 keys of Goals. Look at goals previously written and analyze to mission and keys.</p>	<p>Writing Strategy (PENS)</p> <p>The 7 Habits of Highly Effective Teens</p>	<p>PENS student w/s</p>
<p>SSS/State Benchmarks:</p> <p>0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.</p> <p>0500500.3 Demonstrate Effective Study Skills. .</p> <p>0500500.5 Demonstrate use of effective communication skills.</p>				
<p>Teacher Reflection:</p>				

Unit: Unit (4th 9 weeks, week 2) **Course:** Personal, Career, and School Development Skills I - 0500500

FCAT

Concept:		Pacing: 1week	Date Developed:	
Essential Questions:				
1 What are some guidelines for goal setting?				
Terminology	Skills/ Learning Targets	Learning Activities	Resources	Assessment
Comparing Contrasting Similarities Differences Double Bubble Compound Sentence Coordinating	Students will create double bubble maps to compare and contrast information. Students will write a paragraph using all 4 types of simple	Monday FCAT Testing Make Ups Sentence Writing WB Practice Tutor Journaling Teach Double Bubble Map and the purpose Notes – Overhead 1-28 Model: Friend and Self	Thinking Maps	PENS student w/s Double Bubble Student writing

<p>Conjunctions Dependent Clause</p>	<p>sentences.</p> <p>Students will create content enhancement Frame to classify information.</p>	<p>Write a paragraph with information from double bubble.</p> <p>Tuesday FCAT Testing Make Ups <i>Sentence Writing:</i> Compound Sentence Describe 5-9 up to using comma with coordinating conjunction <i>7 Effective Habits of Teens</i> Habit #3 CE Frame on Time Quadrants p112 Wednesday (19th) Random Acts of Kindness</p>	<p>SIM Sentence Writing Strategy (PENS) The 7 Habits of Highly Effective Teens</p>	<p>Notebook CE Frame</p>
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		<p>Thursday</p> <p>Random Acts of Kindness</p> <p>Peer Tutoring - Develop double-bubble map with info being tutored in.</p> <p>Friday</p> <p>Report Out Random Acts of Kindness</p> <p>Assessing Double Bubble Map – TM 5-7</p> <p><i>Sentence Writing:</i></p> <p>Review notes on CP Sentences</p> <p>Compound Sentence – Describe 10-12</p>	<p>SIM Sentence</p> <p>Writing Strategy (PENS)</p> <p>The 7 Habits of Highly Effective Teens</p>	<p>Double Bubble Notebook</p>
<p>SSS/State Benchmarks:</p>				

0500500.1 Exhibit a strong, positive self image and view self and others in a positive manner.

0500500.3 Demonstrate Effective Study Skills. .

0500500.5 Demonstrate use of effective communication skills.

Teacher Reflection:

APPENDIX F: INTERVIEW PROTOCOL

Interview Protocol

Hello. My name is Kelly Grillo. I am a graduate student at UCF. I'd like to speak with you about your thoughts or suggestion on use of the flash cards you have been working with in class. My work is being supervised by Dr. Dieker and I will provide her contact information later in this conversation.

I think the conversation will take just about 30 minutes. Your name will not be documented on my notes, I will use a code so that no one should be able to tell what you said. Do you think this is something that you would be willing to do?

If at any time you do not want to answer a question, you do not have to, simply say "skip this question" and we will move to the next question.

Provide copy of the consent.

I just want you to know that I am required to read a script so my language might seem a little awkward.

We really appreciate that you have taken time out of your lunch to talk to me about your experience with using the flash cards as part of your Learning Strategies class. The goal of this research is to get a better view of how you feel about the flash cards. Results from this study will be shared with teachers and educators who want to see students like yourself do well in Biology.

My questions will focus on your thoughts about the use of the flash cards and the role you believe they may have in the future for all students.

There is no right or wrong answers. Feel free to express your opinions, whether they are positive or negative. I just want you to openly share with me what you really think and feel about the flash cards. There are no anticipated risks, to you as a participant in this interview other than the small amount of risk associated with confidential studies where a breach of confidentiality might occur but measures will be taken so that this is very unlikely to occur. With your permission, I will be audio-tape recording the discussion so that I do not miss anything you have to say. When we are finished with any audiotapes they will be erased and all data will be stored in a locked filing cabinet. Your responses will be kept confidential and no one will know who said what as a code will be used as identifiers instead of your name.

There is no compensation, or other direct benefits to you for participating in this research you may also choose not to respond to any or all of the questions without an explanation. You may also decline to participate in this interview without any consequences.

If you have any questions about participants' rights, you can direct those to the UCF-IRB Office. I'll give you all that contact information at the close of interview today. And it is also on your copy of the consent form.

Do I have your permission to record our conversation?

If yes, turn on tape recorder and continue as follows:

Again my name is Kelly Grillo. Today is I will state the day _____, and I am speaking with a student of Biology, you do not have to give your name, but please indicate you are in fact a student of biology, wait for response _____. I've just turned on the tape recorder and would like for you to verify I have your permission to tape our conversation now that the tape is running.

As I mentioned, I am tape recording the discussion so that I don't miss anything you have to say.

Do you have any questions before I begin asking questions?

Pause (waiting for response)

Procedure

This part of the interview will focus on your perceptions and utility of the digital flash card intervention in general.

What was your feeling about the flash card intervention?

Do you feel the use of the flash cards daily was easy for you to use?

Please explain why you feel the flash cards were easy to use.

If no... Please explain why you feel the flash cards were not easy to use.

What was your feeling about the flash cards and being able to learn them all?

What part(s) of the Flash Cards were most helpful in trying to learn the Biology terms?

In the future, would you use the flash cards like you did in learning strategies to learn Biology terms?

Why or Why not and please explain.

Share with me your typical study routines for a course like biology/science education.

Share with me your belief about the role technology has within your educational studies.

Can you name specific technology that is of value to you within your current biology educational studies?

Please explain.

If yes, what about programs like "Study Stacks", do you feel this is of value to your studying biology?

Is there anything else you would like to add?

Well I'm about done now. Do you have any further information for me to add in this part of the interview?

The next part of this interview is going to inform me of basic background information (Demographics) as applied to learning in Biology class, as I mentioned before you do not have to answer any of the following questions if you do not want to, are you ready to continue?

Pause (waiting for response)

What is your highest grade you have received in Biology class?

And what type of assignment was that?

What are the typical grades you receive on Biology exams?

What are the total numbers of students in your Biology class?

How do you classify yourself in terms of race?

How do you classify yourself in terms of sex?

Would you mind disclosing any disabilities?

And what type of IEP goals do you have?

Have I left anything out, would you like to add anything to this interview?

Okay, well, thank you very much for letting me talk to you today. Your time is very much appreciated, and your comments have been very helpful.

Now I'd like to give you some contact information. If you have any questions about this research please contact Dr. Lisa A. Dieker, my supervising teacher at [REDACTED].

If you have any questions or concerns about research participants' rights they may be directed to the UCFIRB Office, UCF Office of Research, Orlando Tech Center, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246. The phone number is 407-823-2901.

I have provided an additional copy of the contact information for you and it is also on your copy of the consent form.

Thank you so very much for letting me speak with you today. Your time, which I know is valuable, is very much appreciated and your comments have been very helpful.

Turn off tape recorder. Thank them again, and say goodbye.

APPENDIX G: VERBATIM TRANSCRIPTIONS

Code: DO1

So, Again my name is Kelly Grillo. Today I will um be speaking with you and you are a student of a Biology class[verbal confirmation uhum], Okay, so you do not have to give your name, but please in fact tell me that you are a student of a biology class currently.

Yes I am

Okay, Thank you.

I've just turned on the tape recorder and I would like for you to verify I have your permission to tape our conversation.

You certainly do.

Thank you.

As I mentioned, I am tape recording the discussion so that I don't miss anything that you say.

Do you have any questions before I begin asking questions?

No

Okay, so this part of the interview will focus on the perceptions and utility of the digital flash card intervention, my first question is what were your feeling about using the flash card intervention?

Hmmm I didn't want to like do it everyday and the same thing over and over, because it kind of gets old, but it did help.

Okay [Pause] and do you feel the use of the flash cards daily was easy for you to use?

Yeap, [pause] I did.

Okay. [Pause], and why do you think they were easy to use?

Umm. The way they were organized and displayed really helped the word and the definition uh and then the way for you to remember the definition really helped.

Okay. And what was your feeling about the flash cards being,(paused) and being able to learn them?

Umm. Like I did not think it would work.

Smiles, Okay.

I thought it worked at it a little ah but it worked out better than I thought it was.

Okay, what part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

Umm. Hmm, I guess the ah helping things, the um, you know the things at the end that helps us learn the definition.

The helper words?

Yes.

Okay. In the future, would you use the flash cards like you did in learning strategies to learn Biology terms?

Um. Yes, although I hope I am not going to be in here for awhile.

Umm, Why would you use the words, why would you use the flash cards?

Um to learn the words faster and easier.

Ummm Share with me your typical study routines for a course like biology or like when you're taking science.

Well usually on the same day, I wouldn't study until like before we do a test because it is easy for me to remember it.

So you don't study a little at a time you study right before a test?

Yeah.

Okay, Share with me your belief about the role technology, umm that it has within your educational studies.

Well I think it helps because umm, with all the current technology teenagers these days have short attention spans so unless they have like you know electronic stimulation they lose focus or else.

Okay. Can you name specific technology that you think is a value to you within your current biology educational studies?

Umm. A pencil and paper.

Okay [smiles], well that is technology, how about as far as technology in the way of digital technology?

Umm, well only here is where the flash cards really helped but other than that I don't really use ah technology to help study.

Okay. Umm. Is there anything else you would like to add?

Um, not really.

Okay so the next part of the interview is going to inform me of basic background information (Demographics) about you as it is applied to you learning in Biology class, as I mentioned before you do not have to answer any of the following questions if you do not want to, I you're ready, are you ready to continue?

Yes

Okay, what is your highest grade you have received in Biology class?

Umm, I think a B.

Okay and was that a type of assignment or was that a course grade?

Umm, I think that was a course grade, but my highest second grade was of course an A.

Okay

And Bs and C's.

Um what are the typical grades you receive on Biology exams?

Can you read it again please?

Yeah.

What are the typical grades you receive on Biology tests or exams?

Umm, an A or B.

Okay. What are the total numbers of students in your current Biology class?

Umm, I am not sure, there are a lot, I think like, 30 or more.

Okay. And how do you classify yourself in terms of race?

Umm I am Puerto Rican.

Okay. And how do you classify yourself in terms of sex?

I am a male.

Okay, and would you mind disclosing any disabilities?

Umm, like learning disabilities I have [confirmed confirmation uhum] umm, well according to Ms. ■■■, I have ah ADD, I have also been diagnosed as ADHD and umm she says I have ah a few more learning disabilities, but she did not tell me what they were.

And what type of goals do you have on your IEP? Do you know?

To get good grades.

Okay, anything else you can remember from your IEP?

Just to get the highest GPA I could get.

Okay. And have I left out anything or would you like to add anything to this interview?

Umm, not really.

Okay, well, I'm gonna stop the tape now.

Code: PO2

Ok do I have your permission to record our conversation?

Yes

Thank you.

So, I have the tape recorder on, on, and I have to again say my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology class, do ah, you do not have to give your name, but please indicate that you are in fact a student of a Biology class.

Yes

Okay. So, I've just turned on the tape recorder and would like to verify again that I have your permission to tape our conversation and the tape is running.

Yes.

Okay, as I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you have say.

Do you have any questions before I begin asking questions?

No

All right.

So the first part of this interview will focus on your perceptions and utility of the digital flash card intervention, in general.

What was your feeling about the flash card intervention?

Umm, I thought it worked, umm I learned a little.

Okay umm, do you feel the use of the flash cards daily was easy for you to use?

Yeah.

Okay. And explain why you felt like the cards were easy to use?

Umm. I did not study them that long and I kinda got familiar with them each day, so.

So time was a factor, you liked that it was a short amount of time?

Yeah.

Okay. Um what was your feeling about the flash cards and being able to learn them all?

Umm. I don't know, just another day at school, learning.

Where you able to learn all the cards-all the words?

Not all of them, like most the time I would get half of them right on the tests.

Okay, umm. What part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

Umm. The definition the key words and the definitions.

Did you use the helper, the reminder?

Not, not a lot.

Okay. In the future, would you use the flash cards umm like you did in learning strategies class to learn your Biology terms? Let's say next semester?

Yeah.

Okay, why would you use them?

Because they helped me learn my vocabulary words better than I do now.

Okay, um share with me your typical study, sorry, umm share with me your typical study routines ah for a course like biology or science.

Um we write down all the definitions and the words and we usually ah get the definitions out of a book and then ah pretty much our teacher just tells me to study them.

Okay. Share with me your belief about the role technology, that it has within your educational studies.

Umm technology has come along with ah schools, soon enough everything will be technology.

Do you use it independently at home?

Yeah

To study, to do your homework?

I do a lot of my homework on the computer, yeah.

But you use it as a study support.

Yeah.

Okay, um, can you name specific technology that is a value to you when you're studying for your current biology class?

A computer.

Okay, and what do you do on the computer?

Look up the word, look up the definition.

Okay, um is there anything else you would like to add to our discussion?

No.

Alright so I am about done now umm I have a little bit more information the next part of the interview is going to inform me of basic background information or demographics as its applied to Biology, as I mentioned before you do not have to answer any of the following questions if you do not want to, please just say skip, are you ready to continue?

Yes

Okay, what is your highest grade you have received in Biology class?

B, C.

Okay and was that a type of assignment or was that?

Umm, like a group assignment.

Okay so group work, was it like a lab or?

Yeap.

Um what are the typical grades you receive on Biology exams?

D.

Okay, what are the total numbers of students in your Biology class?

25.

Ah, how do you classify yourself in terms of race?

White, Caucasian.

Okay. How do you classify yourself in terms of sex?

Male.

Okay. And would you mind disclosing any disabilities?

Ah, [Shook his head like he did not know] Umm,

You don't know?

ESE

Okay, and then do you know why you get services under ESE?

Because I am a little bit slower then everybody else.

Okay so do you know the category you receive services under?

[Shook head]

Okay, and what type of IEP goals do you have?

To graduate high school.

Okay, and have I left out anything or would you like to add anything to this part of the interview?

No.

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

Code: DO3

Ok do I have your permission to record our conversation today?

Yes

Thank you.

Okay Again my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology class, do, do you give me permission to record our conversation?

Yes

Okay. Please indicate that you are in fact a student of biology.

Yes

Okay. So, I've just turned on the tape recorder and would like to verify that I have your permission to tape our conversation now that the tape is running.

Yes.

Okay. Thank you. As I mentioned, I am taping the recording, our discussion so that I don't miss anything that you say. Do you have any questions before I begin asking questions?

No

Okay [cough to clear throat] this part of the interview will focus on your perceptions and utility of the digital flash card intervention in general.

So first question is, what was your feeling about the flash card intervention?

It was kinda of difficult on the computer.

Okay, so, so the next question is do you feel the use of the flash cards daily was easy for you to use? You said it was difficult already can you explain why?

Because you if you were switching to another card it was hard to go back to the other cards.

So you wanted it to go back more [Audio not clear]

Okay, so explain that a little the utility of moving forward you couldn't use the back button

Yeah. I couldn't find it.

Okay, you could not find the back button. Okay, that's good to know. [Long pause] Did you notice the help little button on the side that you could've clicked and it gives you all of the um controls that you could use on the computer, did you notice that?

No.

Okay. So what was your feeling about the flash cards and being able to learn um being able to all of them, all of the words, the 16 words?

Can I skip it?

Yeah, ah umm.

What part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

The help things

Okay. So the helper, the helper cards were a help, [we laugh] okay so you did you use that helper words.

Yeah.

Okay, in the future, would you use the flash cards umm like you did in learning strategies class to learn Biology?

Yes.

Okay, why would you use them?

I would feel more comfortable using the flash cards then the computer.

Okay, you wanted paper cards? Okay, share with me your typical study routines for a course like Biology?

Just go over the words over again and again.

Okay, share with me your belief about the role technology, [Microwave use in background] in ah educational studies.

Umm technology is quite a help sometimes but not all the time.

Okay, can you give me an example? [Screaming of kids in background]

Cause like you could be looking for something on the computer, like something specific, but it will give you something else.

Okay, um, can you name specific technology that is of value to you while studying for biology class?

No.

No? Okay, um is there anything else you would like to add to our conversation?

No.

Okay so the next part of this is just some demographic information, and you can skip any of these questions. Um what is your highest grade you have received in Biology class?

C.

Okay what type of assignment was that?

The test.

Okay. What are the typical grades that you receive on Biology exams?

About a C.

Okay.

Maybe B.

Okay. And what are the total numbers of students in your Biology class?

[Shrugs] 19 or 20

Okay, how do you classify yourself in terms of race?

I don't understand.

What's your race? Like how would you, like I would say that I was white or Caucasian?

Mexican.

Okay, and ah how do you classify yourself in terms of sex?

Male.

Okay, and would you mind disclosing any disabilities?

SLD

Okay, and what type of IEP goals do you have?

[Long pause] Just to try harder

Okay, and is there anything I left out today?

No.

Okay you wanna add anything?

No

Okay, thank you so much.

Code: DO4

So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology course, do you, you do not have to give your name, but please indicate that you are in fact a student of biology.

Yes

Okay.

I've just turned on the tape recorder and would like to verify again that I have your permission to tape our conversation now that the tape is running.

Yes.

Okay so I have your permission, sorry.

As I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you say. Do you have any questions before I begin asking questions?

Uhhum

Okay, so this part of the interview will focus on your perceptions and utility of the digital flash card intervention, in general. What was your feeling about the flash card intervention?

I liked the computer.

Okay

And the flash cards.

Okay so do you feel the use of the flash cards daily was easy for you to use?

Yes.

Okay, can you explain why you felt like it was easy?

It was easy because, like, it wasn't all at one time we had a week to study the work.

Okay, So it was chunked up a little bit.

Yes.

All right. *What was your feeling about the flash cards and being able to learn all the words?*

It was alright because I knew like some of words already and I need to refresh my mind about them.

Okay and did you think the 16 words at a time was better than trying to do a lot?

[Nods]

Okay, What part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

The computer part.

Well there was a couple of parts so you had the word, the definition and the reminder words.

Oh, umm the definition and the reminder words

So I take it you didn't like the help words. Um. So in the future, would you use the flash cards like you did um like you did in learning strategies class to learn Biology terms?

Yes.

Okay, so why would you use them?

I used the umm computer [Confirmed uhuh] and I think like if I have biology words to study or a big test or something [Cannot hear due to mumbling]

Oh really good. All right so share with me your typical study routine for a course like Biology

I go home and study.

How, what do you do?

I sit down in my room to close the door, open the book and study a little bit.

Okay. Share with me your belief about the role technology, that it has within your educational studies. So like digital technology.

Um, it was fun.

Okay so you think it adds fun to learning?

Yes

So do you think we should use technology more or less?

More. [Nods]

Um we just have a couple more left. Can you name specific technology that is of value to you within your current biology educational studies?

A computer.

Okay so is there something specific on the computer?

Ah, um that website, the flash card.

Okay the study stack?

Yes

Do you use any other sites?

Umm, not for biology.

Okay, is there anything else you would like to add to this part of our discussion?

Yeah, I liked it, I liked the whole, the whole um words thing, I think I learned a lot from it.

Okay well thank you so much for adding that. The next part, I am about done now, um do you have any further information to add in this part of the interview? So next part of the interview is going to inform me of basic background information called demographics as its applied to Biology, as I mentioned before you do not have to answer any of the following questions if you do not want to, please just say skip, are you ready to continue?

Yes

Okay

What is your highest grade you have received in Biology class?

Ah, B.

Okay and was that a type of assignment or was that?

Um Test or Quizzes.

Okay and what are the typical grades you receive on Biology exams?

Bs and Cs, sometimes A's

Okay, um what are the total numbers of students in your Biology class?

About 25

Okay and how do you classify yourself in terms of race?

Um I think

Like I am Caucasian or white. How do you classify yourself?

Hispanic

Okay. How do you classify yourself in terms of sex?

Male.

Okay, And Would you mind disclosing any disabilities?

No [moved hands to skip while shaking his head No]

Okay, so have I left out anything or would you like to add anything to this part of the interview?

No.

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

Code: PO5

Okay, do I have your permission to record our conversation?

Yes

Okay. [Pause] So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with a student of a Biology class, do I have, you do not have to give your name, but please indicate that you are in fact a student of Biology.

Yes, I am a student of Biology. [smile]

Okay.

I've just turned on the tape recorder and would like you to verify again that I have your permission to tape our conversation and the tape is running.

Yes.

Okay. As I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you say. Do you have any questions before I begin asking questions?

No.

Okay, ah this part of the interview will focus on your perceptions and utility of the digital flash card intervention, in general.

What was your feeling about the flash card intervention?

It was okay, I would rather have the computer though. [Smile]

Okay [Pause] ah, do you feel the use of the flash cards daily was easy for you to use?

Yes.

And can you explain why?

Because all I had to do was read the words at the back and if I missed it was going tell me and if I did it just redo it.

Okay. Ah what was your feeling about the flash cards and being able to learn all of the cards?

It was hard.

It was hard?

Yes.

Okay. Can you say why?

Some of the words I didn't know [Interrupted with Okay] Some of the words were hard to pronounce and it's hard to understand

Okay. So what parts or part of the flashcard was most helpful in trying to learn the biology cards?

The hope, the hope, hope [Interrupted by Ahuh] was kinda easy and easy to understand_

Okay, in the future, would you use the flash cards like you did in learning strategies to learn the Biology terms?

Yes.

Okay, so why? [Pause] Why would you use them?

Because if like I'm late to like study for a test for like school I can just like go through flashcards and learn the words real quick with the definitions and try to memorize them like.

So you would use them for more for study support?

Yeah

Okay. And can you explain to me, ah share with me your typical study routines for a course like biology or a science.

Um. [Pause] Can we skip the question?

Ahuh. Ah so share with me your belief about that role technology, ah has within educational studies.

[Pause] Skip

Okay. Can you name a specific technology that is of value to you within your current biology class, like to study for your class?

Ah [Pause] oh my god ah.

It is okay if you, if you can't you know.

Skip

Okay. ah, is there anything else you would like to add so we can have a full picture of the card use?

No

Okay. And so I'm about done but I have a couple more questions for this part of the interview concluded, the next part of the interview is going to inform me basic background information called demographics as it's applied to learning Biology class, in your Biology class. As I mentioned before, you do not have to answer any of the following questions if you do not want to, are you ready to continue?

Yes

Okay, so what is your highest grade you received in Biology class?

A C.

Okay, and what type of assignment was that?

Ah Vocab.

Okay. And what are the typical grades that receive on Biology tests or exams?

A D or C

Okay, what are the total numbers of students in your Biology class?

About 20 to 30

Okay, and how do you class, classify yourself in terms of race? So I'm more Caucasian or white Hispanic

Okay. How do you classify yourself in terms of sex?

Female.

Okay, and would you mind disclosing any disabilities?

No

Okay, So ah what type of IEP goals do you have?

[Pause] Do better school and get good grades

Okay, and have I left out anything ah would you like to add anything to this interview?

No.

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

Code: PO6

So um Do I have your permission to record our conversation?

Yes you do.

Okay thank you. So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology course, you do, you do not have to give your name, but please indicate that you are in fact a student of biology.

Yes, I am.

Thank you, I just turned on the tape recorder and would like to verify again that I have your permission to tape our conversation now that the tape is running.

Yes you do.

Okay. As I mentioned, I am taping the recording, the discussion so that I don't miss anything that you say.

Do you have any questions before I begin asking questions?

No I don't.

Okay, this part of the interview will focus on your perceptions and utility of the digital flash card intervention.

What was your feeling about the flash card intervention?

[Shrugs] I felt fine it was just normal for me I think.

Okay do you feel the, the, the flash card, um you'd feel. I'm Sorry. Do you feel the use flash card daily was easy for you to use

Yeah.

Okay, and explain why you thought they were easy to use.

Um Well, you, it was like you can always cheat on um and it was you can what you missed on the definitions and stuff and how odd the key words helped you and stuff to remember it so it helped a lot.

So the key words helped lot?

Yeah.

Okay. So what was your feeling about the flash cards and being able to learn them all?

It um I, I, I [Pause] Sorry I lost my train of thought.

No, That's Okay.

Um do you mind repeating the question please?

Okay. What was your feeling about the flash cards and being able to learn them all?

It, it I felt good. Um. [Pause]

Was it easy to learn all of the key words?

Some, Some were still hard but some where easier kinda. I think so

Okay. What part or parts of the Flash Cards were the most helpful in trying to learn the Biology terms?

Probably the key words.

Okay the key words or help words?

Yeah

Okay.[Pause] In the future, would you use the flash cards like you did in learning strategies class [Interrupted by I] to learn Biology terms?

I, I probably would_.

Um, why would you?

Cause it's just, I, I did better than like studying from a book and then taking a test on them, so I got like the more interactive words studying, studying them cards then just looking every up.

Okay, so share with me your typical study routines for a course like Biology or science education.

Um like I said I would just like looking up in the book or having the teacher [Cannot hear word due to mumbling] write them down and study them for a little bit.

Okay. Um Share with me your belief about the role technology, um that it has within your educational studies.

Do you mind breaking it down [Interrupted by Yeah] cause I some [Interrupted by Yeah] some questions are definitely confusing.

Ah No that's okay.

Um, so do you think technology has a role in studying, in your, in your future.

Yeah.

Yeah?

Yeah.

Okay, and Um do you, hold on [Cannot hear the rest]. Um, can you name specific technology that you feel like could help you in your Biology class

Like computers and going up on the internet to find out stuff and [Pause] and yeah.

Okay that's good. Is there anything else you would like to add to our interview today?

No thank you.

Okay. So we're about done now but I have a few more questions in next part of the interview it's going to focus more on background information called demographics as it's applied to learning Biology and it is applied to you in your Biology class. As I mentioned before, you do not have to answer of the following questions if you don't want to. Are you ready to continue?

Yeah.

Okay, the first question is, what is your highest grade you have received in Biology class?

Um I think a B.

Okay and was that a type of assignment or was that?

Oh well just the highest grade for all assignments? Ah Um No I thought the course [Interrupted by okay] I thought you meant like the end of this course.

Oh Okay. So for one course, okay. So what kinds of assignments did you get A's on.

[Sighs] like ah like copying down the vocab words and stuff.

Okay. Um, What are your typical grades that you get on tests or your exams in Biology.

[Sighs] It depends, depends ah be As to F to [Mumbled last word]

Okay, What are the total numbers of students in your Biology class?

Um about 30. [Interrupted by sneeze, "Excuse me" and followed by another sneeze] Give or take.

Okay about 30?

Yeah.

How do you classify yourself in terms of race?

What do you mean?

So I'm Caucasian or white.

Yeah. Um I'm Caucasian too.

Okay.

How do you classify yourself in terms of sex?

Male.

Okay, and Would you mind disclosing any disabilities?

What what do you mean like disabilities?

So do you do you have it, a disability.

Yeah

Okay, and so do you know what type?

SLD, learning disorder.

That's very good, thank you, do you know what type of IEP goals you have?

I know both of them but I forgot them, I think just do good in school and you know get good grades and stuff like [cannot hear due to mumbling]

And have I left out anything or would you like to add anything to this part of the interview?

Not thank you.

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

Code: P07

Okay, So do I have your permission to record this conversation?

Yes maam.

Thank you. So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology course, you do not have to give your name, but please indicate that you are in fact taking Biology

Yes maam I'm taking Biology

Okay. I've just turned on the tape recorder and would like to verify again that I have your permission to tape our conversation now that the tape is running.

Yes maam you have my permission.

Thank you. As I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you to say. Do you have any questions before I begin asking questions?

No maam.

Okay, so this part of the interview will focus on your participation, your perceptions and utility of the digital flash card intervention in general.

What was your feeling about the using flash card intervention?

That it was it was okay and I was hoping it would help increase my grade in Biology.

Okay [Pause], and do you feel that the use of the flash cards daily was easy for you to use?

Yes maam.

Okay, what part was easy?

Uh just overall doing it all.

Okay [Pause] and what was your feeling about the flash cards and being able to learn the cards.

[Pause] Um

You know how they were in groups of 16, were you able to learn them all? How do you feel about that?

I was able to memorize as many as I can I could [Cannot hear due to mumbling]

Okay, What part or parts of the Flash Cards were the most helpful in trying to learn the Biology terms?

Personally, I think they were just helpful all the way around, because [Shrugs] it was just easier to remember. [Pause]

Do you think the 5 minute chunks was good that it wasn't too much time.

We could've done about 6 minutes, but I don't care.

Okay. in the future, would you use the flash cards like you did in learning strategies to learn Biology terms?

Yes maam.

Okay, so why would you use them?

Because it improves my like memorizing vocabulary it made things a lot easier for me

Okay.

Like concepts and whatnot.

Good term help with things, love it. [Laughter in background]

[Smiles]

Okay, share with me your typical study routines for a course like biology or science education course.

Um, what we normally do in Biology?

Ahuh or how do you study for a course like that?

Ah all we really do is take a lot of notes and read over them and over them and keep on reading over them.

So repetitive looking at your notes, reading, thinking, types of, okay. [Pause] And Share with me your typical belief, or sorry, share with me your belief about the role technology, within educational studies.

Like what I believe is good for me?

Ahuh

Ah it can help us understand something if we don't understand it with our teachers [Cannot hear due to mumbling]

Okay. Can you name a specific technology that is a value to you within your current biological educational studies, so in your current science class is there something that you use or ah is a value to study or to learn?

All we really use is notebooks because I, it's a really large class.

Okay, ah is there anything else you would like to add to our discussion?

Not that I can think of.

Right, I'm about done now, do you have any further information to for me to add at this part.

[Pause]

No?

Ah [Interrupted by laugh] no.

Okay, the next part of the interview is going to be to inform me of basic background information called demographics as its applied to learning in Biology class, as I mentioned before you do not have to answer all of the following questions if you do not want to, are you ready to continue?

Yes maam

Okay. So what is your highest grade you have received in Biology?

A C.

Okay, so they're your end of course grade? Oh you said A C, I thought you said A as a C. Okay a C. Ok what was this assignment, or was this a course grade.

It was a course grade [interrupted by okay] it was a quarter.

Okay. What are the typical grades you receive on your exams or your tests?

Around C's

Okay, and what, you mentioned your class is big. What are the total um total number of students in your current Biology class.

I would say somewhere around like 35 to 40.

Okay, that is a big class. How do you classify yourself in terms of race? So I'm Caucasian or white.

Caucasian or white [interrupted with okay] European [Interrupted by laughs] Asian?

Nope [Laughs]

Okay. How do you classify yourself in terms of sex?

I'm male. [smiles]

Okay good, um would you mind disclosing any disabilities?

What do you mean?

Do you have a disability?

Um the school says I have SLD.

Okay

[Cannot hear due to mumbling]

And what type of IEP goals do you have?

Make good grades.

Okay, [Pause] and have I left anything out.

Um no.

Okay, that about raps it up thank you very much for letting me talk to you today on your time. Thank you for your time .Um it is very much appreciated and your comments have been very helpful.

Code: P08

So do I have your permission to record our conversation?

Yes.

Okay, thank you.

So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with student of Biology, you do not have to give me your name, but please indicate that you are in fact currently a student of biology.

I am [smile]

Okay.

I've just turned on the tape recorder and would like for you to verify I have your permission to tape our conversation and the tape is running.

Yes.

Okay, thank you. As I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you say. Do you have any questions before I start asking questions?

No, none what so ever, no [interviewer laughs]

Okay, thank you. This part of the interview will focus on your perceptions and utility of the digital flash card intervention, in general. The first question, what was your feeling about using the flash card intervention?

I think it was a pretty good thing for me

Okay.

I could learn more about it.

Alright, ah do you feel the use of the flash cards daily was easy for you to use?

I think it was challenging but it helped me a little with my Biology in my first period class.

Oh that's really good, can you explain that a little further?

Well I didn't know what Mitosis was before but since you gave me the flash cards about it, it helped me more. And there were some other words I did not know either but since I had some vocab words for that, it helped me a little bit with the tests that I took that had something to do with it.

Do you think that um learning the words helped you engage a little bit more in class like you were able to pay attention a little bit more.

Yeah.

What were your feelings about the flash cards and being able to learn all of the cards?

I think it was, well I did not learn all of them but I learned more than I expected to learn, but so it was a good experience, I think that.

Okay. What part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

I don't really know that answer. [laughs]

Um, so was there any one specific part, like using it every day or the helper word on the card?

Oh' the helper words, the helper words, the helper words.

You did like that.

Yeah.

Okay. Um, in the future, would you use the flash cards like you did ah in learning strategies class to learn Biology terms?

Probably.

Um, why would you use them?

Um it would be easy to remember and I could remind myself everyday.

To use then a little each day?

Yeah [shaking head up and down]

Okay, share with me your typical study, routines ah for a course like biology.

Well, I would either study at home or in class if I had the time.

Okay so what does that look like when you are studying?

I just flip through the cards and study them and look through them again [and with hand motions, motioning how he uses flash cards] and then if I was stuck I would just look at the helper words and I would probably get it more.

Okay, before we started this, the research study the intervention with the cards, what do you do to study? What does that look like?

Just look over the words.

Like your word lists?

Yes.

Okay. Or your notes maybe?

Yes.

Share with me your belief about the role technology, that it has may have within your educational studies.

Well, there could be used to for reminders for tests.

Uhun.

And to study words.

Like the study stack program you used to study terms?

Yes.

Um, can you name specific technology that is of value to you within your current biology class?

A tape recorder?

Okay, okay, that could be. A tape recorder could be a big help. How could you use that?

I would, if I was at home I would study the note from my biology book and put it on my tape recorder and listen to it a few times or just or if I had like a um, video recorder I would tape the class session and look it over at my house.

Oh, that is a good-good plan. Um, is there anything else you would like to add to our discussion today?

No, I'm good.

I'm about done now, um do you have an further information to add, you already said no, so the next part of the interview is going to inform me of basic background information (Demographics) as its applied to Biology, as I mentioned before you do not have to answer any of the following questions if you do not want to. Are you ready to continue?

Umhuh [nodding head yes]

Okay, um what is your highest grade you have received in Biology class?

A or B.

And what type of assignment was that or was it a course grade?

Course grade B probably and tests say A or B.

And that is my next question what are the typical grades you receive on Biology tests or exams? A or B?

As, Bs and Cs.

Okay, And what are the total numbers of students in your Biology class?

I actually don't know, I have some friends in there but I don't pay attention to that I just work on my work.

Okay, um, how do you classify, classify yourself in terms of race?

Hispanic

Okay. How do you classify yourself in terms of sex?

Male?

Umhu. And would you mind disclosing any disabilities with me?

I think I might have had ADHA before when I was a little kid.

Okay.

But that's the past, way long ago.

Do you currently have a disability?

I don't think so.

Okay, so do you currently have an IEP?

[pauses to think and looks up] I actually don't know.

Have I left out anything or would you like to add anything to this part of the interview?

No

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

Code:D09

So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology class, do ah, you do not have to give your name, but please indicate that you are in fact a student of a biology class.

Yes, I am a student of Biology. [smile]

Okay.

I've just turned on the tape recorder and would like to verify again that I have your permission to tape our conversation and the tape is running.

Yes [nod]

Okay

As I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you say.

Do you have any questions before I begin asking questions?

No [Shakes head]

Okay, so this part of the interview will focus on your perceptions and utility of the digital flash card intervention, in general.

What was your feeling about the flash card intervention?

Ah, I think it helped, like, I guess it helped.

Okay umm, so do you feel the use of the flash cards daily was easy for you to use?

Yeah [nod].

Okay, can you explain why you felt like it was easy?

Because we didn't have like, have a teacher keep saying it, and saying it, and we were like on our own, and we listen to our own pace. Yeah.

Okay so you did like it being independent?

Yeah

Okay. What was your feeling about the flash cards being and being able to learn them?

It was hard, but like, I get used to it. If can get a good grade in biology.

Okay, so it, the words were hard? Were the words you using in biology hard?

Yeah, like some of the words were in my class.

What part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

The... what you call It umm? The one that you umm, put your own words or the...

The helper words? The one that you put in your own words? The simple definition?

Yeah.

Well there was a couple of parts like the word, the definition and the helper?

Yeah and no.

Okay, explain your answer.

Yeah because it would obviously help my grades go up, but then no because it would be so confusing, it like, you take time out of your class, like 5 minutes. Yeah.

Okay what if your learning strategy future, were to keep learning the words the way you were in here, for your biology class in there. Would it be no still or yeah?

Yeah

Five minutes a day in this class? So not to take up any of your learning time in biology, but outside of class, would you use them independently?

Yeah.

Okay, ah can you share with me your typical study, share with me your typical study routines ah for a course like biology.

First I look over the words, and then, I'll like, read the passage and stuff. And then go back to the questions and, and then if I didn't know the answer and then go back.

The answer to the end of each section? Or a worksheet that you're working on?

Yeah I would go back, and ask the teacher. Yeah.

Share with me your belief about the role technology, that it has within your ah educational studies.

Yeah I love technology. It's so cool. Like now, it's not like back then. Everything is on a computer now. You can look up things.[pushed bangs away from face]

Okay, um, can you name specific technology that is of value to you within your current biology educational studies?

The science channel? The Animal channel.

You like the science channel?

The Animal channel. That's what we always watch in biology.

Like on cable or recorded shows?

The recorded shows.

Okay, is there anything else you would like to add to our discussion?

That they are helpful.

The next part of the interview is going to inform me of basic background information (Demographics) as its applied to Biology, as I mentioned before you do not have to answer any of the following questions if you do not want to, please just say skip, are you ready to continue?

Yeah.

Okay, what is your highest grade you have received in Biology class?

C.

Okay and was that a type of assignment or was that?

Umm, the things in the book. We always have to read things from the book. Those are the things, I can like, I can pass.

What are the typical grades you receive on Biology exams?

Umm, probably F's or D's.

Okay, What are the total numbers of students in your Biology class?

There is a lot. I really don't know

Can you give me like a rough estimate? Like 25? Twenty-five plus?

There's probably like 30. 30 plus?

Ah, how do you classify, classify yourself in terms of race?

[Long pause]

I'm Caucasian, I'm white. How would you, define yourself as far as your race?

I don't know?[Shrugs] I'm white

Okay. How do you classify yourself in terms of sex?

Female.

Okay, And Would you mind disclosing any disabilities?

I don't like to read out loud. That's my biggest fear, and my disability. And I have stress a lot. Like a lot.

And do you know what your classification is? Like your IEP?

I think, I don't know. Like when I took a test, they told me what I got. But I don't know.

And what type of IEP goals do you have?

[Shakes head] I don't really pay attention.

Okay, and have I left out anything or would you like to add anything to this part of the interview?

[Shakes head]

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

Code: D10

So, again, my name is Kelly Grillo. Today is March 9th and I am speaking with student of a Biology class, do ah, you do not have to give your name, but please indicate that you are in fact a student of a biology class.

Yes. [smile]

Okay.

I've just turned on the tape recorder and would like to verify again that I have your permission to tape our conversation and the tape is running.

You do.

Okay

As I mentioned, I am taping the recording, or the discussion so that I don't miss anything that you say.

Do you have any questions before I begin asking questions?

No I don't

This part of the interview will focus on your perceptions and utility of the digital flash card intervention, in general. The first question what was your feeling about the flash card intervention?

It was helpful and it really help me alot

Okay umm, so do you feel the use of the flash cards daily was easy for you to use?

Yes.

Okay, can you explain why you felt like it was easy?

Because some words I had trouble, and the words helped me a lot by explaining.

So it was chunked up a little bit. Okay. What was your feeling about the flash cards being and being able to learn them?

Umm, well [pause] I can't quite put it right, but um... Can we skip that one?

Yeah

What part or parts of the Flash Cards were most helpful in trying to learn the Biology terms?

The actual words and the definitions.

Well there was a couple of parts like the word, the definition and the helper?

Okay, in the future, would you use the flash cards like you did ah in learning strategies class to learn Biology terms?

Yes I will.

Okay, why would you use them?

Because I find it a lot easier to study the words I memorize them better.

Okay, ah can you share with me your typical study, share with me your typical study routines ah for a course like biology.

Write down notes. And then study the notes. And then write them down again so I won't forget them.

Okay.

Share with me your belief about the role technology, that it has within your ah educational studies.

Well, I do like technology. Like computers and things stuff like that. I do think it helps me a lot by finding the stuff I need to work on. Like giving it to me straight without doing this process of working it out.

Okay, um, can you name specific technology that is of value to you within your current biology educational studies?

Umm, well, we use the microscope.

Do you use anything independently? Umm, like on the computer at home for biology studies?

We don't have a computer at home.

Okay, is there anything else you would like to add to our discussion?

No.

The next part of the interview is going to inform me of basic background information (Demographics) as its applied to Biology, as I mentioned before you do not have to answer any of the following questions if you do not want to, please just say skip, are you ready to continue?

Yes.

Okay, what is your highest grade you have received in Biology class?

Right now my highest grade was a C right now.

Okay and was that a type of assignment or was that?

That would be a 95 [in audible]

What are the typical grades you receive on Biology exams?

Well I haven't taken an exam or a quiz yet because I have missing assignments. I'm trying to make them up before I could get a grade for the stuff

Okay. What about last term?

I scored a 85

Okay, What are the total numbers of students in your Biology class?

I'm not sure about that.

Can you give me a rough estimate about 20 or so, 30 or so

I would say about 18.

Ah, how do you classify, classify yourself in terms of race?

Biracial

Okay.

How do you classify yourself in terms of sex?

I'm a male.

Okay, And Would you mind disclosing any disabilities?

I don't comprehend stuff that well. It takes me a few more time to look at stuff to remember.

Okay so what kind of disabilities do you have?

And what type of IEP goals do you have?

I'm still thinking about that

Okay, and have I left out anything or would you like to add anything to this part of the interview?

No.

Okay, well thank you very much for letting me talk to you today, your time is very much appreciated and your comments have been very helpful.

APPENDIX H: CODE BOOK

Interview Code	Word	Notes
P07	6 minutes	intervention being too short in time
D03	Comfortable	intervention being difficult on the computer
D03	Difficult	intervention being difficult on the computer
D03	Hard	intervention being difficult to return to previous cards
P05	Hard	
P05	rather have	intervention being preferred on the computer
D01	Better	
P02	Better	intervention being better than previous studying
P06	Better	intervention being supportive of learning vocabulary
P07	Easier	intervention being supportive of learning vocabulary
D01	faster and easier	intervention being supportive of learning vocabulary
P06	Good	intervention being supportive of learning vocabulary
P08	Good	intervention being supportive of learning vocabulary
P08	Good	intervention surprising and beating expectations
D01	Help	intervention being supportive of learning vocabulary
D01	Help	intervention being supportive of learning vocabulary
D01	Helped	intervention being supportive of learning vocabulary
D09	Helped	intervention being supportive of learning vocabulary
P02	Helped	intervention being supportive of learning vocabulary
P06	Helped	intervention being supportive of learning vocabulary
P08	Helped	intervention being supportive of learning vocabulary
P08	Helped	intervention being supportive of learning vocabulary
D10	Helpful	intervention being supportive of learning vocabulary
P07	Helpful	intervention being supportive of learning vocabulary
P07	Improves	intervention being supportive of learning vocabulary
P07	Increase	intervention being supportive of learning vocabulary
P08	learn more	intervention being supportive of learning vocabulary
D04	learned a lot	intervention being supportive of learning vocabulary
D03	Liked	intervention being supportive of learning vocabulary
D04	Liked	intervention being supportive of learning vocabulary
P08	More	intervention surprising and beating expectations
P07	Okay	intervention being supportive of learning vocabulary
D09	Own	intervention and likeness of being independent
D09	Up	intervention increasing grades
P02	Worked	intervention being supportive of learning vocabulary
D09	Yeah	intervention being easy to use
P02	Yeah	intervention being easy to use
P06	Yeah	intervention being easy to use

D01	Yes	intervention being easy to use
D04	Yes	intervention being easy to use
D10	Yes	intervention being easy to use
P05	Yes	intervention being easy to use
P07	Yes	intervention being easy to use
P06	Probably	reusability, likely to use intervention again
P08	Probably	intervention and likely to use it again
D01	Yes	using intervention again
D03	Yes	using intervention again
D04	Yes	using intervention again
D09	Yes	interventions and using it in the future
P02	Yes	using intervention again
P05	Yes	using intervention again
P07	Yes	reusability, likely to use intervention again
D04	Computer	feeling of technology and most valued, the computer
P02	Computer	feeling of technology and most valued
P06	Computers	computer being the most important aspect
D04	fun	feeling and value of technology, fun
D01	Helps	feeling of technology and its role
D03	Helps	feeling that computers are sometimes helpful
D10	Microscope	valued technology, microscope
D03	No	feeling no technology has value
P08	carry around	
D04	computer part	computer being the most important aspect
D10	Definitions	the definitions being the most helpful aspect
D10	Explaining	intervention and helpfulness
D01	Helper words	helper words being most helpful-most helpful aspects
D03	Helper words	helper words being most helpful-most helpful aspects
D09	Helper words	helper words being most helpful-most helpful aspects
P02	Helper words	helper words being most helpful-most helpful aspects
P05	Helper words	helper words being the most helpful
P06	Helper words	most helpful aspect-key words
P08	Helper words	helper words being most helpful-most helpful aspects
P06	Interactive	helpfulness in being more interactive
D01	Organized	
P07	Overall	helpfulness, aspects of interventions
D04	Refresh	helpfulness in being a refresher
D04	Week	
P08	Yeah	helper words being most helpful-most helpful aspects
P02	Normal	intervention being normal, average "another day"
P06	Normal	intervention with neutral feeling
D01	Before	comments toward previous study routine—cramming
D04	book study	previous study routine-book reading repetitive

P06	book study	
P02	Computer	
D03	repetitive study	
D09	repetitive study	previous study routines-- repetitive looking over
D10	repetitive study	
P07	repetitive study	previous study routine- repetitive reading over notes
P08	repetitive study	previous study routine of repetitive looking over notes
D09	science channel	technology that is a value-TV
P08	tape recorder	tape recorder being a valued piece of technology
P02	Half	intervention assisting test performance
P08	not learn	learning partial of the words
P06	Some	learning partial of the words

APPENDIX I: STUDY STACK™ COPYRIGHT PERMISSION

Study Stack™ Image Use Permission

Kelly,

You have my permission to use images of the studystack website.

Please share a link to your paper with me if possible when it becomes available.

John Weidner

john.weidner@studystack.com

APPENDIX J: WEBCOURSES@UCF COPYRIGHT PERMISSION

Webcourse@UCF Image Use Permission

Kelly,

We have no problem if you use screen captures from Webcourses provided the images came from the course created for your dissertation. If you got the images from another course, you will need permission from the owner of the course.

Feel free to use screen captures from your own biology pages in Webcourses. Just identify the pages as Webcourses@UCF.

Thanks,
Linda Futch
Linda.Futch@ucf.edu

**APPENDIX K: EDUCATION COMMISSION OF THE STATES COPYRIGHT
PERMISSION**

Education Commission of the States Science Graduation Requirements Use Permission

RE: Permission to Use Science Graduation Requirements in Dissertation Work

Jennifer Dounay Zinth [jdounay@ecs.org]

You replied on 6/16/2011 4:29 PM.

Sent: Thursday, June 16, 2011 4:21 PM

To: [Kelly Grillo](#)

Absolutely.

Jennifer Dounay Zinth

From: Kelly Grillo [mailto:Kelly.Grillo@ucf.edu]

Sent: Thursday, June 16, 2011 2:20 PM

To: Jennifer Dounay Zinth

Subject: RE: Permission to Use Science Graduation Requirements in Dissertation Work

Jennifer,

Thank you so much for the citation.

Can I also reprint the science portion in my appendices as well?

Kelly J. Grillo

From: Jennifer Dounay Zinth [jdounay@ecs.org]

Sent: Thursday, June 16, 2011 3:16 PM

To: Kelly Grillo

Subject: RE: Permission to Use Science Graduation Requirements in Dissertation Work

Good afternoon, Kelly. Below is the APA citation I have used when citing the science section of the graduation requirements database. Will this work?

Dounay, J. (2007). *High School Graduation Requirements: Science*. Retrieved from <http://mb2.ecs.org/reports/Report.aspx?id=902>

Jennifer Dounay Zinth

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