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# Increasing College Entrance Testing Vocabulary for Secondary Students with High-Incidence Disabilities

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# Increasing College Entrance Testing Vocabulary for Secondary Students with High-Incidence Disabilities


## Abstract

This study investigated the effects of an instructional technology device, specifically, a computer-based graphic organizer, called the *Real-World Connections Vocabulary* graphic organizer (Ellis, 2015), on vocabulary acquisition for college entrance testing skills of students with high-incidence disabilities. Although graphic organizers have been studied since the 1960's, there is very little research regarding the effectiveness of computer-based graphic organizers when used with high school students with mild disabilities, and their benefit acquiring college entrance exam vocabulary knowledge, namely, the ACT exam. By means of a single-subject, multiple probe across participants design, this study demonstrated that a functional relation did exist between the tool and vocabulary acquisition for each of the three participants. Additionally, a social validity survey rendered positive results regarding its use.



## Keywords

vocabulary acquisition, reading comprehension, computer-based graphic organizers, secondary students with high-incidence disabilities, instructional technology

The importance of reading comprehension cannot be underestimated. According to Rasinski, Padak, and Newton (2017), its significance was first identified more than seventy years ago when research indicated that reading comprehension skills were strongly connected to one's knowledge of vocabulary Davis, 1944). Researchers argue that of all the skills taught in the public education classroom, a student's ability to read and comprehend text is of the utmost concern, especially with regards to post-secondary employment expectations (Kuder, 2017). Even though 'reading' involves many different processes, it can be concentrated into two key components: the ability to decode or recognize words and the ability to understand their meaning, which ultimately leads to comprehension, "the all-important end" (Schloss et al., 2007, p. 234).

This concern for student's reading comprehension has continued over the last several decades. For example, in a report to the Nation, and the Secretary of Education in 1983's *A Nation at Risk,* a report from the National Commission on Excellence in Education, emphasized the belief that public education systems were not preparing students for the present-day workforce. One of the major assertions of this report was that approximately 40% of secondary high school students were unable to construct simple inferences from reading material. This was a landmark report which stated that high school students were scoring significantly lower than in previous years. This report led to the ultimate creation of the National Assessment of Educational Progress (NAEP), a website funded by the Commissioner of Educational Statistics, head of the National Center for Education Statistics (NCES) within the U.S. Department of Education. This site continually assesses student performance in the academic areas of reading, math, science, social studies, writing, and technology/engineering literacy. According to the most recent information available on the Nation's Report Card website, using information compiled from NAEP in the area of reading, scores for students in both the 4$^{th}$ and 8$^{th}$ grade levels have decreased significantly when compared to scores two years ago, but equally as significant are the reading assessment scores of high school students. 12$^{th}$ graders are tested less frequently than their younger grade counterparts, but according to the most current 12$^{th}$ grade assessment, the 2015 Nation's Report Card, the NAEP results showed these student's reading scores have continually decreased from 1992 (292 points), the year in which NAEP testing began, to 2015 (287 points) out of a possible 500 points. (NAEP, 2019). Of more concern are the averages of students with and without disabilities within these most recent 12$^{th}$ grade scores. Students without disabilities produced a mean score of 291, which is only one point below the 1992 average, while students with disabilities produced a mean score of 252, nearly forty points below the nations average (NAEP, 2019). Finally, when drilling down into these same reading

statistics, students in grade 12 in 2015 only 12% of all students with disabilities tested across the nation were proficient in the area of reading.

**Implications for Students with Disabilities**

Traditionally, students with disabilities score poorer than their peers without disabilities on vocabulary, as well as reading comprehension, measures (Leko, Alzahrani, Handi, 2019; Vaughn et al., 2015). As recently as 2015, based on findings from the NCES, *Average Scale Score for Reading* in which reading scale scores range from 0-500, students without disabilities averaged a 269-scaled score while students with disabilities average score was a 226. More specifically, in the isolated area of vocabulary, scale scores range from 0-500, students without disabilities have demonstrated improvements by increasing their vocabulary knowledge scores from 222-224 between 2009 and 2013; whereas scores for students with disabilities have decreased from 187 to 184 during the same time frame. This evidence demonstrates that despite educators' best efforts, there is a continued need to target vocabulary, leading to improved reading comprehension instruction, especially at the secondary level (Bryant, Goodwin, Bryant, & Higgins, 2003). In fact, Kuder (2017) most recently states that a review of the current literature shows that of the five most common types of intervention, (fluency, word study, vocabulary, comprehension, multi-component methods), vocabulary instruction produces the largest effect size (1.62) thus indicating improvement in this isolated skill continues to be critical area for instruction.

Vaughn et al. (2015) states that as students' age, vocabulary knowledge and reading difficulties become compounded. In a study of 9$^{th}$ grade students, Lang et al. (2009) found that these students require greater support and interventions to improve their deficits in both background knowledge and vocabulary for meaning to occur. Vaughn et al. (2015) also completed a meta-analysis of the number of reading interventions available for students with reading disabilities; they found there were twice as many reading interventions available for elementary students than for secondary students. The overwhelming consensus from this information indicates that remediating secondary students with reading deficits, specifically vocabulary acquisition, remains a challenge and warrants continued research (Boon, Fore, & Spencer, 2007; Bryant et al., 2003; Kennedy, Thomas, Meyer, Alves, & Lloyd, 2014).

Additionally, educators report feeling pressured to ensure meaningful outcomes for all students, regardless of a student's disability, academic, or behavioral need (Hazmi & Ahmad, 2018). As a result, both teachers and administrators are looking outside the proverbial box for more effective means of closing the gap and improving student performance. Consequentially, as the 21$^{st}$

century marches on and assistive technology – more specifically, instructional technology – becomes more ubiquitous, it begins to take a greater position on the educational platform (Lombardi et al., 2017; Malcolm & Roll, 2017). This, combined with students' seemingly innate enthusiasm for electronic devices and computerized devices, have caused educators to rush and create more modern high-tech versions of traditional evidence-based strategies such as graphic organizers and other direct instruction techniques, but little evidence exists to measure their effectiveness (Kennedy et al., 2014). Research takes time, and with the rapid speed at which technology is evolving, it is difficult for researchers to keep up with the demand for sound knowledge (Malcolm & Roll, 2017).

**Background of the Study**

Educators continue to search for research-based, effective tools to overcome students' academic difficulties while also taking advantage of technology available to them in modern classrooms. One such tool, the graphic organizer, was first identified in 1963 by Dr. David Ausubel as a means of increasing students' knowledge by building on their current understanding and presenting new information through well-organized, visual models (Dexter & Hughes, 2011; Singleton & Filce, 2015). These models allow students to better understand content which, therefore, make them highly effective in improving the reading comprehension of students with disabilities (Gajria, Jitendra, Sood, & Sacks, 2007; Kuder, 2017; Watson, Gable, Geer, & Hughes, 2012). As students enter secondary grades, learning becomes more dependent upon their ability to grasp information-driven text that contains subject-specific, technical vocabulary which, as already established, can be a challenge for students with disabilities and may ultimately lead to students being less prepared as they enter the work force (Gajria, Jitendra, Sood, & Sacks, 2007, Kuder, 2017, Leko, Alzahrani, & Handy, 2019). The use of graphic organizers can aide instructors as they motivate students to forge through this oft-times, muddy content.

A second concept, differentiated instruction, became vitally important between the passage of the No Child Left Behind Act (2002) and the reauthorization of the Individuals with Disabilities Education Improvement Act (2004) in which federal mandates re-emphasized the importance of including all students in the general education classroom to the greatest extent possible. The use of differentiated instruction implies one responds to a student's individual needs while considering their learning style to help ensure learning is accessible to the student (Tomlinson, 1999). But as Stanford and Reeves (2009) posit, one single teaching approach will not accommodate every student. Therefore, teachers must be diligent in their attempt to vary instruction via effective differentiated instruction techniques

to meet the needs of all their students, which invariably will support the overall growth of their students most effectively.

Along similar lines, the Universal Design for Learning (UDL) Framework outlines that teachers should be proactive in their approach to teaching and learning by purposely structuring instruction to provide successful opportunities for all learners (Kennedy et al., 2014; Meyer & Rose, 2011; Stanford & Reeves, 2009). Teachers who choose the UDL approach plan for success via various and diverse modalities instead of attempting to solve problems, and redirect student error by taking a more proactive approach.

Another approach, Assistive Technology (AT), has been shown to be very successful when employing both differentiated instruction and UDL strategies (Basham et al., 2010; Elder-Hinshaw, Manset-Williamson, Nelson, & Dunn, 2006; Kennedy et al., 2014; Meyer & Rose, 2011; Tomlinson, 1999). Assistive technology may be a significant part of a student's success in the 21st century (Malcolm & Roll, 2017). This concept, as defined by the Individuals with Disabilities Education Improvement Act (2004), states that it includes any item that can be used to improve the educational performance of a student with a disability. Although it is widely accepted that AT is to focus on the needs of an individual student, it also encourages educators to evaluate the appropriateness of technology to support student performance (Basham et al., 2010). The notion of *instructional technology* is an extension of this concept, in that assistive technology advocates for educators to consider technologically enhanced programs that purposely support the diverse needs of students including those that expressly address instruction (Basham et al., 2010; Puckett, Judge, & Broso, 2009). The progression of instructional technology in recent years, has led to a barrage of educational tools, but their benefits and usefulness has been debated and under-utilized at best (Johnson, Dudgeon, & Kuehn, 2007; Johnston & St. Evans, 2005; Malcolm & Roll, 2017; Smith & Okolo, 2010).

There is limited research on high school students with mild/high-incidence disabilities regarding the acquisition of vocabulary that centers on college entrance and career readiness exams (Malcolm & Roll, 2017); specifically, in the content area of reading and using instructional technology in the form of a computer-based graphic organizer. Targeted instruction of academic vocabulary promotes content-area knowledge (Fisher & Frey, 2014; Vaughn et al., 2015). Graphic organizers, albeit not electronic in nature, have been proven to promote this cause (Ae-Hwa, Vaughn, Wanzek, & Wei, 2004; Ausubel, 1963; Gajria, Jitendra, Sood, & Sacks, 2007; McMackin & Witherell, 2005; Singleton & Filce, 2015). With the emphasis of rigor in education and, thus, the cognitive demand placed upon students steadily

increasing, the challenge placed before students is accumulating (Kim et al., 2017; Lombardi et al., 2017; Malcolm & Roll, 2017; Vaughn et al., 2015). To this end, teaching vocabulary is not only vital, but is a key component in the success of students with disabilities at the secondary level (Vaughn et al., 2015; Malcolm & Roll, 2017; Watson et al., 2012). The use of technology to teach vocabulary through an evidence-based approach such as graphic organizers makes pedagogical sense, and is a need within the educational community, but needs to be researched to determine its effectiveness; therein lies the basis for this study.

The purpose of this study was to determine the effectiveness of a computer-based graphic organizer (CBGO) on improving vocabulary knowledge with high school students. The study specifically examined the effectiveness of a graphic organizer, *Real-World Connections Vocabulary* (Ellis, Deschler, Lenz, Schumaker, & Clark, 1991; Ellis, 2015), on the improvement of American College Testing (ACT) vocabulary word knowledge, which is a test presently given to all 11$^{th}$ grade students in the state where this study took place, thus indicating its relevancy. This study evaluated students' performance on pre- and post-test measures related to ACT vocabulary terminology and their definitions, as well as pre- and post-test scores on the *Woodcock Reading Mastery Test: WRMT-III* (Woodcock, 2011); specifically, the *WRMT-III* subtest area of Reading Comprehension which focused on synonyms, antonyms, and analogies. Finally, this study also examined students' perception of the ease-of-use of the CBGO, the vocabulary's perceived usefulness to them, and the program's effectiveness.

**Need for the Study**

Even though the Every Student Succeeds Act of 2015 and the Individuals with Disabilities Education Improvement Act of 2004 both mandate improving efforts for students with disabilities as well as the consideration and appropriate inclusions of effective use of technology, there is very little research to support this combined effort (Kennedy et al., 2014; Kuder, 2017, Lombardi et al., 2017). According to a recent meta-analysis of the literature on this topic by Ciullo and Reutebuch (2013), twelve studies met both criteria and of those, and only eight of the twelve centered on students eligible for services under the category of specific learning disabilities in secondary schools (grades 6-12) albeit, these eight did render positive results. In each case, their positive results were contingent upon the principles of explicit instruction (Ciullo & Reutebuch, 2013), but again, only eight focused on secondary students with learning disabilities.

Although there is one specific study that rendered positive results regarding the effectiveness of the overall Differentiated Visual Tools (DVT) Model (Ellis, Willis & Deshler, 2011), there are no studies regarding the effectiveness of the

specific DVT graphic organizer used in this study, the *Real-World Connections Vocabulary* visual tool (Ellis, 2015) and its impact on students with disabilities. Several researchers do establish the need for a CBGO to provide students with visual tools that support instruction and scaffold learning (Ellis & Rock, 2001; Lawrence-Brown, 2004; Rock, Gregg, Ellis, & Gable, 2008: Tomlinson, 2001).

Overall, research is limited as to the effectiveness of computerized graphic organizers. Results from this study provide validation regarding the use of instructional technology, specifically, CBGO to improve vocabulary acquisition, which is an integral component of reading comprehension for secondary students with high-incidence disabilities educated in the 21st century (Gajria, Jitendra, Sood, & Sacks, 2007; Malcolm & Roll, 2017; Lombardi et al., 2017).

## Research Question

Considering (1) the importance of vocabulary knowledge to strengthen reading comprehension skills, as well as (2) the use of technology in this modern era to support this achievement, and (3) the lack of information in these combined two fields, specifically (4) concerning secondary students with high-incidence disabilities, the research question involved in this study is: What are the effects of a computer-based graphic organizer strategy on increasing the ACT vocabulary knowledge of secondary students with high-incidence disabilities?

## Method

### Participants

The criteria for participation was as follows: (a) possessed below-average vocabulary skills as defined as students who had previously received remediation and accommodations in the subject of vocabulary by, both, their grade level and assigned, special education teacher (b) had reading goals identified in his or her Individualized Education Plan (IEP), and (c) were recommended for the study by his/her current general education English teacher based on an agreed upon need. The students' past vocabulary instruction included instruction from both the general and special education teacher with a goal of learning five vocabulary words each week through the use of oral instruction, flashcards, vocabulary games, conversational activities, as well as both formative and summative assessments. Demographic and assessment information is included in Table 1.

Table 1.

*Participants Assessment & Demographic Information*

| Student | Age | Ethnicity | Grade | Disability | IQ | Predicted Achievement (PA) | Overall Achievement Score | 10th Grade English Aspire Score | 10th Grade Reading Aspire Score |
|---|---|---|---|---|---|---|---|---|---|
| Jack | 15 | White | 10 | LD | 93 | 95 | 65 | 427 (Close) | 429 (Ready) |
| Nicole | 16 | White | 10 | LD | 110 | 106 | 73 | 416 (In need of support) | 418 (In need of support) |
| Lulu | 16 | White | 10 | OHI | 82 | N//A | 81 | 417 (In need of support) | 414 (In need of support) |

i. Exceeding – Level 4, highest category
ii. Ready - Level 3
iii. Close – Level 2
iv. In Need of Support – Level 1, lowest possible category

The first participant, Jack, was a 15-year-old boy in the 10th grade. Jack had an overall full-scale IQ standard score of 93, obtained with the *Universal Nonverbal Intelligence Test* [UNIT] (Bracken & McCallam, 1998). He had received services for special education since he was 11 years old. Jack was found eligible for special education services using a Severe Discrepancy Model in which there must be 16 points between a student's Predicted Achievement score and overall achievement score on a separate measure. Jack's overall achievement score on the *Kaufman Test of Educational Achievement II* (KTEA-II; Kaufman & Kaufman, 2004) produced a total standard score of 65. Jack's predicted achievement was 95. This indicated a 30-point difference between his predicted achievement and his achievement. Jack received support for academic needs including Language Arts skills by the resource teacher in the resource room for pull-out services for approximately 60 minutes each week as well as through inclusive means in his general education English classroom. Within general education English, Jack took weekly vocabulary assessments that he failed and retook consistently with accommodations in the resource room.

The second participant, Nicole, was a 16-year-old student in the 10th grade. She had received special education services since she entered kindergarten. According to her most recent eligibility information, she obtained an IQ standard score of a 110, which was equivalent to a Predicted Achievement score of a 106. When compared with her overall achievement score of a 73, this produced a 33-point difference between her IQ and her achievement, therefore making her eligible for services through SLD. Nicole received support through inclusive means in her general education English classroom as well as in the resource room for approximately 70 minutes each day. Similar to Jack, Nicole frequently failed

vocabulary tests in her general education English class and re-took them in the resource room each week.

The third participant, Lulu, was a 16-year-old student in the 10th grade. She had received services through special education since she was 10 years old. Her eligibility was Other Health Impaired (OHI) as a result of psychiatric issues that impact her ability to grasp reading content as well as her lack of adequate progress without special education support in the general education classroom. Her documented medical diagnoses included Obsessive-Compulsive Disorder (OCD), depression with psychotic features, general anxiety disorder, and a sensory processing disorder. She took medication and was under the care of mental health professionals whom she was currently meeting with on a monthly basis. In addition to her need for support in the general education classroom, she had many absences throughout the school year related to repeated hospitalizations and doctors' appointments. Lulu received support through both inclusive means in her general education English classroom, as well as in the resource room for approximately 70 minutes each day. With this support, she successfully passed her English vocabulary tests in the general education English classroom. During periods of time in which Lulu had emotional complications or successive absences, she completed makeup work in the resource room to remain on track.

**Setting**

The study took place in a public, Title I high school situated in a rural town within the Southeast U.S. The high school was comprised of approximately 490 students in grades 9-12, of which 81.5% received free lunch services; at the time of the study. Moreover, all three of the students in this study received free lunch services. Sixty percent of the students at the high school were white, while thirty-six percent were African-American, and four percent fell into the "other" category. The first author, the students' special education teacher, implemented instruction in a high school conference room daily for less than one hour each day. The teacher was a doctoral student with 21 years of classroom teaching experience, held an Education Leadership certificate, an Ed.S. degree in Special Education, and a National Board Teaching Certificate in the area of Exceptional Needs Specialist.

**Materials**

Materials used in this study included a computer-generated, vocabulary graphic organizer, entitled *Real-World Connections Vocabulary* (Appendix A) published by Dr. Edwin Ellis (2015). This intervention tool is an evidence-based, graphic organizer used for vocabulary acquisition (Dexter & Hughes, 2011). In addition to this, the researcher, along with a consensus of experts, chose 30 commonly encountered vocabulary words from a list of words provided by *College*

*Board's Top 100 Common SAT/ACT Vocabulary Words* (Appendix B**).** The experts consisted of one professor, four high school English professors, a Special Education Director, one guidance counselor, and one assistant superintendent and this researcher. The first author then created five different probes with ten vocabulary words on each probe (Appendix D); each probe included various combinations of the thirty vocabulary words. The reason for five different measures was an attempt to control for the testing effect which can threaten the internal validity of a study (Campbell & Stanley, 1963). By creating multiple probes, the researchers decreased the likeliness of the student memorizing the test answers as opposed to learning the vocabulary word and its definition. In addition to the vocabulary probes, each student completed subtests of the *Woodcock Reading Mastery Test – III* (WRMT-III; Woodcock, 2011) and a teacher-made pre-test and post-test. Before and after instruction, students completed the synonym, antonym, and analogies subtest of the WRMT-III, the section deemed 'word comprehension.' In addition, students completed a pre/post-test that consisted of thirty questions, one for each of the thirty vocabulary words included in this study (Appendix C).

In order to avoid potential threats to interval validity (mainly the effects of test/retest), five assessments with ten questions on each were designed from a pool of thirty. These items were based on feedback from a consensus of experts. Reliability of the pretest/posttest was assessed by distributing the instrument to nineteen $10^{th}$ graders. After completion, each was scored as either correct or incorrect. Split-half reliability was utilized using SPSS to determine reliability of the pretest/posttest. A Cronbach Alpha of .8 or better was required as results within this range indicate good ($\alpha > 0.8$) or excellent ($\alpha > 0.9$) internal consistency. Reliability tests yielded a Cronbach's Alpha Coefficient of r =.986.

A content validity analysis was initially conducted by three master teachers in the field of reading. The master teachers rated each item on the pre/post-test as relevant, somewhat relevant, or irrelevant. Items were assigned a Likert scale score from 1 to 3 with three being 'relevant', 2 being 'somewhat relevant', and 1 being 'irrelevant.' The mean score for each item was 3.0 indicating these skills were most likely relevant to vocabulary. This information was shared with the consensus of experts and led to these words being chosen for the focus of this study.

The independent variable consisted of the *Real-World Connections Vocabulary* graphic organizer (Ellis, 2015). This graphic organizer is but one component of a program called "Differentiated Visual Tools" created by Edwin Ellis. These tools integrate instruction and technology to produce formative assessment data that can be used to simplify complex instruction. This model is based on multiple principles: (a) technology can be used to enhance instruction

without compromising the integrity of classroom curriculum, (b) clarity of instruction is critical as students become older and curriculum becomes more complex, (c) standards are sequentially ordered and therefore indicate that learning should be scaffolded, (d) teacher's time is limited, which can make planning difficult, therefore technology-based instructional resources can be used to help speed the planning process, (e) when learners are engaged, performance is maximized, (f) teachers should be afforded latitude when selecting tactics that best align with their instructional styles, and (g) visual and semantic prompts are powerful instructional tools (Ellis, 2015).

**Experimental Design**

The researchers utilized a single-subject, multiple probe across participants design. The multiple probe design was most appropriate for this study as it allowed the researchers to verify the presence of a functional relation between the intervention and behavior through the replication of effects across different participants (Horner & Baer, 1978). Multiple probe technique employs the use of intermittent baseline prior to the introduction of the intervention. The researcher collected baseline data until they were stable. The researcher defined stability as no more than 10% variance in the last three data points compared to the mean rate of responding.

Each student began baseline on the same day in separate sessions. Then, baseline probes were administered routinely for the first student, but, as is standard for multiple probe approach, the probes were administered only randomly throughout extended baseline periods for the second and third participant so as to not encourage learned incorrect responses during this stage. Once the first student demonstrated stability, the researcher implemented instruction using the *Real-World Connections Vocabulary*, graphic organizer (Ellis, 2015). As each student reported he/she was available throughout the entirety of the summer to participate in the study, the order in which students were chosen to proceed was via random assignment. Once the first student demonstrated mastery, a 90% or higher on three probes in succession, the second student moved from baseline to intervention if his baseline data were stable. When the second student earned a 90% or higher on three probes in succession, the third student moved from baseline to intervention. Students completed probes at the beginning of lessons in order to assess learning from the previous lesson. Once students achieved mastery, they moved to maintenance, instruction ended, and they completed a probe once a week for the remainder of the study.

**Instructional Procedures**

Specifically, first, during instruction, the researcher stated the ACT vocabulary word, its exact definition, and its meaning in practical, relatable terms. The teacher then used the word in a sentence and engaged the student in a discussion regarding synonyms and antonyms of the word. Next, the student and the teacher discussed real-world applications of the vocabulary word. Finally, the teacher asked the student to complete one line of the Differentiated Visual Tools, *Real-World Connections Vocabulary* graphic organizer (Ellis, 2015). On the graphic organizer, students typed the word, its exact definition, then created either one sentence or made a real-world connection to the vocabulary word that would help them later remember the meaning of the vocabulary word.

The teacher repeated these steps for each of the five words of the day (stated the (1) word and (2) definition; used the word in a (3) sentence, discussed with the student (4) synonyms and antonyms, and (5) real-world applications). The teacher ended each session by reviewing the words, once again, orally and printing the student's completed graphic organizer for the student to keep. The researcher taught five vocabulary words each session and introduced a total of ten new words each week. Students completed test probes three times a week during the intervention phase prior to beginning instruction. The length of each session varied but lasted no longer than 45 minutes; session were held Monday through Friday, barring one holiday; the length of the study lasted eight weeks.

**Fidelity and Inter-rater Reliability**

Fidelity is an essential part of any program and ensures replication by others (Horner et al., 2005). The researcher assessed treatment fidelity with a checklist (Appendix E) along with the assistance of recorded video observation. The teacher recorded one out of every three sessions. The special education teacher who completed the checklist has a master's degree and fifteen years' experience in the classroom. The overall treatment integrity was 100% accuracy for 100% of each of the recorded sessions.

The researcher also checked each of the student's probes for inter-observer agreement. The researcher scored each item as either correct or incorrect, then calculated the number and percent correct on each probe and graphed the data (Appendix G). A special education teacher with 15 years' experience and a master's degree checked 20% of the probes for interobserver reliability. Agreement was calculated on a question by question basis by dividing the number of agreements by the total number of agreements and disagreements and multiplying that by 100.

As no errors were noted, this method rendered a score of a 100% interobserver reliability.

**Social validity.** After the study, the teacher orally administered a social validity checklist to each student to determine the social relevance of the computer-based graphic organizer and instructional technology on ACT vocabulary instruction (Appendix F). The assessment consisted of nine questions pertaining to students' perceived effectiveness and usefulness of the study (ACT vocabulary words). Four of the questions were Yes/Maybe/No questions. These four specifically addressed the following: (a) whether or not the students liked the CBGO, (b) if it helped them learn new vocabulary words, (c) if they thought the words learned would be on the ACT exam, and (d) would they recommend using the program again. Five of the questions were open-ended in nature. The open-ended questions assessed the following: (a) what the students felt they learned from using the vocabulary graphic organizer, (b) what they liked best about the tool, (c) what they did not like regarding the tool, (d) what might they change about the tool, and (e) if there was anything else they wanted to say regarding the program.

## Results

### Baseline Data

Prior to onset of intervention, each student completed baseline probes. Each of the three students' performance was stable across the behavior examined, ranging only between 30% and 40% for all. Once the first student Jack demonstrated stability, the researcher began use of the intervention, "*Real-World Connections Vocabulary*," CBGO (Ellis, 2015). Jack's baseline mean performance was 36% with a range of 30% to 40%. The data path showed a neutral trend. Nicole's baseline level was 38% with a range of 30% to 40%. Her data path showed a neutral trend as well. Lulu's baseline level was a 36% with a range from 30% to 40%. Her data path also showed a neutral trend. Student results are shown in Figure 1.

**Figure 1.**

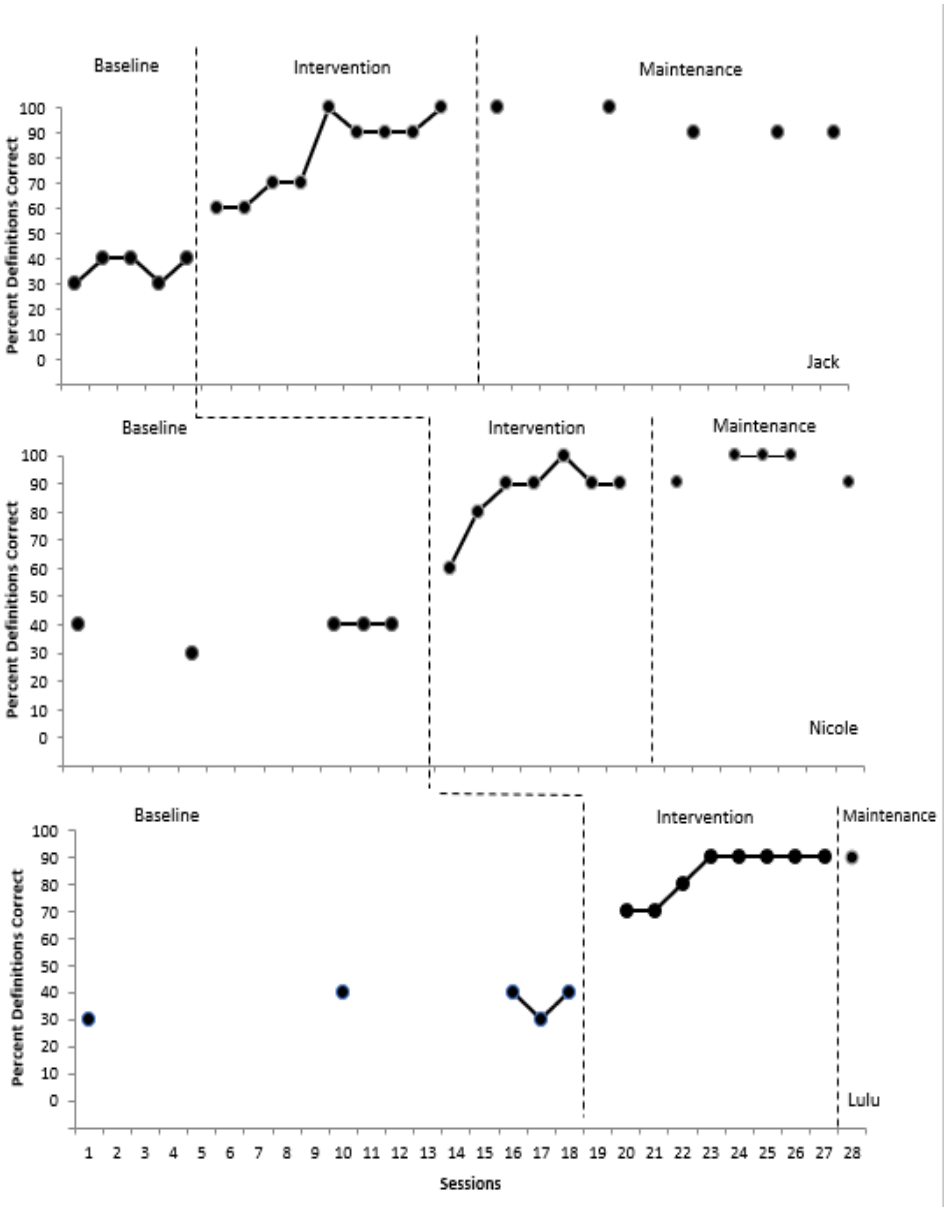


***Figure 1*** Students' Performance on ACT Vocabulary

## Performance during Instruction

**Jack.** Jack was the first student to begin intervention. The mean level of performance was 81.1% with his scores ranging between 60% to 100% mastery of content. When this information was compared to Jack's mastery during the baseline phase of 36%, the researcher was able to indicate a rapid change after intervention.

Such a pronounced slope is strong evidence that the behavior had changed, and that the intervention was proven to be effective and significant. The percentage of non-overlapping data was 100% with a +2 change in performance level. A Tau-U was used to calculate the effect size. The Tau-U combines overlap of data while controlling for undesirable baseline trend. The Tau-U statistic was 0.96, indicating a strong effect.

Jack established generalization in the area of 'word comprehension' on the WRMT-III (Woodcock, 2011) which evaluated Jack's knowledge of synonyms, antonyms, and analogies. Using this measure, when comparing his pre- and post-test scores, his net improvement was +8 points (Table 2). In Figure 1, his mean level of performance was 81% with a 45% mean difference between baseline and intervention phase averages.

**Nicole.** Nicole's mean level of performance during the baseline phase was 38% but improved during the intervention phase to a mean level of performance of 85.7% with her scores ranging between 60% to 100% (Figure 1). This indicated an immediacy of effect from the last data point in the baseline to the first data point in intervention, with none of the data points overlapping. Similar to Jack's performance, the trend positively increased with regard to level and variability, thus demonstrating an increase in vocabulary knowledge. Her mean level of performance was an 86% with a 48% mean difference between baseline and intervention phase averages (Figure 1). The percentage of non-overlapping data was 100% with a +2 change in performance level. Tau-U was 0.94, indicating a strong effect.

Nicole showed generalization in the area of 'word comprehension' on the WRMT-III (Woodcock, 2011) which evaluated Nicole's knowledge of synonyms, antonyms, and analogies. Using this measure, her net change in standard scores from her pre- to post-test were a +10 (Table 2).

**Lulu.** Lulu showed a level of performance during baseline of a 36% but increased to 83.75% during the intervention phase with scores ranging between 70% and 90%. The trend steadily increased throughout intervention; her mean level of performance was an 84% with a 48% mean difference between baseline and intervention phase averages (Figure 1). The percentage of non-overlapping data points was 100% with a +2 change in performance level. Tau-U was 0.95, indicating a strong effect.

Lulu demonstrated generalization in the area of 'word comprehension' on the WRMT-III (Woodcock, 2011) which evaluated Lulu's knowledge of

synonyms, antonyms, and analogies. Using this measure, her net change in standard scores from her pre- to post-test were a +15 (Table 2).

Table 2.

*Standardized Scores: Pre/Post-Test*

| WRMT-III Subtest: Word Comprehension | Pre-Test Standard Score | Post-Test Standard Score | Net Change in Standard Score |
|---|---|---|---|
| Jack | 56 | 63 | +8 |
| Nicole | 75 | 85 | +10 |
| Lulu | 64 | 79 | +15 |

The overall results across all three students from the Tau-U statistic were significant as well (Table 3.). With a $p < .05$, the data indicated an effect size of ES = 0.9 with a confidence interval of $CI_{95} = .5622 < > 1$. Visually, there is a difference, but the Tau-U explains how significant of a difference. With an effect size greater than .9, this indicates a functional relation and meaningful academic benefits overall related to the *Real-World Connections Vocabulary* graphic organizer (Ellis, 2015).

Table 3.
*Tau-U Statistical Information*

| | Non-Overlapping Data | Change in Perform-ance Level | Statistical Signif-icance | Effect Size | Confidence Interval | Significant Academic Benefit |
|---|---|---|---|---|---|---|
| Jack | 100% | +2 | p<.05 | 0.9556 | $CI_{90}$ = .407 < > 1 | Meaningful |
| Nicole | 100% | +2 | p<.05 | 0.9429 | $CI_{90}$ = .364 < > 1 | Meaningful |
| Lulu | 100% | +2 | p<.05 | 0.9500 | $CI_{90}$ = .388 < > 1 | Meaningful |
| Overall | 100% | +2 | p<.05 | 0.9496 | $CI_{95}$ = .5622< > 1 | Meaningful |

**Pre- and Post-Test Data**

In addition to the WRMT-III (Woodcock, 2011) data described above, each student was given a pre- and post-test using the 30 vocabulary words used during the intervention phase of this study. All three students demonstrated significant progress when comparing their progress from pre- to post-testing. Jack who had scored a standard score 56 on the WRMT-III pre-test (Woodcock, 2011), scored a 63 on the post-test. Nicole scored a 75 on the pre-test, scored a standard score of an 85 on the post-test. Finally, Lulu scored a SS of a 64 on the pretest, scored a 79 on the post-test. Concurrently, Jack scored a 97% on the post-test, Nicole scored a 100% on the post-test, and Lulu scored a 93% on the post-test. The assessment data are summarized in Table 4.

Table 4.

*Pre- and Post-Test Performance on Researcher-Created Probes*

| Student | Pre-test Number Correct (Percentage) | Post-Test Number Correct (Percentage) | Net Change |
|---|---|---|---|
| Jack | 10 out of 30 (33%) | 29 out of 30 (97%) | +19 (+64%) |
| Nicole | 11 out of 30 (37%) | 30 out of 30 (100%) | +19 (+63%) |
| Lulu | 11 out of 30 (37%) | 29 out of 30 (97%) | +18 (+60%) |

## Maintenance Procedures

The maintenance phase began when each student reached 90% proficiency on three probes during the Intervention phase. Once a student had moved to this phase, once a week for the continuation of this study, they were given a maintenance probe to determine if the participant-maintained comprehension over time of both the ACT vocabulary word and definition. Results indicated in Figure 1 that participants maintained the skills mastered during the Intervention phase.

## Discussion

This study examined the effects of a computer-based, graphic organizer on the improvement of 10th grade students' vocabulary acquisition. The results indicate a functional relation between these two variables. All three students demonstrated mastery of 30 ACT vocabulary words taught through the use of *Real-World Connections Vocabulary* (Ellis, 2015). These results show that a modern, technologized tool (CBGO) rendered positive results in teaching age-appropriate, tenth and eleventh grade content (ACT vocabulary words) to students with high-incidence disabilities. Additionally, in reference to the relevancy of this tool, these students reported they liked the graphic organizer and felt it helped them learn the ACT vocabulary words, the words would be seen on the ACT exam, and that they would use this CBGO again if requested to do so by a future instructor.

In the five question, open-ended response section, Jack stated that he liked the fact that the tool was computer-based best because he felt it saved him "oxygen" in the form of trees, paper, and "technically, animals too." Nicole felt she learned vocabulary words that she would encounter both on the ACT exam as well as in the "real world, too." She liked how the program was organized with the word first, then the meaning, then the sentence, essentially in a linear form. Lulu, the student with an educational diagnosis of OHI related the instruction to her mental health issues stated she liked learning new words, and most specifically she appreciated learning that the ACT vocabulary word, 'asylum' does not mean 'a bad place' as she had once thought based on various movies she had seen before. She also felt this tool was helpful and made the information being taught less confusing. Each of the three students, who gave up a considerable portion of their summer to participate in this study, reported that it was a positive experience and two of the three students asked independently if they could return to the high school to work in this teacher's classroom or to help the principal more throughout the summer. One student said she was very thankful to get to come sit in the air conditioning and that, alone, was motivation enough for her to come to school each summer day, as her home does not provide her with this luxury.

The results are important because it shows a promising practice for teaching vocabulary using more modern, 21st century tools. The pervasiveness of technology in schools is increasing rapidly (Cuillo & Reutebuch, 2013). According to the most recent statistics from the National Center for Educational Statistics (NCES; 2017), 98% of teachers' report having varying degrees of access to computers for instructional purposes. They also state the overall, nationwide percentage of students with instructional computers with internet access is 65% (NCES; 2017). This information demonstrates that access to technology is increasing. Therefore, it is up to teachers and administration to determine the efficacy of these tools for educational purposes. Additionally, as a result of this increase, researchers' interest in its usage and effectiveness is increasing (Cuillo & Reutebuch, 2013), thus increasing the demand for quality materials.

This indicates a need to provide teachers with tools which are researched-based to ensure the most effective student outcomes. With regards to this program and the data rendered in this study, it has been demonstrated that students made significant gains when provided with appropriate, assistive technology tools and instruction.

**Implications**

With regards to improving vocabulary acquisition, traditional graphic organizers have proven to provide students with disabilities a visual and spatial modality to better acquire new information through their use of lines, arrows and graphic arrangements (Bos & Vaughn, 2002; Darch & Eaves, 1986; Gajria, Jitendra, Sood, & Sacks, 2007; Rivera & Smith, 1997). The overall question this study answered was, in this modern age of technology, can this technique be used most effectively to tackle this ongoing problem? As computers are becoming more commonplace in the classroom, the true question becomes are they effective and do they positively impact student learning (Kennedy et al., 2014; Kuder, 2017). As secondary teachers become more dependent upon their usefulness, research at this level is needed to verify their strengths, and this study supports this.

Three specific implications for this study include, first, technology should be considered as an effective means of instruction in Tier 2, Response to Intervention (RtI). Tier 2 instruction is integral to the RtI process and often averts students from being referred to special education services (Individuals with Disabilities Education Improvement Act, 2004; Smith & Okolo, 2010). With extra support and accommodations, these students are often successful without the need for the special education referral process (Smith & Okolo, 2010). As with all students with disabilities, decisions should be made on an individual basis; based

on the results from this study, this method could be a viable means of support that renders positive results.

A second implication from this study is that, through the use of computer-based graphic organizers, evidence further supports the consideration of using technology as a Universal Design for Learning practice and Differentiated Instruction technique for secondary students. The use of UDL, DI, and the inclusion of technology within this study provides additional research towards effective evidence-based practices for increasing the performance of students with high-incidence disabilities (CAST; Meyer & Rose, 1998; Tomlinson, 1999).

The third implication from this study is that, through the use of technology, specifically CBGOs, students may be better able to increase vocabulary knowledge which ultimately better prepares students with disabilities for their post-transition goals (Kim et al., 2017; Vaughn et al., 2015; Watson et al., 2012). Overall, in these ways, results from this study positively supports that further evidence exists regarding the effectiveness of computerized graphic organizers helps to increase vocabulary acquisition of students with high-incidence disabilities.

**Limitations**

The findings from this study do indicate a functional relation between a computer-based, graphic organizer, using the *Real-World Connections Vocabulary* (Ellis, 2015) and 10$^{th}$ grade students' vocabulary acquisition, but some limitations do exist. First, since treatment integrity was only completed in 33% of the studies, this presents a threat to internal validity and future studies might increase the percentage of sessions assessed (Ciullo & Reutebuch, 2013; Swanson, Wanzek, Haring, Ciullo & McCulley, 2013). Also, this study was conducted during the summer months when each student was free of other academic restraints. This lack of other concerns and obligations may have sped up mastery of content and scores rendered on the WRMT-III. Additionally, the constraints of this study mandate each student proceed to mastery in a one-on-one setting. This type of setting is not traditional, nor typical in nature, thus a larger group might have rendered a different outcome. This study was completed by a special education teacher known to these students. In fact, the first author had known each of these students for over two school years, this creates a limitation in that it is not known if another researcher, not known to these students, would have received the same amount of return. The researcher was also a special education teacher. A general education teacher, one that is untrained to work with students with disabilities, might, too, have seen a different outcome. Moreover, this study involved only student with high-incidence, mild disabilities. A wider net, one that included students with different disabilities, might have produced different results. Each of the students within this study were

either fifteen or sixteen years old 10th graders, therefore one cannot generalize the results to another age group or grade. This study involved a "teaching to the test" approach in that, during intervention, despite oral conversations between the researcher and the participant regarding word meanings, as well as the student typing their own 'real world analogies' of the vocabulary word onto the intervention tool, this study involved administering identical pre- and post-tests as well as the same five probes throughout the length of the study. Therefore, future studies might use synonyms on probes and pre/post-tests instead of exact words and definitions. Finally, a larger sampling of students with disabilities and varying levels of academic abilities would allow one to generalize these results to a larger population.

**Recommendations for Future Research and Conclusion**

Because of the limitations discussed in the previous section, there are several recommendations for future research with regards to the use of computer-based graphic organizers with students with high-incidence disabilities. The first would be the need to replicate this study to confirm the independent variable is effective using quasi- or experimental designs. The second would be to establish effectiveness with students with disabilities other than those addressed in this study to confirm effectiveness with a larger group of students with disabilities. All three students involved in this study were Caucasian, future research would benefit from determining if results were effective with other students from various racial backgrounds, as well.

Analysis of data collected regarding the effectiveness of a CBGO on increasing the ACT vocabulary knowledge of secondary students with high-incidence disabilities rendered positive results. This study provides additional support that technology-driven, graphic organizers can be as useful in improving student performance as traditional graphic organizers.

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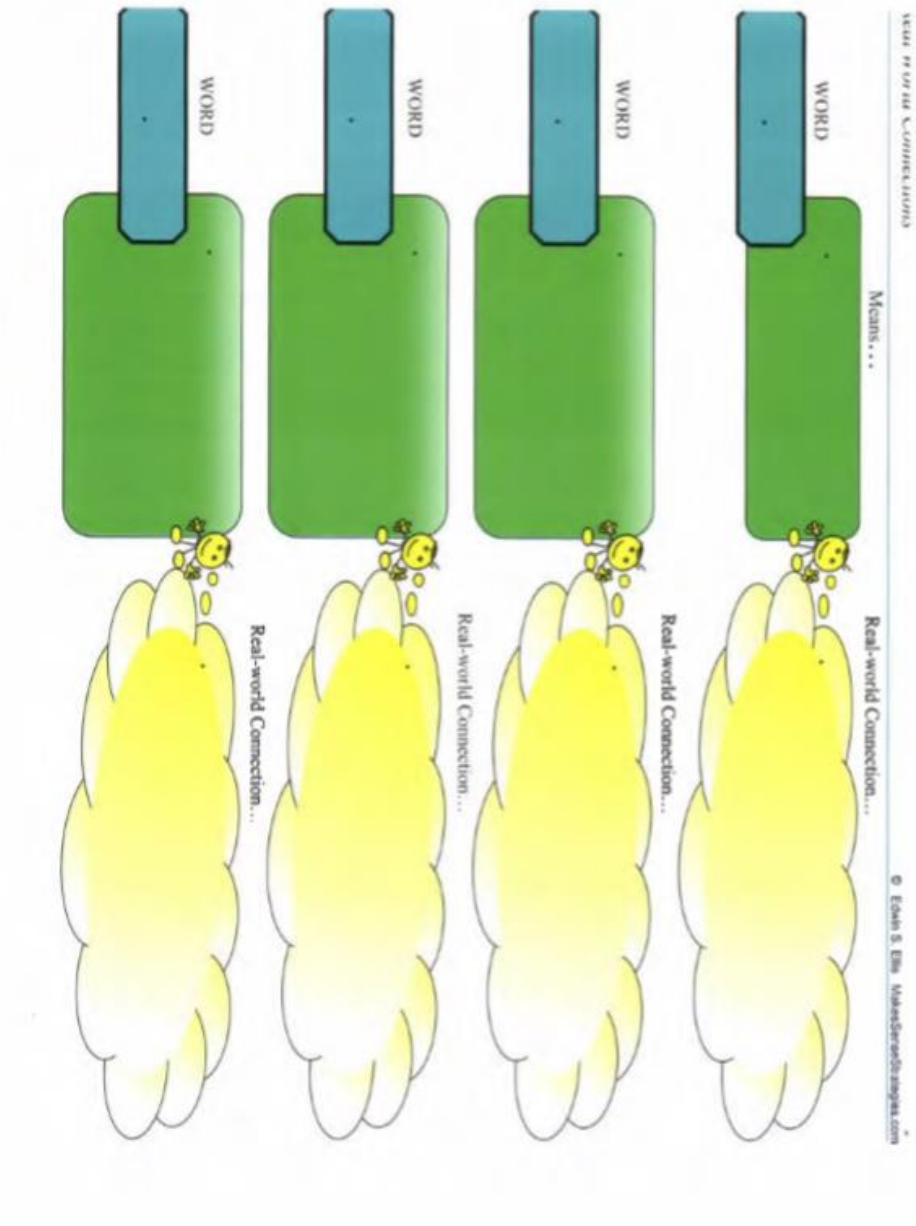
Appendix A: Differentiated Visual Tools, *Real-World Connections* PowerPoint Sample (Ellis, 2015)



## Appendix B: 30 Vocabulary Words and their Definitions Adapted from College Board's Top 100 Common SAT/ACT Vocabulary Words

1. Adversity – misfortune
2. Anecdote – short account of event
3. Asylum – sanctuary
4. Censure – to criticize harshly
5. Collaborate – to work together
6. Compassion – sympathy, mercy
7. Compromise – to settle differences
8. Condescending – patronize
9. Diligent – hard-working
10. Divergent – variant, moving apart
11. Empathy – sharing of feelings
12. Enhance – improve augment
13. Exemplary – outstanding
14. Frugal – thrifty
15. Hypothesis – theory requiring proof
16. Incompatible – unable to work together
17. Intuitive – instinctive, untaught
18. Longevity – long life
19. Nonchalant – calm, casual
20. Novice – beginner
21. Precocious –talented beyond one's age
22. Procrastinate – to delay unnecessarily
23. Prudent – wise, careful, cautious
24. Resilient – quick to recover
25. Spontaneity – impulsive action
26. Substantiate – to verify, confirm
27. Superficial – lacking in depth
28. Tactful – diplomatic, polite
29. Tenacious – persistent, resolute
30. Wary – watchful, alert

https://itisyoureducationownit.weebly.com/uploads/1/4/1/6/14169651/college_board_top_100_common_s.pdf

## Appendix C: Teacher-Created Pre/Post Test

Name: _____ Vocabulary – Pre/Post

Directions: Circle the correct answer that identifies the meaning of each word.

1) Adversity means:
   a. Shorten
   b. Misfortune
   c. Peaceful
   d. Momentary

2) Nonchalant means:
   a. Flushed
   b. Lucky
   c. Calm, casual
   d. Trustworthy

3) Compassion means:
   a. Hard working
   b. Regard with scorn
   c. Fearless
   d. Sympathy, mercy

4) Prudent means:
   a. Wise, careful, cautious
   b. Elusive, sly, ambiguous
   c. Controlled, restricted
   d. Respectable due to age

5) Empathy means:
   a. Pleasure seeker
   b. Overused, too much
   c. Tiring, weakening
   d. Sharing of feelings

6) Wary means:
   a. Persistent, resolute
   b. To clear from blame
   c. Watchful, alert
   d. Temporary, fleeting

7) Incompatible means:
   a. Unable to work together
   b. To attribute to someone
   c. Rash impulsive
   d. Unavoidable, certain

8) Asylum means:
   a. Trivial
   b. Beginner
   c. Speaker
   d. Sanctuary

9) Precocious means:
   a. Persuader of legislators
   b. Talented beyond one's age
   c. To attribute to someone
   d. Pompous, self-important

10) Substantiate means:
   a. To verify, confirm
   b. Impulsive action
   c. Profound respect
   d. Secret, stealthy

11) Anecdote means:
   a. To delay unnecessarily
   b. Short lived, an image
   c. Short account of event
   d. To work together

12) Intuitive means:
   a. Improve, augment
   b. Instinctive, untaught
   c. Rash, impulsive
   d. Dried up

13) Compromise means:
   a. To settle differences
   b. Misfortune
   c. Disloyal
   d. Hard-working

14) Procrastinate means:
   a. Overused, clichéd
   b. Momentary, fleeting
   c. To delay unnecessarily
   d. Respectable due to age

15) Tenacious means:
   a. To end an activity
   b. Persistent, resolute
   c. To clear from blame
   d. To observe carefully

16) Superficial means:
   a. Wealth, success
   b. Inflammatory
   c. Controlled, restricted
   d. Lacking in depth

17) Condescending means:
   a. Nameless
   b. Arrogant
   c. Patronizing
   d. Impulsive

18) Exemplary means:
   a. Unavoidable
   b. Outstanding
   c. Harmful
   d. Ornate

19) Longevity means:
   a. Honesty
   b. Decency
   c. Disloyal
   d. Long life

20) Tactful means:
   a. Temporary, fleeting
   b. Diplomatic, polite
   c. To observe secretly
   d. Elusive, shy

21) Diligent means:
   a. Short account of event
   b. Indirect, roundabout
   c. Sympathy, mercy
   d. Hard-working

22) Censure means:
   a. Theory requiring proof
   b. To criticize harshly
   c. Beginner
   d. Fearless, adventurous

23) Spontaneity means:
   a. Clear from blame
   b. Impulsive action
   c. Persistent, resolute
   d. Diplomatic, polite

24) Frugal means:
   a. Thrifty
   b. Lucky
   c. Ornate
   d. Helpful

25) Hypothesis means:
   a. Final decision
   b. Short lived, an image
   c. Theory requiring proof
   d. Unavoidable, certain

26) Resilient means:
   a. Quick to recover
   b. Time consuming
   c. Slow, hermit-like
   d. Ambiguous

27) Novice means:
   a. Beginner
   b. Misfortune
   c. Agreeable
   d. Opponent

28) Divergent means:
   a. Shorten, abridge
   b. Act of refraining from
   c. Variant, moving apart
   d. Out of date

29) Collaborate means:
   a. Sanctuary
   b. To work together
   c. Nameless
   d. Friendly, helpful

30) Enhance means:
   a. Patronizing
   b. Extremely dry
   c. Trust among friends
   d. Improve, augment

## Appendix D: Teacher-Created Test Probes A (sample)

Name: _____ Vocabulary – Test A

Directions: Circle the correct answer that identifies the meaning of each word.

1) Adversity means:
   a. Shorten
   b. Misfortune
   c. Peaceful
   d. Momentary

2) Nonchalant means:
   a. Flushed
   b. Lucky
   c. Calm, casual
   d. Trustworthy

3) Compassion means:
   a. Hard working
   b. Regard with scorn
   c. Fearless
   d. Sympathy, mercy

4) Prudent means:
   a. Wise, careful, cautious
   b. Elusive, sly, ambiguous
   c. Controlled, restricted
   d. Respectable due to age

5) Empathy means:
   a. Pleasure seeker
   b. Overused, too much
   c. Tiring, weakening
   d. Sharing of feelings

6) Wary means:
   a. Persistent, resolute
   b. To clear from blame
   c. Watchful, alert
   d. Temporary, fleeting

7) Incompatible means:
   a. Unable to work together
   b. To attribute to someone
   c. Rash impulsive
   d. Unavoidable, certain

8) Asylum means:
   a. Trivial
   b. Beginner
   c. Speaker
   d. Sanctuary

9) Precocious means:
   a. Persuader of legislators
   b. Talented beyond one's age
   c. To attribute to someone
   d. Pompous, self-important

10) Substantiate means:
   a. To verify, confirm
   b. Impulsive action
   c. Profound respect
   d. Secret, stealthy

Appendix E: Treatment Integrity Checklist

**ACT Vocabulary and Differentiated Visual Tools, "Real World Vocabulary" Graphic Organizer**

Student: _____Date: _____

For each cell, insert a 1 for 'Yes' or a 0 for 'No' indicating whether or not the teacher completed the task requested below.

| Steps | Word 1 | Word 2 | Word 3 | Word 4 | Word 5 |
|---|---|---|---|---|---|
| 1. Introduce ACT vocabulary word. | | | | | |
| 2. State the exact ACT definition of the new word. | | | | | |
| 3. Discuss the meaning of the new vocabulary word. | | | | | |
| 4. Discuss the meaning of the vocabulary word's definition. | | | | | |
| 5. Use the word in a sentence. | | | | | |
| 6. Discuss synonyms of the vocabulary word. | | | | | |
| 7. Discuss antonyms of the vocabulary word. | | | | | |
| 8. Have student complete one row of the computer-based graphic organizer. | | | | | |

**Note**: After 1st word is placed on graphic organizer, teacher begins same process for vocabulary words 2-5.

| Overall Score / Total |
|---|
| / 40 |

= _____%

Observer's Signature: _____

Appendix F: Social Validity Checklist
Social Validity Interview (Student Form)

Student: _____ Interviewer: _____ Date: _____

**Say,** "I have some questions to ask you. I just want to know how you feel about the computer-generated, graphic organizer you have been using."

**Questions:**

| | |
|---|---|
| 1) Did you like the computer-generated, graphic organizer? | ~~Yes~~ Maybe No |
| 2) | |
| 3) Did the graphic organizer help you learn new vocabulary words? | ~~Yes~~ Maybe No |
| 4) Do you think these vocabulary words will be on the ACT test? | ~~Yes~~ Maybe No |
| 5) Would you use the program again if the teacher wanted you to? | ~~Yes~~ Maybe No |
| 6) What did you learn from using the vocabulary graphic organizer? | |
| 7) What did you like best about the tool? | |

| |
|---|
| 8) What did you not like about the tool? |
| 9) If you were to change, what would you have changed about the tool? |
| 10) Is there anything else you want to say about the program? |

# Appendix G: Data Collection Sheet (Front and Back Side)

*"Effects of Computer Based Graphic Organizers and Instructional Technology for Students with High-Incidence Disabilities"*

**Data Collection Sheet**

Student's Assigned Name: _____

**Baseline Data**

| | | |
|---|---|---|
| WRMT-III, Word Comprehension (Antonyms, Synonyms, and Analogies) | Raw Score = | SS = |
| Pretest score (30 ACT vocabulary words) | /30 | % |

**Intervention Data**
(Scores on ACT Vocabulary Assessment Probes)

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test Session #:** | | | | | | | | | | | | | | | | | | | | | | | |
| **Test Version: (A-E)** | | | | | | | | | | | | | | | | | | | | | | | |
| **Score:** (10 questions) | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 | /10 |
| **Percentage Correct:** | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % |

**Post-Test Data**

| | | |
|---|---|---|
| Post-test score (30 ACT vocabulary words) | /30 | % |
| Completion of Social Validity Checklist | (Circle Yes or No) | Yes or No |

*"Effects of Computer Based Graphic Organizers and Instructional Technology for Students with High-Incidence Disabilities"*

**Data Collection Sheet**

Student's Assigned Name: _____

**Graph of Data**