PREP, TALK and CHECK:
Dictation, Composition and Revision Strategies to Improve the Writing Skills of University Students with Learning Disabilities

by

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Master of Arts, Wilfrid Laurier University, 2003
Bachelor of Arts, University of Guelph, 2002

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Supervisory Committee

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Abstract

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The purpose of this study was to investigate the effectiveness of an intervention drawing on the instructional principles of the Self-Regulated Strategy Development Model (SRSD) to support the use of three writing strategies (PREP, TALK and CHECK) combined with the use of assistive technology for post-secondary students with learning disabilities (LD) and writing difficulties. Participants were four students between the ages of 18 and 32, registered with a campus disability service office at a mid-sized western Canadian university. In a multiple-probe, multiple-baseline within-subjects design, participants received intervention support during one-on-one sessions with a writing tutor. Intervention support covered planning, composing and revision processes and the integration of speech-recognition technology into participants' academic routines. Percentage of non-overlapping data points (PNDs) indicated strong effects for spelling error rate (PNDs = 100), correct word sequences (PNDs = 91.3) and rate of incorrect word sequences (PNDs = 100). Effects were moderate for word count (PNDs = 82.6) and small for punctuation (PNDs = 60) and précis quality (PNDs = 56.5). Results indicate that the intervention was effective for reducing errors in participants' writing, particularly along the dimensions of spelling, punctuation, capitalization, grammar and semantics. Results also indicate that the intervention was strongly effective at increasing the sequences of correct words, and therefore aided participants in generating higher-quality writing assignments to meet the academic demands of university. Implications for educators and psychological service providers working with postsecondary students with disabilities are discussed.

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Introduction and Review of the Literature

Students with Learning Disabilities (LD) and documented writing difficulties are a rapidly growing population on postsecondary campuses in Canada, the United States and Europe (Foley, 2006). Students with LD are also among the largest group of postsecondary students with disabilities (e.g., Standing Senate Committee, 2011; Harrison & Wolfworth, 2008). These students often experience persistent writing problems (e.g. Connelly, Campbell, MacLean, & Barnes, 2006; Lindstrom, 2007; Troia, 2006), writing is an area of great academic concern for students with LD (Hatcher, Snowling, & Griffiths, 2002; Higgins & Zvi, 1995; Li & Hammel, 2003), and potentially one of the most demanding academic challenges (Higgins & Raskind, 1995). Students experiencing writing difficulties are at a particular disadvantage in postsecondary contexts, where writing is a primary means of assessment (Connelly et al., 2006; Graham, 2006; Harrison, 2009). Many students with LD and writing difficulties are accessing postsecondary academic skill centers that target writing competencies specifically (Kuo, Hagie, & Miller, 2004; Troiano, Liefeld, & Trachtenberg, 2010). It follows that educators and service providers need theory-based training, intervention and resource materials to serve students with LD and writing difficulties in higher education (Li & Hammel, 2003; Martinez-Marrero & Estrada-Hernandez, 2008). The purpose of the present study is to investigate the use of an intervention drawing on the principles of the Self-Regulated Strategy Development (SRSD) model (Harris & Graham, 1996; Graham & Harris, 2003). This intervention integrates student use of dictation via speech recognition (SR) software into regular, one-on-one writing support between a qualified service provider and a student with documented learning or writing difficulties. First, this literature review will examine what is known about writing difficulties in this population of students, the leading cognitive theories of the composition processes, and the

principles and precedents in the now-well-established SRSD literature that can frame the use of this intervention in higher education. Lastly, the review presents the latest research in cognitive and educational psychology to inform empirically based writing support at the postsecondary level, as well as available support for dictation software to circumvent barriers to written expression.

Learning Disabilities and Writing Difficulties in Postsecondary Students

The BC Ministry of Education and the Canadian Learning Disabilities Association (CLDA) defines LD as follows:

> Learning Disabilities refers to a number of disorders that may affect acquisition, organization, retention, understanding or use of verbal or non verbal information. These disorders affect learning in individuals who otherwise demonstrate at least average abilities essential for thinking and/or reasoning. As such, learning disabilities are distinct from global intellectual disabilities.
>
> Learning disabilities result from impairments in one or more processes related to perceiving, thinking, remembering or learning. These include, but are not limited to: language processing, phonological processing, visual spatial processing, processing speed, memory and attention, and executive functions (e.g. planning and decision-making) (2002).

According to this definition, LDs can range in severity and interfere with the acquisition or use of oral language, reading, writing or mathematics (CLDA, 2002). The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5; American Psychiatric Association, 2013) also outlines the diagnostic features of LD (referred to as Specific Learning Disorder) with impairments in reading (often referred to as dyslexia), written expression and mathematics. LDs typically manifest early in development, but these disabilities can impact students into adulthood, also (e.g. Higgins & Zvi, 1995; Swanson & Hsieh, 2009; Troia, 2006). For instance, Hatcher, Snowling and Griffiths (2002) found that 23 UK postsecondary students with dyslexia ages 19 to 52 years old (mean age = 24) demonstrated important cognitive differences compared to 50 age-

matched controls, particularly in significantly lower scores on measures of nonword reading (nonwords embedded in a context of 52 and 44 words; Gross-Glenn et al., 1990; Finucci et al., 1976), writing speed (a copying task created by the researchers) and verbal short-term memory as measured by the digit span subtest of the *Wechsler Adult Intelligence Scales-Revised* (WAIS-R; Wechsler, 1994); furthermore, in criterion-based academic measures, students with dyslexia wrote more slowly than their non-LD peers, also scoring one standard deviation lower in a timed précis task created by the researchers (described as an ecologically valid measure of academic writing under time constraints). Other studies have demonstrated lasting difficulties in adults related to cognitive, linguistic and literacy processes important to writing (Gregg, Coleman, Stennett, & Davis, 2002; Harrison, 2009).

It is important to note that not all postsecondary students with LD have difficulties and concerns with academic writing, although a great majority do experience such difficulties (Li & Hammel, 2003; Lindstrom, 2007). It is also important to note that students with LD, learning difficulties and writing difficulties are not a homogeneous group, and the nature of their writing concerns may differ. According to Li and Hammel (2003) sources of writing difficulties in postsecondary students with LD may be mechanical (e.g. transcription processes) or contextual (e.g. synthesizing ideas) in nature. Lindstrom (2007) also outlines different sources of writing underachievement, including encoding breakdowns, thinking and oral language abilities, social cognition (or sense of audience) as well as motivation and anxiety problems that may impede fluency and writing quality. In a synthesis of the literature, Martinez-Marrero and Estrada Hernadez (2008) summarized common problems in the writing of this postsecondary population, including: a lack of cohesiveness (e.g. sentence-level problems); problems with text production, planning and editing; superficial revisions for transcription-level elements (e.g. spelling,

punctuation); and problems with organization, grammar and maturity of themes. Writers with dyslexia often demonstrate difficulties with semantics, grammar and mechanics, with negative implications for written syntax (Gregg, Coleman, Davis, & Chalk, 2007). Furthermore, poor executive functioning (e.g. the conscious control of thought, action and emotion; Bunge & Zelazo, 2006) may contribute to students' difficulties monitoring sentence-level errors when planning, organizing and generating academic essays (Gregg et al., 2007).

The literature refers to a broad spectrum of writing concerns among students with a history of learning and writing difficulties. Several researchers have investigated the relationship between transcription dysfluencies (e.g. spelling, grammar, punctuation, and handwriting fluency) and writing quality. In this body of literature, the automatized transcription processes support the generation of quality prose, particularly under time constraints**.** For instance, Connelly, Dockrell and Barnett (2005) examined whether there was a relationship between handwriting fluency and written exam performance in typically-achieving UK undergraduate students. Twenty-two undergraduate psychology students completed a measure of handwriting fluency (Berninger, Mizokawa, & Bragg, 1991), and they also handwrote two essays – an unpressurized (e.g., an informal writing task with available support and input from course tutors) in class essay and a timed exam in a developmental psychology course. Fluency was positively correlated with students' essay marks, scored according to an essay rubric developed by the investigators (Connelly, Dockrell, & Barnett, 2004). In particular, fluency was correlated significantly with the quality scores of the body and conclusion of students' essays, and the researchers concluded that slow writers have less opportunity to plan and edit, a constraint that impacts a range of higher-level dimensions in essay performance. Interpreted according to a

capacity view of writing, in this study, lower-level automaticity in transcription constrained the quality of even typically-achieving students' knowledge representation in timed exam writing.

Connelly, Campbell, MacLean and Barnes (2006) later investigated how transcription constrained postsecondary writing, this time in students with LD. These researchers investigated whether transcription problems impacted higher-level aspects of writing in a sample of 21 postsecondary students with dyslexia and two control groups, 20 age-matched peers and 19 participants of equivalent spelling skill. In addition to a battery of cognitive and linguistic measures (addressed below), students wrote persuasive essays in response to a prompt for the Graduate Records Examination. Essays were later scored according to written expression subscale of *Wechsler Objective Language Dimensions* (WOLD; Rust, 1996), including a holistic score for: overall quality and analytic scores for ideas and development; organization, unity and coherence; vocabulary, sentence structure and variety; grammar and usage; and capitalization and punctuation. Students with LD scored lower than both comparison groups on measures of word reading and non-word reading, as measured by the Sight Word Efficiency and Nonword Reading subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999), handwriting fluency (Berninger et al., 1991), working memory as measured by an adapted listening span task (Daneman & Carpenter, 1980; Leather & Henry, 1994) and accuracy of spelling in the essay. Students with LD also wrote lower-quality essays than their age-matched peers. For these students, transcription-related scores such as listening span, handwriting fluency, and essay word count (and index of writing fluency) were positively correlated with quality. These students also demonstrated lower scores for vocabulary, capitalization and punctuation compared to age-matched controls. Connelly and colleagues (2006) concluded that transcription skills constrained quality in student writers with LD, and

these writers demonstrated poorer spelling and punctuation in comparison to age-matched peers. The researchers also concluded that among students with LD, higher-level components of writing such as organization, ideas, sentence structure and grammar were comparable to that of their age-matched peers. Sources of writing difficulty among writers with LD appeared to be related to transcription problems. These results are consistent with studies of transcription in younger writers (Graham, Berninger, Abbott, Abbott, & Whittaker, 1997) as well as adults (Peverly, 2006). Connelly et al. (2006) also recommended dictation (speech-to-text) as a potentially helpful transcription intervention for struggling postsecondary writers with LD.

Other researchers have detected deficits in the higher-order aspects of writing among postsecondary writers with LD. Harrison (2009) examined the component reading and writing skills of 20 postsecondary students with self-reported writing difficulties in comparison to 22 students with no history of learning or writing difficulties. These students completed a test battery including measures of cognitive and linguistic processing as well as literacy tasks, and they also completed a handwritten persuasive essay. Essays were scored according to the analytic scoring criteria for the Wechsler Individual Achievement Test-Second Edition (WIAT-II; Wechsler, 2002), which includes dimensions of lower-level (mechanics) and higher-level (organization, theme development and vocabulary) writing. There were significant group differences in handwriting fluency as measured by a task developed by Hoskyn and Swanson (2003), essay word count, essay mechanics, organization and lexical diversity or written vocabulary (with students with writing and learning difficulties achieving lower scores than their age-matched, non-LD peers). These students also made more orthographically implausible spellings. Harrison (2009) concluded that, among students with writing difficulties, a lack of automaticity in transcription processes constrained both writing quality and written quantity.

Harrison also concluded that students' writing suffered as a result of these transcription dysfluencies, particularly organization and written vocabulary scores.

An earlier study by Harrison and Beres (2007) provided some important findings about student's perceptions of higher- and lower-level writing difficulties and strategies. These researchers compared the quality of undergraduate writing collected from 20 students with self-reported writing difficulties and 22 of their peers without writing difficulties. In addition to completing a test battery including measures of cognitive and linguistic processing, students completed literacy tasks including persuasive essay writing, and students also gave retrospective reports about their approach to the writing task in an interview following the assessment session. Essays were scored according to WIAT-II analytic criteria: for higher- and lower-level elements of persuasive writing (The Psychological Corporation, 2002). Writing fewer words than their comparison peers, students with writing difficulties obtained lower scores on mechanical or lower-level aspects of their writing, but they also scored lower on higher-level elements including organization, theme development, and written vocabulary. Retrospective reports about students' writing process and strategies revealed the struggling writers reported more low-level strategies (e.g., strategies related to spelling, handwriting or punctuation) compared to typically achieving writers, who reported more higher-level strategies (e.g., strategies related to organization, planning or lexical choice). Harrison and Beres (2007) concluded that students with writing difficulties produced poorer quality writing with more transcription errors and lower higher-level scores, and these students also emphasized lower-level writing processes. These researchers also determined that their findings were consistent with the research involving younger writers with LD (e.g., Graham, Schwartz, & MacArthur, 1993) who tend to overemphasize lower-level processes and aspects of writing. Harrison and Beres (2007) also

noted that their participants had 15 minutes to complete their essays, in contrast to participants in the study by Connelly et al. (2006), who stopped writing after 30 minutes. Furthermore, while students with writing difficulties did describe some higher-level strategies in their reports, it appeared that their peers maintained a balanced approach to higher- and lower-level strategies more successfully.

An earlier study provided some important considerations for the future investigation of writing strategies and writing behavior among adults with LD and writing difficulties. Wengelin (2005) investigated the relationship between word-level dysfluencies and lexical diversity in 11 adult participants with dyslexia and 10 adults with no history of reading or writing difficulties. These participants composed an essay on the computer, and among the writers with dyslexia, this researcher found a significant relationship between mid-sentence pauses related to encoding difficulties, as measured by the keystroke program ScriptLog, and more limited lexical diversity as measured by theoretical vocabulary (Menard, 1983; Broeder, Extra, & Van Hout, 1986; Voionmaa, 1993). Wengelin proposed that students with writing difficulties may rely on words that are easier to spell, limiting the sophistication of written vocabularies. This finding is consistent with other research. Harrison (2009) found postsecondary students with writing difficulties had lower written vocabulary scores despite well-developed oral vocabularies. Gregg et al. (2007) also suggested students with poor spelling skills rely on words that they can spell, hence limiting the degree of sophistication in their written vocabularies.

In summary, the literature documents the difficulties and profiles of learning disabilities in the adult population, as well as a range of writing concerns in planning and organization, spelling and mechanics, as well as vocabulary and fluency for these adults. Research into the component processes of postsecondary writers with LD suggests that transcription-level

dysfluencies result in poorer quality writing (e.g. lexical diversity, fluency, organization) compared to their non-LD peers. Writing is a primary means of assessment in postsecondary learning (Connelly et al., 2006; Graham, 2006; Harrison, 2009), and many of these students are accessing academic skill centers that target writing (Kuo et al., 2004; Troiano et al., 2010). Gregg (2007) has argued that these students are historically underserved, and professionals have focused too narrowly on accommodation rather than intervention at the postsecondary level; likewise other researchers have pointed to the dearth of evidence-based instructional support for these studies (Li & Hammel, 2003). There is a growing need for evidence-based intervention to provide students with individualized instruction, strategies and technology to meet academic demands (Gregg, 2007). The following section reviews the leading models of writing in order to frame an intervention that meets this demand.

The Writing Process: Theories and Models

The earliest theoretical perspectives on writing and the writing process focused on the recursive, metacognitive routines and subroutines required during this cognitively demanding task. For instance, in a frequently cited model, Hayes and Flower (1980) outlined writing as a series of goal-directed activities and interconnected, sometimes competing processes: planning, translating and reviewing. Hayes (1996) later renamed these stages planning, text generation and revising (see Harris, Graham, Brindle, & Sandmel, 2009), and also added memory, motivation and transcription processes (Hayes, 2012). In the original Hayes and Flower model, skilled writers must deal with many demands at once, such as creating plans, drawing information from memory, considering audience or reader needs and executing the mechanics of writing. While Hayes initially intended to model sequenced sub-processes (Hayes, 2012), McCutchen (1988) built on Hayes and Flower's (1980) concept of the writer's mind as a busy information-

processing device that must coordinate many activities at once, proposing that the writer's processing constraints create a scenario much like that of a busy switchboard operator that must struggle to reconcile competing demands (see also, Torrance & Galbraith, 2005). Focusing mainly on adult writers, this Hayes and Flower (1980) model was largely concerned with metacognitive processes (Peverly, 2006).

Another early model, this one developmental in nature, emphasized the metacognitive routines and subroutines of writing on the road from unskilled to more skilled writing. Bereiter and Scardamalia (1987) contrasted novice and expert writers, defining writing as a recursive problem-solving process where writers employ both rhetorical and self-regulatory strategies. Writers must mentally represent the task, analyze the problem and set goals, translate the problem and either engage in knowledge telling (novice writers) or knowledge translation (expert writers). Specifically, sophisticated solutions require expert writers to retrieve and transform discourse knowledge and content knowledge from long-term memory. According to these researchers, less sophisticated solutions, like those exhibited by novice writers, involve less sophisticated processing. Specifically, novice writers retrieve and write information from long-term memory. The result, knowledge telling, has been described as a composing method where one sentence acts as a retrieval cue for the next (e.g. McCutchen, 1988; Graham & Harris, 1999), and where the writer may miss adhering to important structural or rhetorical goals. However, it important to note that a body of literature investigating the development of writing in children indicates that, as lower-level activities such as spelling and handwriting become automatized, writing remains a complex, taxing task for young writers, particularly up to the third grade (Berninger & Amtmann, 2003).

These complementary models (Bereiter & Scardamalia, 1987; Hayes, 1996; Hayes & Flower, 1980) emphasized that writing is taxing, goal-directed work that involves the coordination of multiple processes to plan, produce and review text; however, more recent capacity models are concerned with how lower-level transcription processes and higher-level executive control processes work together within the constraints of a capacity-limited working memory system. Berninger and colleagues (Berninger, 1999; Berninger & Amtmann, 2003; Berninger, Fuller, and Whittiker, 1996) emphasized components of transcription and working memory in a model of writing. Berninger (1999) argued that the automaticity of transcription impacts the allocation of working memory resources and the coordination of component processes in writing. This same researcher built on the conceptual work of the early cognitive theorists in writing (Bereiter & Scardamalia, 1987; Hayes & Flower, 1980) to propose a Functional Writing System composed of lower-level transcription processes (e.g. handwriting, spelling) and higher-level executive control processes (e.g. conscious attention, reviewing, self-regulation strategies) (Berninger, 1999; see also Berninger & Amtmann, 2003). Represented as a triangle, with generated text at the apex, finite working memory resources allocated to these lower- and higher-level processes determine the quality of the written composition. For instance, a lack of automaticity in transcription processes (e.g. spelling, handwriting) may constrain not only the amount of text produced, but also the quality of text as assessed by higher-level indices of writing (e.g. development, organizational structure). In Berninger's developmental model, transcription processes become increasingly automatized as young writers approach early adolescence, freeing up limited space for greater challenges in executive management of writing tasks (e.g. reviewing and revising) as well as the retrieval and transformation of knowledge in long-term memory. Explicit instruction for developing writers, particularly struggling writers,

should blend transcription skills and high-level processes (Berninger, 1999). A subsequent section will address how these capacity views have informed work with adults with writing difficulties.

McCutchen (2000) also emphasized the importance of fluent text-generation processes in a developmental model of memory and writing processes. This researcher built on previous work about the coordination of knowledge and processing (Hayes, 1996; Hayes & Flower, 1980) to propose that young writers and less sophisticated writers are constrained by short-term memory and working memory limitations. These writers depend on knowledge telling strategies, where one sentence cues the next a cue for knowledge retrieval. More skilled writers are fluent at both text generation and transcription. With flexibility, these writers juggle knowledge about how to write, topic knowledge, and the competing writing processes. Skilled writers may also demonstrate greater knowledge about topics, genres, and routines for coordinating these writing sub-processes as well as demonstrate greater encoding fluency, enabling them to build retrieval structures in long-term memory (McCutchen, 2000).

Capacity theories can also help frame specific writing difficulties identified in the literature. In a limited working memory system, a lack of fluency and automaticity can impact or constrain the executive control processes required to generate quality text. The literature addressing younger struggling writers (elementary and high school) identifies particular pattern of challenges among students with LD who have severe writing difficulties: these writers often produce less polished, coherent or expansive writing; demonstrate little advance planning; have difficulty generating ideas; struggle with mechanical concerns; lack strategies for higher-level activities such as planning, revising and monitoring the text at all stages of the writing process (e.g. Harris et al., 2009). Graham and Harris (2003) also argue these young writers often exhibit

specific characteristics that include: producing lists instead of producing coherent documents; producing small amounts of written work; engaging in little or unsystematic revision; minimizing planning, writing and reworking processes; emphasizing mechanical attributes of a text over higher-level concerns; exhibiting difficulty considering reader perspectives; and demonstrating limited knowledge about writing (genres, conventions, devices) and writing processes (writing, evaluating, revising). For further discussion, see Graham and Harris (1999; see also Graham, 2006).

In summary, capacity views of writing (Berninger, 1999; Berninger & Amtmann, 2003; McCutchen, 2000; Peverly, 2006) frame the difficulties faced by adult students with LD. Transcription dysfluencies may constrain both quality and quantity of the written product (Harrison, 2009; Harrison & Beres, 2007; Connelly et al. 2006), even along higher-level dimensions such as lexical diversity (Gregg et al., 2007; Harrison, 2009; Wengelin, 2005). The current study uses the *Functional Writing System* (Berninger, 1999; Berninger & Amtmann, 2003) and the growing literature in adult writing difficulties (Connelly et al., 2004; Connelly et al., 2005; Gregg et al., 2007; Harrison, 2009; Harrison & Beres, 2007; Wengelin, 2005) to frame the component processes and the cognitive task of writing. Peverly (2006) suggests that instruction should target fluency and efficiency to free up resources for higher-order skills. Gregg (2007) has suggested postsecondary writers with LD should be provided with opportunities to practice writing in supportive contexts, building fluency through consistent use of technologies and writing strategies and, most importantly, encouraging environments and explicit instruction. This suggestion is consistent with the literature in younger writers (Graham & Harris, 2000; Harris et al., 2011). The next section provides the framework for a tested

intervention model for supporting the metacognitive routines and subroutines of academic writing.

Self-Regulated Strategy Development and Metacognitive Support for Academic Writing

The following section describes intervention research in secondary and postsecondary writing. By drawing on (1) tested principles in the study of younger writers, as well as (2) foundations in self-regulation and specific writing support for postsecondary writers, this section outlines the design of writing support materials for postsecondary writers with LD that will be used in the present study.

Self-Regulated Strategy Development (SRSD) is an instructional model for teaching both higher- and lower-level writing strategies to students experiencing academic difficulties (Harris & Graham, 1996). Berninger and Amtmann (2003) have described this approach as a collection of executive strategies or metacognitive supports for the regulation of cognitive processes involved in writing. This description refers to Berninger's Functional Writing System, where higher-level executive control processes guide the translation of ideas into meaningful text. In the SRSD's criterion-based approach to writing support, instructors guide students through a series of six recursive stages in the development of self-regulated academic strategies (Graham & Harris, 2003; Mason, Harris, & Graham, 2011; Pressley & Harris, 2006). These strategies are specific to targeted academic tasks, most often written composition (also reading and math). Self-regulated strategies including goal setting, self-monitoring, and self-instructions (Graham & Harris, 1999) are also incorporated within this instructional model. This literature grew from the cognitive modeling or cognitive apprenticeship research (see De La Paz & Felton, 2010; Wong, Harris, Graham, & Butler, 2003) and sociocultural theory (John-Steiner & Mahn, 1996), where

more competent experts emphasized tacit cognitive processes for novice and struggling learners, gradually fading support until students could perform those processes independently.

Some SRSD writing strategies target planning, composing and revising processes, often represented by mnemonics such as PLAN (Pay attention to the prompt, List main ideas to develop your essay, Add supporting details, Number major points; De La Paz, Owen, Harris, & Graham, 2000), WRITE (Work from your plan to develop a thesis statement, Remember your goals, Include transition words in each paragraph, Try to use different kinds of sentences, Exciting words; De La Paz, Owen, Harris, & Graham, 2000), and SCAN (does it make Sense, is it Connected to my belief, can you Add more, Note errors; Graham & MacArthur, 1988). Targeted genres and document types have varied from narrative to informational texts, argumentative essays and social science writing (Mason & Graham, 2011). Typically delivered in six to nine 40-minute sessions in either one-on-one or group settings, strategy instruction proceeds through a series of steps or a cluster of strategic activities that ensure the writing process unfolds in a coordinated, regular fashion (Graham & Harris, 1999). The instructional stages unfold flexibly, and students: develop pre-skills for completing writing tasks and executing selected strategies (develop background knowledge); discuss the strategy and its impact on writing quality (discuss it); observe an instructor model the strategy and engage in guided practice and supported self-statements (model it/support it); memorize the strategy steps, often with the aid of a mnemonic (memorize it); and practice target strategies and self-regulation procedures (independent performance) (Graham & Harris, 1999; Mason & Graham, 2008).

Some core research has investigated self-regulation in undergraduate students, specifically how students define their tasks, set goals and select strategies to complete their coursework. Skilled completion of these academic tasks draws on metacognition, what

Zimmerman defines as the ability to adjust behavioral and environmental functioning in response to changing academic demands (2004). For instance, Butler (1995; 1998) created a Strategic Content Learning program that supports recursive cycles of task analysis, strategy implementation and self-monitoring in postsecondary students with disabilities. This method has been compared to the SRSD approach (Wong et al., 2003) in its focus on students' metacognitive control over the application of academic strategies. Hadwin and Winne (2013; Winne & Hadwin, 1998, 2008) have advanced a model of self-regulated learning, and have outlined the metacognitive features of high-quality or effective learning in undergraduate students. This model emphasizes the learning of processes over prescribed or rigidly defined learning skills, where students must first construct accurate task perceptions before setting high-quality goals. These goals should involve standards for monitoring, evaluating and regulating learning, and, in the case of novel tasks, goals should include the execution of study processes (see Winne, 2011; Winne & Hadwin, 1998). Next, students must enact the work, engaging in strategies to achieve their goals. This phase involves knowledge not only of applicable strategies, but also why and how to apply them (e.g. Winne, 2011). Reflection and adaptation are crucial components of metacognitive awareness in undergraduate students, as continual refinement, flexibility and adaptation are hallmarks of effective self-regulation. For instance, in the study of writing specifically, Zimmerman and Risemberg (1997) proposed writing self-regulation is "not a single capability but a complex system of interdependent processes that are closely linked to an underlying sense of self-efficacy as a writer" (p. 97).

The present study will draw on these SRSD principles as well as studies of self-regulation in undergraduate students. It will also emphasize the critical characteristics of SRSD instruction: this method involves the explicit teaching of strategies, self-regulation procedures and needed

knowledge, and it makes students collaborators within an interactive and reciprocal learning context (Graham & Harris, 2003). The SRSD method employs individualized instruction, feedback and support, and students proceed at their own pace through the stages of strategy instruction. Lastly, SRSD instruction is ongoing, with the introduction of new strategies or upgrading as required (Graham & Harris, 2003).

Planning and composing. Past research has employed structured planning documents and think-sheets to scaffold the planning and composing processes for younger writers. The Plan, Organize, Write strategy (POW; Harris et al., 2003) has been used with elementary and secondary school writers with difficulties (Harris et al., 2012). This strategy and others like it, such as POW (Pick my idea, Organize my notes, Write and say more; Harris, Graham, & Mason, 2006) and TREE (Topic sentence, Reasons, Explain, Ending; Harris et al., 2006) are structured to help struggling students develop more sophisticated approaches and compositional strategies, like those employed by more skilled writers (Graham & Harris, 2003). By instructing students how and when to fill in blanks or fields in think sheets, these materials scaffold the explicit attention to text structures and regular writing routines. The present study uses this approach in undergraduate writing by building on important examples from the SRSD literature.

De La Paz and Felton (2010) developed and tested an SRSD approach for improving evidence-based argumentation in upper-secondary history writing, and their approach employed sophisticated think-sheets designed to support complex, discourse-specific activities. This quasi-experimental design involved 160 eleventh-grade students in the general education classroom (four teachers, two schools, one experimental and one comparison class per school). Students were required to construct an elaborated written argument from multiple, even conflicting, sources of evidence. Teachers delivered a semester-long (one lesson every two weeks, embedded

in an American history unit) modification of De La Paz's (2005) historical reasoning strategy. To support the planning and logic of these papers, a flow chart, "Thinking with historical documents," led students through a series of questions about the context, value and validity of historical sources, prompting them to monitor and regulate their process of providing specific answers and analysis. Essays were scored for number of words written, overall quality (on a six-point rating scale) and coded for argument analysis, claims per 100 words, rebuttals and document use. Students in the experimental condition wrote longer post-test essays, were twice as likely to earn the highest score for quality and were three times as likely to receive the highest rating for claim development. These students also wrote more rebuttals at post-test and used more documents and quotations to further their arguments. De La Paz and Felton (2010) proposed student improvements were due to more increased knowledge of text structures; specifically they claimed the intervention supported student learning of argumentative conventions, expressed in flow charts that structured disciplinary inquiry. They also concluded low to average high school writers could achieve high levels of writing proficiency and sophistication with explicit strategy instruction and clear expectations of "what it means to engage in disciplinary literacy activities" (p. 190).

The De La Paz and Felton (2010) study also contains an important weakness: the significant pretest difference between the experimental and control groups. Compared to their intervention-group peers, students in the comparison condition wrote longer essays with more claims and rebuttals. Students in the comparison group also scored lower on their post-test essays for quality compared to pretest. The researchers proposed the post-test materials could have been slightly harder or that students in the experimental group had better knowledge about the post-test topic (p. 189); however, these problems could indicate poor program fidelity or differential

selection effects – different initial characteristics (Gall, Gall, & Borg, 2010) of the participants in the study groups. Future research, particularly early research in postsecondary writing strategy implementation, should consider multiple-case designs where students receive the same instruction from the same instructor (preferably in the same space). Despite these methodological issues, future research designs could draw from De La Paz and Felton's (2010) detailed and instructive example of how instructors can make writing strategies and disciplinary processes "transparent" to students (p. 190). Their "Thinking with Historical Documents" think-sheet potentially supports more complex processing in comparison to the simpler mnemonics often used in SRSD research (e.g. PLAN, WRITE, POW; Graham & Harris, 2003).

MacArthur and Lembo (2009) also used structured think-sheets to support adult learners in an SRSD approach to persuasive essay writing instruction. In this multiple baseline design, the researchers delivered individualized instruction to three adult learners preparing to write the General Educational Development (GED) examination. All three participants were between 40 and 44 year old and native English speakers; none reported any history of learning disabilities. Participants completed writing probes during baseline (a minimum of three essays) and at posttest phases. SRSD instruction lasted an average of ten instructional sessions per student (one-on-one tutoring, two or three times per week). The instruction presented strategies for planning, writing and revising persuasive essays, including brainstorming (identifying opposing positions, reasons and evidence on both sides), taking a side (choosing a position), planning (identifying reasons, evidence, counterarguments and rebuttals from the brainstorming material), composing (writing the paper in the IRRC text structure mnemonic, Introduction, Reason, Rebuttal, Conclusion) and evaluating (self-evaluating with the use of a scoring guide). Essays were scored for text structure elements, overall quality and length. Students showed post-test gains in text

structure elements and overall writing quality, with percentages of non-overlapping data-points (PNDs) of 100 percent and 89 percent respectively. The researchers concluded results were comparable to previous effects reported (De La Paz, 1999; Graham, 2007), and strategy instruction could be as effective in this adult population as with young struggling writers. In their stated limitations, these researchers noted they did not gather information on maintenance of strategy use or gains in writing, nor did they investigate generalization of the writing prompts for the GED. They suggested more research is needed about the characteristics of adult writing, in order to chart potential implications for instruction. These tasks also required adults to write about familiar topics, rather than gather information and perspectives to inform their writing, a task that more closely resembles academic writing. They proposed future research could explore the effectiveness of adult instruction that integrates reading, writing and group discussion about controversial public issues.

This study (MacArthur & Lembo, 2009) contributes to the SRSD research in its use of graphic organizers and strategy materials for adult students, similar to components offered by De La Paz and Felton (2010); however, one key limitation of MacArthur and Lembo's (2009) work is the weak program fidelity reporting. Instructors completed a checklist of targeted activities, the investigators conferred about the sessions, and the first researcher listened to two tapes of each student's lesson. The recursive and criterion-based nature of the SRSD could pose challenges for program fidelity: intervention proceeds at the student's pace and according to student's needs. Each individualized intervention may proceed differently. Well-trained instructors – both in the SRSD method and in postsecondary writing – are crucial to the success of this research, as are well-trained researchers.

There are also important differences between writing argumentative responses in a GED examination (MacArthur & Lembo, 2009) and learning to emulate disciplinary discourse structures in postsecondary writing tasks; however, this IRRC strategy provides students with a clear outline of text elements and expectations within the essay (Introduction, Reason, Rebuttal, Conclusion). A complementary study by Kiuhara, O'Neill, Hawken and Graham (2012) provides an example of how more specific strategies can further demystify the architecture and subcomponents of a text and the process of text construction. In a multiple-probe, multiple-baseline design, these researchers delivered strategy instruction to six tenth-grade students with a range of challenges including ADHD, anxiety, emotional disturbances, developmental delay and speech and language impairments. To supplement the STOP and PLEASE strategies, Kiuhara and colleagues (2012) developed AIMS (Attract the reader's attention, Identify the problem or the topic so the reader understand the issues, Map the context of the problem, and State the thesis so the premise is clear). As a series of mental operations for the process of introduction writing, AIMS models a required argument schema. At post-test, students produced longer, more complete and higher-quality essays. They also increased their planning and writing time, and the researchers concluded persuasive essay-writing strategy instruction was effective, based on their finding that quality scores increased by 130-160% on average across participants between baseline and intervention phases. They encouraged other researchers to investigate the effectiveness of other planning, drafting, revising and editing strategies.

Revision and editing. Past SRSD research has employed structured support in revision with younger writers. For instance, Graham and MacArthur (1988) developed the SCAN technique (Scan each sentence, does it make sense? Is it connected to my belief? Can you add more? Note errors). Likewise, as discussed above, MacArthur and Lembo (2009) supported

adults' revision through the use of a printed rubric. The present study will draw on think-sheets to scaffold undergraduate writing. As no peer-reviewed studies have yet published SRSD strategies or materials that support postsecondary revision processes, the design of materials draws on other research in self-regulation and postseondary writing and self-regulatory processes. In addition to fluent transcription processes, as discussed in previous sections, success in postsecondary writing draws on knowledge and analysis of the task at hand, as well as knowledge of how, why and when to apply appropriate writing strategies. In a modified model of writing, Hayes (2012) proposed that planning and writing are specialized writing tasks (as opposed to the planning-translating-reviewing process distinction in the original Hayes and Flower model). In Hayes (2012) three-dimensional framework, the writer draws upon resources (attention, working memory, reading and long-term memory) to coordinate writing processes within a specific task environment. Presiding at the control level, current plans and writing schemas guide the process, influenced by motivation and goal-setting.

Plans and writing schemas were the subject of analysis in a study by Wallace, Hayes, Hatch, Miller, Moser and Silk (1996). These researchers examined the relationship between revision and task definition in college writers. In a first study, 47 students from three entry-level writing classes at Iowa State University were randomly assigned to treatment and control groups. These participants were asked to write and revise a job application letter. The treatment group received an eight-minute tutorial in revision. Both groups marked their changes in red ink for a typist. Examiners collected first and final drafts, as well as student's quality ratings of their own first and final drafts. Revisions were scored for the quality of improvements made according to a 9-point scale created by the researchers. Raters also scored the scope of revisions (changes within the sentence, single-sentence changes and multiple sentence changes), and tallied the

number of revisions in each category. T-tests showed significant differences in average quality improvement scores, with treatment group writers scoring an average of two points higher compared to controls. Controls were also more satisfied with their initial drafts than their peers who received a revision tutorial. The number of multiple-sentence revisions also predicted quality improvement scores from draft to revised copy.

In a second study, these same researchers (Wallace et al., 1996) studied revision in 61 basic-level college writers at a Pittsburg college. These writers achieved low SAT-verbal scores, and were assigned the same writing and revision task as the previous study. There was no significant difference in quality improvement in a comparison of treatment and control group scores, nor was there any perception of quality change in writers between draft and revision stages. As in the first study, multiple-sentence changes predicted quality improvement scores in the revised copy. In a discussion of both studies, the researchers suggested that the revision tutorial offered in treatment conditions led to more multiple-sentence revisions in entry-level, general classroom writers but not basic writers. They also concluded that basic writers may have experienced either a deficit in writing skills or difficulty coordinating skills. They suggested that a short tutorial that targeted student perceptions about revision could profoundly impact performance, and that task definition is an important aspect of revision performance. They also suggested future research could repeat revision lessons.

The present study proposes to build on this work (Wallace et al., 1996) by examining whether students with writing difficulties benefit from one-on-one support that distinguishes between local (word substitutions, changes in spelling, grammar and punctuation) and global (changes for meaning, logic and structure that occur across sentences). The present study will also investigate whether struggling writers can benefit from multiple lessons or tutorials that

target the revision schema through a series of structured think-sheets. These are important issues for postsecondary writers with difficulties, as other research has identified a tendency for undergraduate students to employ local-level revision approaches. For instance, Butler and Britt (2011) investigated whether revision schema tutorials as well as tutorials about argument schemas (how to construct arguments) could produce higher quality revision goals in undergraduate students. They distinguished between local level revisions (spelling, grammar, punctuation) and global revisions (changes for meaning at the sentence-, paragraph-, and whole-text levels) and drew on work by Myhill and Jones (2007) suggesting that novice writers often treat revision as a simple proofreading task where the purpose is to edit local errors. Butler and Britt (2011) also referenced a MacArthur, Graham and Harris' (2004) finding that younger struggling writers may lack the knowledge of the global-level focus required in revision stages, as well as essential knowledge of text structures and task schemas for revision. In a 2 x 2 between-subjects design, Butler and Britt (2011) assigned a writing and revision task to 109 college freshmen new to academic writing in psychology classes. Participants first read articles about cellphones and driving, and then responded to a prompt about a controversy ("Should cellphones be banned while driving?"). Researchers collected first drafts and delivered a revision tutorial and an argument-building tutorial to the treatment groups. Next, students were given the chance to revise their original writing. Independent raters scored the essays according to a rating scale by Bridwell (1980) for global and local changes and Wallace et al. (1996) for the improvements resulting from changes made during revision. Students receiving the argument tutorial made significantly more global changes to their drafts. Likewise, students receiving the revision tutorial also made significantly more global changes. The researchers concluded that their study replicated other research demonstrating a tendency to local revision (Hayes, 1996;

Hayes & Flower, 1986; Sommers, 1980; Wallace et al., 1996) in less-skilled writers. Butler and Britt (2011) suggested future research could include a tutorial about argument schemas before the writing phase, as revising this schema during revision could help students to focus on structural concerns. They suggested that students require a global revision goal and training in textual elements that are the target of global level revision. These researchers linked their suggestions for the creation of multiple-session tutorials in revision to Graham and Perin's (2007) policy recommendations that educators should teach adolescents specific strategies for planning and revising and goal setting methods for product expectations.

Themes from the literature in academic writing support. This section drew on methods in the SRSD method, research in undergraduate self-regulation and undergraduate writing support to outline some core principles for the design of postsecondary writing intervention. Li and Hammel (2003) identified a need for explicit writing interventions for postsecondary students with writing difficulties. Established as a successful and flexible instructional method for children and adolescents (Graham & Harris, 2003; Graham & Perin, 2007; Mason & Graham, 2008), the SRSD literature informs the design of intervention materials in the present study. Researchers in this area may build from the essentials, namely that SRSD interventions can: (a) provide explicit, structured subroutines in genre-specific writing (Graham & Harris, 2003), and (b) help remove unnecessary executive burdens in the task of learning a discourse, particularly in compositional planning, revising and editing (Graham & Perin, 2007). A small number of studies provide a starting point for this work with postsecondary students (Berry & Mason, 2010; De La Paz & Felton, 2010; MacArthur & Lembo, 2009). In summary, this section has established that more complicated graphic organizers and think-sheets may be an important component of postsecondary writing interventions using the SRSD method, especially

since these programs will draw on more than one strategy to support student writing. Another important theme involves program fidelity. SRSD interventions for postsecondary students will require strong and detailed reporting on adherence to program elements, which can prove difficult in both lengthy case studies (MacArthur & Lembo, 2009) and quasi-experimental designs involving many teachers and classrooms (e.g. De La Paz & Felton, 2010). Intervention should also draw on literature in the development of postsecondary writing in order to provide ecologically valid materials, particularly ones that fold disciplinary reading and writing tasks into the instruction (De La Paz & Felton, 2010) over the course of a multi-stage, multi-strategy intervention. The result of this work may be extensive, structured, explicit instruction that blends the strengths of multiple theoretical approaches to intervention (Wong et al., 2003).

Dictation Software and Assistive Technologies for Writing

Previous sections outlined the guiding theoretical framework in the present study. In the *Functional Writing System*, lower-level transcription processes and higher-level executive control processes operate within a limited working memory system to determine the quality of text produced (Berninger, 1999; Berninger & Amtmann, 2003). Hence, dysfluencies in lower-level transcription processes can constrain higher-level translation processes (e.g. planning, organizing, reviewing), negatively impacting quality among postsecondary writers with LD. Research in assistive technology (AT) has investigated whether speech-to-text and speech recognition (SR) software can alleviate or even circumvent transcription deficits, potentially removing barriers to written expression in this population of writers (e.g., De La Paz, 1999; MacArthur & Cavalier, 2004; Higgins & Raskind, 1995; Higgins & Zvi, 1995; Martinze-Marerro & Estrada-Hernandez, 2008). AT is defined as any technology that assists, increases or maintains the functional capabilities of an individual with disabilities (Day & Edwards, 1996; Holmes &

Silvestri, 2012; Wissick & Gardener, 2008). Some researchers have reported a rise in the use of AT among postsecondary students with disabilities (e.g., Fichten, Barile, & Asuncion, 2003), as well as the added importance of fluency with learning technologies for postsecondary students with disabilities (Parker & Banerjee, 2007). In the case of SR software such as *Dragon Dictate* (Nuance Communications, 2013), students with intact oral language have the opportunity to place less emphasis on mechanical and encoding difficulties in the writing process by dictating their written assignments to a computer. The logic is that this process can support higher quality written work, deemphasizing transcription and text production problems that may result in weak written language abilities (De La Paz, 1999; Holmes & Silvestri, 2012; Raskind & Higgins, 1998). SR options may also improve writing fluency through the greater rate of speech (up to 160 words per minute) compared to the average person's written output per minute (25 words per minute) (De La Paz, 1999). While these aspects of dictation may seem promising, Holmes and Silvestri (2012) warn that these potential benefits have been extrapolated and inferred, not sufficiently demonstrated. Scarce empirical research has established the efficacy of this AT option for postsecondary students with disabilities (Higgins & Zvi, 1995; Martinez-Marrerro & Estrada Hernandez, 2008), despite the fact that many psychologists recommend dictation in psychoeducational assessment reports (Holmes & Silvestri, 2012). A few promising studies appear to suggest the value of investigating dictation as an efficacious AT for postsecondary students with LD.

First, although the literature has focused more on young writers (e.g., De La Paz & Graham, 1997; MacArthur & Graham, 1987; Reece, 1992) a small number of studies have used experimental designs to investigate the effectiveness of SR options for secondary students or postsecondary students with LD. These studies have contributed some encouraging results that

suggest SR programs may indeed provide benefits, minimizing mechanical problems and drawing on students' strengths in oral expression. For instance, MacArthur and Cavalier (2004) proposed that, by potentially removing mechanical barriers (e.g. spelling and punctuation) to written expression in secondary students with LD, the use of dictation software could impact both length and quality of written output. In a repeated-measures group design, these researchers compared writing across three conditions: dictation to a scribe, dictation to computer software (Dragon Naturally Speaking, Version 4; 1998) and handwritten output in persuasive essays. Thirty-one high school students (21 with LD and writing difficulties) were trained in the use of this dictation software and also metacognitive strategies for planning, writing and revising in this transcription mode. In this study, students received brief instruction in a planning strategy that employed a graphic organizer; however as research assistants provided no explicit feedback, this approach was not consistent with the principles of an SRSD intervention. In each condition, students wrote a letter to the editor about a controversial topic; they also completed post-test interviews about speech recognition software. According to a seven-point holistic quality rubric that assessed content, organization, word choice, sentence fluency and conventions, students with LD produced the highest quality essays when participating in the human scribe condition, followed by dictation to a computer. The researchers found no significant differences in quality across conditions for students without LD. Dictation conditions saw improved composition in students with LD, in contrast to their non-LD peers. These researchers concluded that dictation removed a disability-related barrier (transcription dysfluencies) without changing the construct being tested (communication of knowledge). Hence, they argued SR is a valid accommodation. These researchers also argued that composing, independent of writing mechanics, is an important educational goal. While this study does include participants from a secondary school population,

it is reasonable to suggest that if students at this educational level can benefit from dictation, then this transcription mode may support older writers at the postsecondary level. Furthermore other researchers have argued that high school students with LD and writing difficulties should receive training in assistive technologies – like SR – before they transition to postsecondary education (Day & Edwards, 1996; Mull & Sitlington, 2003).

In an earlier study, Higgins and Raskind (1995) also compared postsecondary writers with LD across conditions capturing differences in writing media. Twenty-nine postsecondary students with documented LD at California State University (CSU) wrote three essays – dictated via Dragon Dictate system Version 1.01, dictated to a human scribe, and composed with no support (either handwritten or using a word processor without spellcheck). The writing assignment modeled the university's Upper Division Written Proficiency Exam, and quality scores as assessed by a holistic, six-point rubric were significantly higher in the dictation condition. Words spelled with seven or more letters also best predicted the quality scores, and the researchers proposed speech recognition technology supported these students to draw on their oral vocabularies in writing at a statistically significant level, hence positively impacting quality scores. Higgins & Raskind (1995) proposed that speech recognition software helped students by providing automatic spellings, and also canceling out any mental distractions required in the checking and rechecking of spelling problems. These researchers proposed that using this software encouraged students to use longer words, a strategy that addresses limited vocabularies among students with writing difficulties (Gregg et al., 2007; Harrison, 2009; Wengelin, 2005); however Higgins and Raskind (1995) also listed some cautions and limitations. First, the small sample may not be reflective of other postsecondary student populations with LD. Second, in this study, success and quality were measured according to the institution's exit exam writing task;

however, success in writing may be measured differently on different campuses, in different departments and in different cultures. Future research and writing support should take into account departmental writing expectations for students. These researchers also did not account for the effects of extended time for timed writing assignments.

Reporting on a larger but connected longitudinal efficacy study of AT (speech-to-text, text-to-speech and screen review technologies) also at CSU, Higgins and Zvi (1995) suggested that postsecondary students with LD benefitted from the use of dictation software and human scribing in their written compositions. These results were part of a three-year study of CSU's blended computer and writing support program. When using discrete (word-by-word) dictation software or a human transcriber, postsecondary students with LD wrote essays that compared in quality ratings to their non-LD peers. Students with LD also obtained significantly higher scores when using SR than when writing with no assistance. These results should be interpreted with caution, as the researchers reported significant differences across treatment conditions at pretest, although they refrained from reporting the nature of these differences. The use of the same participants across several studies (Higgins & Raskind, 1995; Higgins & Zvi, 1995; Raskind & Higgins, 1998) could also have contributed to practice effects (Li & Hammel, 2003). Despite these problems, one key contribution of this study lies in the researchers' rich description of blended educational support and research activities, particularly in the discussion of how the students and tutors interacted with one another over the course of the longitudinal study. These researchers proposed that regular, one-on-one contact with a qualified writing instructor provided unexpected benefits, even in the unassisted writing condition. In particular, regular discussions about the writing process helped students to identify their strengths (rather than focusing solely on mechanical weaknesses).

In their reflections on the activities at CSU's blended computer and writing support program, Higgins and Zvi (1995) also proposed an emotional component to truncated writing fluency, where students described a history of instructor emphasis on mechanical errors and writing remediation, as well as a feeling of shame when reviewing their professors' comments. This study, while offering no conclusive results about AT efficacy, does present important considerations for the design of future writing support programs, particularly in the reminder that supportive intervention and instructional contexts are key for building trust and rapport with adult students experiencing writing difficulties, consistent with other recommendations in the literature (Gregg et al., 2007). Students with LD should receive explicit instructions in the tools, strategies and expectations of writers in their disciplines (Gregg, 2007).

Themes from the literature in SR. The present study aims to blend higher-level strategic support in writing activities with transcription support in assistive technologies. No studies to date have combined dictation and writing support in the SRSD model for postsecondary students with LD, and more research is needed in the efficacy of the use of AT to support writing difficulties in postsecondary students (Holmes & Silvestri, 2012; Li & Hammel, 2003; Martinez-Marrero & Estrada-Hernandez, 2008); however the literature in dictation and SR offers some important considerations for the present study. First, researchers should strongly consider including advanced planning support in programs or instructional materials that transition writers to dictation (e.g. De La Paz & Graham, 1999; MacArthur & Cavalier, 2004). Second, programs that introduce dictation should seek to do more than circumvent mechanical problems. Educators should also support text production skills in struggling writers, such as the generation and organization of ideas (e.g. Higgins & Zvi, 1995). Third, speaking words to compose a written product is different from encoding words by typing or printing letters of the

alphabet, and other researchers have established the important differences between reading, writing, speaking and hearing language (Berninger, Abbott, Abbott, Graham, & Richards, 2002). While SR technologies may enable students to deemphasize encoding or written transcription difficulties, this method of composing will represent a new transcription mode for some students. Fluency and automaticity in this transcription mode may take some time and training. Lastly, earlier literature emphasized the limitations of early dictation software (e.g. MacArthur & Cavalier, 2004; De La Paz, 1999), particularly the discrete software that transcribed word-by-word at a slower pace, as opposed to more recent versions, which capture continuous speech. Greater computing power and more user-friendly speech-recognition software may offer an easier transition for students LD who switch to this mode of transcription for academic essays.

A case study by Wetzel (1996) also offers some useful considerations for the design of future research in this field. This researcher used an exploratory case design to investigate whether middle school students with LD and writing difficulties could learn to use a discrete (word-by-word) dictation software, VoiceType. Wetzel also asked whether speech-recognition software could indeed help these young writers bypass their specific difficulties in producing text. Although the study included three students, the researcher focused on one participant in the results. This student dictated six short narrative passages over 10 weeks, only partially mastering the procedures required for correcting words and entering voice commands with the chosen AT. Wetzel's also discussed the difficulties experienced by all three students with this software (e.g. onerous correction procedures required by a slower, discrete technology). The 74% recognition rate meant that, for these struggling writers, one-in-four words on the screen did not reflect their spoken output, and the result was distracting. Future research in the efficacy of voice recognition

AT for writing concerns should include an analysis of the training procedures, difficulties and strategies encountered by students as they master this new transcription mode.

Addressing an Identified Gap in Services

In summary, the literature has identified a need for evidence-based intervention to support postsecondary students with LD and writing difficulties. For these students writing may be a barrier to academic success, graduation, personal expression and communication, and meaningful participation in the workforce (Graham, 2006; Gregg, 2007; Harris et al., 2009; Harrison, 2009; Li & Hammel, 2003; Yeh, 1998). For these students, difficulties and dysfluencies in transcription processes entail limited resources for higher-level translation processes in writing, particularly along dimensions of purpose, structure and vocabulary (Connelly et al., 2006; Harrison, 2009; Wengelin, 2007). Capacity views of writing (Hayes, 2012; McCutchen, 2000; Peverly, 2006), particularly Berninger's *Functional Writing System* (1999; Berninger & Amtmann, 2003) provide a framework for conceptualizing these difficulties. In a capacity-limited working memory system, writing quality depends on fluent and automatized transcription processes and higher-level executive control processes. In this framework, the SRSD instructional method (Harris & Graham, 1996; Harris, Graham, & Mason, 2003) can scaffold explicit executive routines for planning, writing and revising for students with LD. Furthermore, integrated in this instructional approach, AT that draws on students' strengths in oral expression may help ameliorate transcription deficiencies, consistent with a trend toward increasing use and accommodation among students with LD (Gregg, 2007; Holmes & Silvestri, 2012; Li & Hammel, 2003; Martinez-Marrerro & Estrada Hernandez, 2009). No studies have yet combined higher-order writing support with SR technology in this population, as recommended in the literature (De La Paz, 1999; MacArthur & Cavalier, 2004). Lastly, in the study of

postsecondary writing, researchers have used Hayes' (1996; see also Hayes, 2012) framework to conceptualize planning, writing and revising not as discrete tasks but as specialized writing tasks. This research has also indicated that postsecondary writers need support learning how to construct argument schemas before the revision or even composition, and also training in how to follow specific task schemas like revision in order to set higher-quality goals (e.g., to improve writing across global and semantic dimensions as opposed to simply policing for errors).

Rationale. The intervention developed for the present study targets planning, writing and revision processes according to these themes and recommendations from the literature, particularly the use of structured think sheets to guide complex, higher-order writing activities (De La Paz & Felton, 2010; MacArthur & Lembo, 2009). In a multiple-probe, multiple baseline, within-subjects design, the research questions are as follows: (1) Do postsecondary students with LD and writing difficulties produce higher quality writing (measuring the lower-level aspects of writing such as spelling, grammar, capitalization and punctuation and higher-level précis quality) when using a combined planning and dictation strategy? The literature suggests students may achieve improved scores across elements of transcription (Higgins & Zvi, 1995; MacArthur & Cavalier, 2004). (2) After targeted, one-on-one support to integrate SR technology into their writing processes, do students with writing difficulties report that speech-to-text software is a valuable support for mechanical difficulties such as spelling, grammar and punctuation? (3) How do students with writing difficulties use a collection of assistive technologies to support the writing process through planning, composition and revision stages? The results of this study can inform the design and delivery of intervention and curriculum support for this vulnerable population, already listed as lacking evidenced-based programming in higher education (Gregg, 2007; Li & Hammel, 2003; Martinez-Marrerro & Estrada-Hernandez, 2008).

Method

Research Design

This study employed a single-subject design, a practical research method for evaluating effectiveness in applied or clinical interventions (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). Single-subject designs enable researchers to infer causal relationships between an intervention (independent variable) and an observed effect (dependent variable or variables) in a specific setting or context, within a specific individual (Freeman & Sugai, 2013; Kratochwill et al., 2010). According to Horner and colleagues, single-subject designs can provide a "fine-grained, time series analysis of changes in a dependent variable(s) across systematic introduction or manipulations of an independent variable" (2005, p. 172). In the present study, the individual was the unit of analysis, and each individual or case acted as their own control; also, the outcome variable was repeatedly measured across and within different conditions (Kratochwill et al., 2010). The design was also selected to determine who did and did not respond to the intervention, in a particular context and setting, serving as "a window into the process of participant change" (Kratochwill et al., 2010, p. 3).

Multiple-baseline, multiple-probe within-subjects studies require three demonstrations of the experimental effect (Horner et al., 2005). In this study, in order to establish that the effectiveness of the intervention combining three writing strategies (PREP, TALK, and CHECK) and the use of AT, the dependent variables (DVs) were required to demonstrate increased quality scores (writing probe quality measures) and decreased rates of errors (measured through incorrect word sequences) in the intervention phase. In order to establish a systematic replication of the desired effect, these increased quality scores and decreased rates of spelling, grammar and punctuation errors had to be replicated systematically (Kratochwill et al., 2010). Through the

staggered introduction of the intervention at different time points for different participants, the design was required to establish an experimental control that could allow for the dismissal of certain threats to validity, such as the passage of time, measurement effects or uncontrolled variables (Horner et al., 2005; Kratochwill et al., 2010). Furthermore, changes in DVs were required to covary with the manipulation of the intervention (Kratochwill et al., 2010).

Analysis of single-case designs. Single-case designs allow for the visual inspection of graphed data points across baseline, post-instruction and maintenance probe phases in order to determine whether there is a pattern of change that meets the requirements of the design (Horner et al., 2005; Kratochwill et al., 2010). This analysis includes looking for specific baseline patterns, examining each phase for within-phase patterns, completing a visual analysis to compare phases and identify a possible effect, and integrating the information from these analyses. The design also requires an evaluation of the level, trend and variability in the data points (Horner et al., 2005), along with the immediacy of the effect (Freeman & Sugai, 2013). Analyses also involve evaluation of the proportion of overlap between baseline and intervention scores (Kratochwill et al., 2010). Scruggs and Mastropieri (2013) outline guidelines for interpreting this percentage of non-overlapping data points (PNDs), which was also employed by Rogers and Graham (2008) in a meta-analysis of single-subject writing intervention research: when 90% of data points in the intervention do not overlap with the baseline phase, it is considered a large effect. When 70% to 90% of data points do not overlap with baseline scores, the intervention is considered moderate, and 50% to 70% is considered small. When fewer than 50% of scores do not overlap with the baseline score, the intervention is considered not effective.

Threats to the design. Attrition was a potential threat to the design (Kratochwill et al., 2010), and at least five data points per phase were required in order to meet the standards for acceptable evidence in single-case designs. Instrumentation and inter-assessor agreement were additional threats to validity. Changes in instrumentation or scoring over time could compromise the validity of the results (Kratochwill et al., 2010); therefore, the current study included interrater reliability scores for all measures, as per recommendations that inter-assessor agreement be collected for at least 20% of data points in each condition (Kratochwill et al., 2010). The researcher also ensured that each participant received the same précis-writing task in the same order. Additionally, treatment fidelity is a common quality concern in single-case writing intervention studies (Rogers & Graham, 2008). The researcher obtained evidence that treatment was delivered as designed for each participant. Appendixes A, B and C each present the fidelity checklists for corresponding phases of the intervention, PREP, TALK, and CHECK. Results for interrater reliability and treatment fidelity are reported in a subsequent section.

Participants

Participants were four students between the ages of 18 and 32, registered with the campus disability center at a western Canadian university. The study required the recruitment of six to eight participants, accounting for possible attrition, as the design required a minimum of three, as outlined by a review of defining single-subject research design features (Horner et al., 2005). To be considered for inclusion, students needed a recent assessment that identified a learning disability, and they also needed to report a history of writing difficulties. Participants were recruited through posters at the campus disability office. See

Appendix D Intake Interview and Inclusion Criteria for a copy of the intake interview and inclusion criteria. Signed consent forms were collected from all students prior to participation in the study. Students were reminded that they could decline to participate at any point over the course of the study. Four participants responded to the recruitment posters over the course of the three-month period between October and December 2013. Their profiles, relevant coursework experiences and goals for the study are described below, case by case.

Table 1 *Literacy Scores from Initial Assessment*

	Angie			Samantha			Tyler			Amber		
Measure**	RS	SS	%tile	RS	SS	%tile	RS	SS	%tile	RS	SS	%tile
TOWRE Sight Word Efficiency*	68	75	5	57	68	2	95	97	42	82	84	14
TOWRE Phonemic Decoding Efficiency*	16	60	<1	33	78	7	51	94	35	43	86	17
WRAT-3 Spelling	34	81	10	37	92	30	46	108	70	43	102	55
CTOPP Rapid Digit Naming*	23	10	50	48	2	<1	23	10	50	28	8	25
CTOPP Rapid Letter Naming*	24	10	50	32	6	9	27	8	25	29	7	16
CTOPP Elision*	8	4	2	18	10	50	20	12	75	20	12	75
WAIS-III Vocabulary	50	12	-	42	11	-	63	18	-	51	13	-
WAIS-III Digit Span	11	6	-	16	9	-	13	7	-	13	7	-
Handwriting Fluency (letters in 60 seconds)	93	n/a	n/a	66	n/a	n/a	80	n/a	n/a	67	n/a	n/a

**For participants 25 years old and above, norms used: 17-0 through 24-11.*

***TOWRE and WRAT measures employed standard scores, with scores of 90-110 representing the average range, with a standard deviation of 15. CTOPP and WAIS measures employed scaled scores, with scores of 8-12 falling the average range, with a standard deviation of 3.*

Angie. Angie, a 32-year-old female undergraduate student, was in her second year of a double major in Psychology and English literature at the time of the study. She reported receiving a formal diagnosis of both dyslexia and ADHD in her late 20s. In her mid- and late 20s, she pursued community college courses. Table **1** reports the results of the initial assessment completed during Angie's first meeting with the researcher. This brief collection of literacy-related measures identifies Angie's difficulties with sight word reading, phonemic decoding of pseudowords and spelling. Angie also demonstrated difficulties manipulating phonemes and recalling increasingly long strings of digits, and these difficulties are consistent with a learning disability diagnosis.

Norm-referenced comparisons for the WIAT-II writing sample are not available, as participants did not complete the Word Fluency and Sentences tasks that also comprise the full Written Expression subtest; however, Angie's performance in this task was, qualitatively, indicative of writing difficulties and dysfluencies. Writing 116 words in 15 minutes, Angie sighed, shook her head, frowned, and crossed out a great deal of her work. She also made comments like, "I don't know how to spell it – Ah!" while writing, often scratching out the intended word and choosing something different. With 104 correct word sequences and 17 incorrect word sequences, errors were mainly due to spelling and punctuation problems.

Self-reported strengths and difficulties in academic writing. Angie reported finding academic writing time consuming and uncomfortable. She hoped to learn how to write more fluent first and second drafts instead of spending many hours deleting and rewriting entire paragraphs and sections of her essays because she could not express what she wanted to say. Leading up to a deadline, she said she spent as much time as possible changing and rewriting her papers, because she was rarely satisfied with her written product.

Samantha. Samantha, an 18-year-old female undergraduate student, had not yet declared a major, and was currently completing her first semester of general postsecondary studies. The participant reported a formal diagnosis of dyslexia that had occurred when she was approximately 8 years old. She reported a close, regular collaboration with learning assistance staff in the areas of reading and writing since elementary school; however, in her postsecondary pursuits, she noted that she was unsure of how to find the "starting point" for her term papers and essays.

Table 1 reports the results of the initial assessment completed during Samantha's first meeting with the researcher. Difficulties with sight word reading and phonemic decoding of pseudowords were evident, as well as deficits in rapid automatized naming speed of both digits and letters. These scores are consistent with the profile of a student with a learning disability. The participant's pretest essay (WIAT-II, Prompt A) demonstrated a great deal of lower-level dysfluencies. Upon reviewing her writing sample at the completion of the task, Samantha noted that she couldn't "see the difference" between words she had spelled inconsistently such as "thy" and "they" or "ave" and "have." Samantha's pretest writing consisted of 164 correct word sequences and 36 incorrect word sequences. Spelling and punctuation errors made up the bulk of error sequences. These initial writing scores are outlined in Table 5.

Self-reported strengths and difficulties in academic writing. During the initial interviews, Samantha noted difficulties detecting errors in her own text. She said that her professors often told her she confused word meanings such as "in" or "at," "from" or "for," and resulting in poor quality and clarity in her writing. Her graded assignments were often covered in circled spelling and grammatical errors, and her professors warned that the presentation of her ideas suffered greatly from many small but distracting typos. "I'm always told it's a really good

idea. Then they [professors] go on and say the things I've done wrong," she said of her professors' feedback. She reported feeling "sidetracked" by spelling and grammatical concerns, often neglecting to evaluate the structure and organization of her term papers.

Tyler. Tyler, a 23-year-old undergraduate student, was pursuing his first semester of an undergraduate degree at the time of the study, and he planned to major in History. He reported a recent diagnosis of dyslexia and ADHD. Table 1 reports the results of Tyler's initial assessment with the researcher. Tyler reported previously attending different community college courses and programs, including a brief pursuit of a carpentry ticket and courses in opera and theatre. Explaining his past frustrations with college-level literacy demands, he explained. "I remember feeling depressed. I thought I wouldn't get anywhere with education ... [But] I really liked thinking and I really liked academics."

***Self-reported strengths and difficulties in academic writing*.** In his more recent university courses, Tyler described a process of excessive editing and drafting, activities he felt took "a ridiculous amount of time." He reported spending a full semester writing and rewriting a term paper, often exceeding his word limits by five thousand words before he was able to express his ideas adequately. In his work with the researcher, he hoped to develop a more efficient writing routine, especially detecting spelling and grammatical errors. Tyler's performance on the initial WIAT-II Essay task corroborated some of his descriptions and concerns. Although Tyler wrote a good deal in 15 minutes (306 words), his text also contained many spelling and capitalization errors. Upon completion of the task, he noted that he had fallen into a familiar pattern of listing copious details and facts because he was afraid of "missing something" when he would rather have attended more to the logic and structure of his essay.

Amber. Amber, a 25-year-old undergraduate student pursuing prerequisite undergraduate courses for a physiotherapy degree, had recently been diagnosed with ADHD and a learning disability impacting written expression. Amber also reported a history of academic difficulties, including intense frustration with the writing activities she had undertaken in earlier community college courses. In the initial assessment, Amber's scores indicated below average performance in sight-word reading of real words and non-words, the rapid automatized naming of letters, and the use of short-term and working memory resources to recall increasingly long strings of digits. These difficulties are consistent with a learning disability. According to Amber, when writing, she spent the majority of her time reading and rereading her sentences to search for mechanical errors, often at the expense of coherence. In her initial Essay task (WIAT-II, Prompt A), Amber made a great deal of mechanical errors due to problems with spelling, handwriting, the correct use of capitals and punctuation rules. With the inclusion of handwriting problems, these difficulties contributed to an incorrect word sequence rate of 27%. Upon completing the 15 minute essay, she told the examiner that she often found writing to be stressful and upsetting.

***Self-reported strengths and difficulties in academic writing*.** In her work with the researcher, Amber hoped to develop clear routines for planning and composing. "I've got this stuff in my head but I don't know how to put in on paper," she explained. "It takes me way more time (than peers) to formulate my thoughts." She was eager to use SR software because she found typing and handwriting too taxing. She explained her frustration with past attempts to improve her writing, which always resulted in the same ritual of deleting sentences before she had finished composing them: "I think of beating the same drum and somehow expecting a different song."

Procedure

The following section outlines the study's procedure, including the initial interview and literacy assessment, baseline data collection, intervention delivery, regular writing probes and follow up interviews. An orienting table for the study's procedures is provided in Table 2. The principles of the intervention framework (SRSD) are outlined below, along with the rationale and content of the three writing strategies (PREP, TALK and CHECK) designed specifically for the purposes of this study.

Table 2 *Study Procedures Orienting Table*

Assessment, Pretest and Initial Interviews	Intervention	Posttest	Maintenance
90-minute literacy assessment conducted (standardized tests) Retrospective Strategy Report conducted Strategic Knowledge Interview conducted Pretest (WIAT-II, Prompt A) completed by handwriting Précis-writing probe (baseline) completed by handwriting *	Participants introduced to strategic procedures, PREP, TALK and CHECK materials, and technology, according to SRSD framework Participants given opportunities for practice and researcher feedback during instructional phase (not scored) During post-instruction, prompts (scored) completed by participants, with access to PREP, TALK and CHECK materials but without researcher feedback during the task	WIAT-II (Prompt B) completed with the use of speech recognition software Exit Interview and Social Validity Check conducted	Participants completed a maintenance précis-writing probe at six or eight weeks following post-test

* Assessment, interviews, pretest and the first baseline probe completed during initial session. Additional baseline probes completed over subsequent sessions. Angie, Samantha and Tyler completed a total of three baseline probes. Amber completed four baseline probes.

Assessment and initial interviews. After consenting to participate in the study, participants completed a 90-minute assessment of cognitive, linguistic and literacy performance in a battery of standardized measures. The purpose of the assessment was to gather information about participant's particular LD profiles, as already summarized above; they also answered a

series of open-ended questions about their current technology tools and writing routines used to produce course projects and academic writing assignments (see Appendix E and Appendix F). The purpose of this interview protocol was to create a profile of each student's past academic experiences and writing support opportunities, current academic writing process and preferred tools. The resulting technology and writing process profiles were later compared with the student's description of the writing process and preferred tools during the Exit Interview (see Appendixes I through L, also referenced later in the results section). Results were compiled in brief individual assessment reports that noted students' strengths, weaknesses and goals specific to academic writing. The researcher used this information to guide targeted instruction during the intervention. For instance, if participants asked for help with editing strategies, and also demonstrated difficulties with punctuation (e.g., fused sentences) in their writing samples, the researcher would compile resources, handouts or website links to help students identify and correct these problems in their own writing.

Intervention timing. The study spanned a minimum of twelve 60-to-90-minute sessions for each participant, as outlined by Horner et al. (2005) and also Rogers and Graham (2008), who suggested a minimum of five data-points are required for both A and B conditions in a multiple baseline design. All participants completed the full course of the intervention, including baseline and post-instruction phases, and three participants returned for a maintenance probe (Angie, Samantha and Amber). Consistent with the intervention design, three participants – Angie, Samantha and Amber – met with the researcher twice per week over approximately a six-week period, with a follow-up session occurring between six and eight weeks after the completion of the intervention. One participant – Tyler – met with the researcher over a ten-week period for two reasons: (1) he was not always available to meet twice per week, and (2) he took a

holiday over the winter break and was not available for sessions for a period of more than two weeks. All writing prompts were administered in the same sequence across participants. Three participants – Angie, Samantha and Tyler – received the intervention after three baseline sessions. One participant – Amber – received the intervention after four baseline sessions; therefore, Amber wrote a fourth baseline prompt that the other three participants did not. Her post-instruction and maintenance writing probes followed the same sequence as the other three participants. Each participant received at least three hours of preliminary instructional sessions and between 10.5 and 12 hours of post-instruction support, depending on their comfort with the strategies and their progression through the recursive SRSD model (Graham & Harris, 2003; Mason, Harris, & Graham, 2011); therefore, each participant's intervention course consisted of between 10.5 and 13.5 hours of one-on-one writing and technology support with the researcher.

Intervention delivery. Students were encouraged to bring their coursework and regular assignments, as these materials were directly relevant to them. In their collaborative work together, the researcher presented three connected metacognitive strategies: PREP, TALK, and CHECK for planning, composing and revising postsecondary writing assignments (see Table **3**, below). Each of these strategies was outlined in a two-page handout for students, combining the mnemonics with diagrams and contextual information. Students were encouraged to troubleshoot and apply these strategies in their coursework and writing routines. Mason, Harris and Graham (2011) have outlined the instructional stages of the SRSD approach:

1. *Develop background knowledge*. Instructors evaluate student's prior knowledge about the content of the lessons and introduce the strategies.
2. *Discuss it.* Instructors discuss the practices of good writers and the features of good writing. They also discuss the purpose of introduced strategies and tools.
3. *Model it*. Instructors model effective metacognitive processes and strategy use.
4. *Memorize it*. Students memorize the strategy, the steps and components of the strategy and the purpose for each of these parts.

5. *Support it*. Instructors provide scaffolded support of the strategies, self-regulatory processes and metacognitive routines of the intervention material.
6. *Independent performance*. Students employ the writing strategies and coordinate writing routines without teacher support.

This instructional process is recursive, as students may move through the phases at different rates. Instructors may also determine when review or revision of specific strategies is needed, or when new strategies should be introduced (Mason et al., 2011). **Figure 7**, **Figure 8**, and **Figure 9** present sample personalized intervention materials. Angie, Samantha, Tyler and Amber each interacted with the researcher following the process outlined in the accompanying tutorial manual (developed by the author for the purposes of this study). In collaboration, each participant and the researcher developed personalized goals and learning aids for the execution of each of the three strategies, PREP, TALK, and CHECK.

Table 3 *PREP, TALK and CHECK Mnemonics*

Mnemonic strategy	Steps
PREP (Planning)*	**P**repare your blueprint. **R**esearch, read, reflect and plan. **E**valuate an outline. **P**repare your workspace for dictation.
TALK (Composing)*	**T**alk out your planned elements into an essay using dictation software. **A**rrange the pin on your blueprint to mark your place. **L**eave concerns about spelling, grammar, punctuation and awkward phrasing for the next phase. **K**eep to your plan and complete a first draft before you revise.
CHECK (Revising and Editing)*	**C**reate a checklist. Evaluate for ideas first. **H**it your structural targets. **E**valuate for spelling and grammar using an assistive tech. **C**lean up more spelling, grammar and punctuation using MS Word. **K**eep some time free for a last proofread.

** Each mnemonic strategy is presented in a one-page handout with accompanying contextual information and support. See **Figure 7, Figure 8** and **Figure 9** for examples of personalized materials that participants developed with the researcher to accompany each mnemonic.*

Technologies. The focus of the study was the use of higher level strategies for planning, organizing, composing and revising academic assignments, along with the use of speech recognition software. The speech recognition software for Macintosh (*Dragon Dictate 3*; Nuance, 2013) was selected instead of the PC software options due to available resources for the study. Participants were not required to purchase the software, and it was provided by the researcher during the study. Participants were also provided with the opportunity to explore the usefulness of two other technologies – concept mapping software and a text-to-speech screen

reader. These latter two technologies are often recommended for students with LD and WD (Holmes & Silvestri, 2012; Martinez-Marrerro & Estrada-Hernandez, 2008; Mull & Sitlington, 2003). These technologies were included into the work with the tutor/researcher in order to give participants the opportunities to personalize their learning goals. It was reasoned that some participants could already have used these technologies in their work, and should have access to those writing supports for their purposes of the study. For those who did not already use the technologies, one-on-one support trying and troubleshooting these technologies was offered as a service to interested participants. Technology training and support integrating assistive technologies into academic activities is identified as an asset for postsecondary students with disabilities (e.g., Connor, 2012; Sitlington, 2003). The concept mapping software, *Inspirations* (Inspiration Maps, 2012) for the iPad was selected for low cost and simplicity of use. Using this technology, participants worked with the researcher to use this software to identify discourse structures and genre elements in their application of the PREP strategy. Table 3 outlines the PREP strategy and *Figure 7*. Tyler's Personalized Planning Goals (PREP) provides an example of a personalized learning aid to accompany one student's use of that strategy, created using the concept mapping software. The screen reader, *Voice Dream Lite* (Voice Dream, 2012) for the iPad, was also selected for low cost and simplicity of use. Upon completion of baseline prompts, participants were given the option to read the writing probe passages using this technology.

Planning. The PREP mnemonic structures strategic planning processes according to a routine: (1) Prepare your blueprint; (2) Research, read, reflect and plan; (3) Evaluate an outline – does it fit the blueprint?; (4) Prepare your workspace for dictation. This strategy draws on the evidence that postsecondary writers must learn the argument schema for a genre (Butler & Britt, 2010) and the common recommendation t hat adult writers with LD use concept maps and

graphic organizers for planning their written work (Li & Hammel, 2003). Using this instructional tool, the instructor and the student identify how the paper should be built by building concept maps or diagrams to identify the "blueprint" or required structure. The participant gathers materials and plans their specific arguments (with the aid of a graphic organizer if necessary), comparing the detailed outline (e.g., specific information) to the argument schema (e.g., structure). Lastly, the participant prepares to turn plans and notes into connected text by using dictation software.

Composing. The TALK strategy requires participants to consider the sources of difficulty in their own writing, and their past experiences composing assignments. The strategy also requires students to set deliberate, intentional limits on some potentially less helpful writing activities in their repertoire (e.g. "hunting" for errors while composing rough drafts or frequently interrupting the drafting process to review for mechanical problems). A routine is outlined for drawing on strengths in oral expression and limiting the focus on lower-level dysfluencies. This routine is summarized by a mnemonic: (1) Talk out your planned elements into an essay via dictation software; (2) Arrange the pin on your blueprint to mark your place; (3) Leave concerns about spelling, grammar, punctuation and awkward phrasing for the next phase; (4) Keep to your plan and complete a first draft before you revise. In this phase the student draws on the argument schema and the detailed plan in a composition process that emphasizes clearly elaborated writing goals. It also provides the participant and the instructor opportunities to discuss sources of difficulty in the participant's writing and to design responsive tutorials that meet the students' specific needs (e.g. sentence building, vocabulary expansion, punctuation errors), as recommended by Gregg (2007) and Gregg et al. (2002).

Revising and editing. The CHECK strategy requires participants to reflect on past sources of writing difficulty and instructor feedback; it also requires students to follow a revision schema that prioritizes the evaluation of higher-level meaning, logic and structure over lower-level error detection. A tendency to emphasize lower-level strategies and surface revisions has been noted in younger students with LD (i.e., Harris, Graham, & Mason, 2003) and in some studies with adults (i.e., Harrison & Beres, 2007). The CHECK mnemonic outlines a routine as follows: (1) Create a checklist and evaluate for ideas first; (2) Hit your structural targets; (3) Evaluate for spelling and grammar using an assistive technology; (4) Clean up grammar and punctuation using Microsoft Word; Keep some free time for a last proofread. This strategy continues to integrate assistive technologies for writing into the student's routine. Elaborated writing goals are also prioritized and a clear revision schema created by requiring the student to reflect on past sources of difficulty and past learning. Participants are also required to identify and classify their revision goals as higher-level (global changes) or lower-level (local changes), and to prioritize accordingly. Lastly, CHECK requires students to compare their written work to the argument schema structure specified in the planning phase.

Initial sessions. In the first meetings with the researcher, participants completed the initial assessment and answered questions posed in the Strategic Knowledge interview and Retrospective Strategy Report. Baseline writing probes were collected, which consisted of handwritten summaries of equivalent informational texts.

Instructional sessions. Once the baseline prompts were gathered, the researcher introduced the SR technology and the PREP, TALK and CHECK strategies. To remind participants about how the strategies fit together, the researcher wrote these words at the top of the whiteboard: PREP (planning process), TALK (composing process), CHECK (revision and

editing process). Next, the researcher introduced the teaching materials, each sorted into three packages, for PREP, TALK, and CHECK. The theoretical underpinnings of the strategies were explained to students and discussed in the context of their actual writing experiences (e.g., writing a paper for a course) and their past feedback about strengths and weaknesses in academic writing, as well as their literacy profiles. To introduce these ideas the following concepts are crucial: (1) the distinction between higher-level and lower-level writing processes and concerns, also referred to as transcription and translation processes (Berninger & Amtmann, 2003), (2) the previously reviewed research suggesting specific writing characteristics of postsecondary students with LD, including less advanced vocabulary, poor cohesion and organization, fewer words written, and (3) the importance of clearly identified schemas for genre structures (blueprints) in addition to clearly outlined schema for the revision process.

After at least twenty to thirty minutes of technology training using *Dragon Dictate 3 (*Nuance Communications, 2013*),* participants were given between two and three opportunities to review the researcher's modeled use of the PREP, TALK and CHECK strategies from start to finish, and at least two or three opportunities to apply the strategies in their own writing.

Post-instruction sessions. Once participants had integrated the use of the strategies with their SR activities, and once they had successfully completed at least two or three writing prompts using SR software, the sessions proceeded to the post-instructional phase. The researcher continued to provide support as required, and as outlined in the recursive framework of the SRSD approach. All participants completed a minimum of five post-instruction sessions.

Writing probes. In order to measure the efficacy of the intervention, equivalent writing probes were administered each session. These probes were adapted from a timed précis task created by Hatcher et al. (2002) in an assessment battery for screening students with specific

reading difficulties in higher education. The task required each participant to read a newspaper article, followed by a timed writing task. Students were instructed to read the article for the purposes of creating a précis. These researchers determined the task was an ecologically valid measure of reading and writing in higher education. The original scoring criteria include dimensions of content, structure and legibility (Hatcher & Snowling, n.d.). The present study adapted the task to create a series of short writing probes administered during each session and scored along dimensions of content, structure and vocabulary. Participants were asked to read a brief article from a national newspaper (approximately 350 words; a new article each time). They were then required to generate a précis of the article. In the present study, this task is specific to the task of academic writing, where students must communicate knowledge and information in succinct, grammatically correct prose.

Exit Interview and social validity check. After students completed the post-test writing task (WIAT-II Essay, prompt B) and the maintenance probe, the sessions concluded with the Exit Interview. Questions included checks for social validity, namely whether students felt the strategies could be helpful and applicable in their coursework. A copy of the Exit Interview protocol is provided in **Appendix G Exit Interview and Social Validity Check.**

Measures

Initial Assessment Information

A short collection of cognitive, linguistic and literacy measures were administered by the researcher, a graduate student in Educational Psychology trained in academic assessment and intervention, in order to gain a profile of each participant's strengths and weaknesses on skills and subskills related to writing and their LD profile. These scores informed a case summary or case profile of each student in the later presentation of the intervention results, and have also been referenced previously in the participant descriptions.

Cognitive Measures

Verbal short-term and verbal working memory. Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997) assessed participants' verbal short-term and verbal working memory. The Digits Forward subtest requires examinees to repeat increasingly longer strings of numbers. Examinees receive a score of 0 if their repeated string of digits contains any errors, and a score of 1 if the string contains no errors. Scoring is discontinued if an examinee obtains scores of 0 in both trials. The Digits Backward Subtest requires examinees to listen to increasingly long strings of digits and repeat them backward. Examinees obtain a score of 1 for a correct sequence and score of 0 if the trial contains any errors. Administration is discontinued if an examinee obtains two scores of 0 in a set of two consecutive trials. Standard administration procedures were followed as outlined in the WAIS-III administration guide.

Lexical access. The RAN-digits and RAN-letters subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Raschotte, 1999) provided measures of processing speed. RAN-Digits presents participants with a 4 by 9 grid of randomly displayed digits, 0 through 9. Participants must name the numbers quickly, with accuracy. RAN-Letters

presents participants with a 4 by 9 display of the letters a, c, k, t, n and s, also randomly displayed, and students must name the target letters quickly, with accuracy. Both subtests were administered according to standard procedures outlined in the manual. Each subtest consists of two trials, and these trials for each subtest were combined into raw scores. Scaled scores are provided in the CTOPP manual, for comparison to a normative sample. The manual reports high test-re-test reliability for the digits task (r = .89) and the letters task (r = .91).

Linguistic Measures

Expressive vocabulary. The Vocabulary subtest of the WAIS-III (Wechsler, 1997) requires examinees to provide oral definitions for spoken words presented simultaneously in written form from the stimulus booklet. This subtest assesses expressive vocabulary, as the words are presented in order of increasing difficulty, and examinees are instructed to provide oral definitions for up to 33 words. Administration is discontinued after six consecutive scores of zero. Examinees can obtain a score of 0, 1 or 2 on each word, according to criteria listed in the examiner's manual.

Literacy Measures

Handwriting fluency. Students were required to print the letters of the alphabet in lower case as quickly and accurately as possible in 60 seconds (Berninger, Mizokawa, & Bragg, 1991). If they completed the alphabet within the one-minute testing time, participants were instructed to begin again and continue writing the letters until otherwise instructed. As the "building blocks of written language," the retrieval of letters from memory and the production of letters on the page are relevant skills in the study of writing and composing process (Berninger, 1999, p. 102).

Word and pseudoword reading fluency and accuracy. The Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999) requires participants to read two types of

printed words that target word-reading efficiency and phonemic decoding efficiency. The Sight Word Efficiency subtest measures participants' ability to recognize familiar words accurately and fluently. This list consists of 106 real words, printed on an 8.5 x 11 inch card, presented in order of increasing difficulty. Participants were instructed to read each word as quickly and accurately as possible in 45 seconds. If a participant hesitated for more than three seconds, the word was scored as incorrect.

The Phonemic Decoding Efficiency Subtest measures participants' ability to apply graphophonemic knowledge to decode printed words. This list consists of 63 invented words or non-words to eliminate the possibility of sight-word reading. Printed on an 8.5 x 11 inch card, these words also appear in order of increasing difficulty. Participants were instructed to read each word as quickly and accurately as possible in 45 seconds. If a participant hesitated for more than three seconds, the word was scored as incorrect.

In both subtests, raw scores were transformed into standard scores, in order to compare participants' achievement levels to peers in a normative sample.

Spelling in isolation. The Wide Range Achievement Test – 3rd Edition (WRAT-3; Wilkinson, 1993) assessed participant's spelling skills. The test presents 40 words of increasing difficulty. Participants are instructed to listen to the dictated target word in isolation, in the context of a sentence, and once again in isolation, and they are instructed to spell each word as quickly and accurately as possible. Examinees are instructed to "take a guess" when unsure of accurate spelling. Testing is discontinued after ten consecutive errors. Correct words are assigned one point each. Raw scores were transformed into standard scores, in order to compare participants' achievement levels to peers in a normative sample, appropriate for use with individuals in kindergarten through to adulthood (Administration Manual, p. 10).

Essay writing. At pre- and post-test, participants completed the Essay task (Prompts A and B) from the WIAT-II. This standardized, norm-referenced measure requires examinees to produce a sample of expository writing. The WIAT-II manual reports strong reliability estimates for interrater (r = .87) and test-re-test (r = .77) reliability. Administration of this task will adhere to standardization as outlined in the administration manual. Participants wrote by hand, and the examiner transcribed their work before submitting it to the second rater for scoring. This procedure helps to control for any examiner bias related to handwriting quality (Graham & Weintraub, 1996). Two raters scored the essays.

Writing Probe Measures

Scoring for the dependent variables in the intervention involves a series of assessments measuring writing quality along dimensions of fluency and accuracy during the baseline and intervention phases. Raters were trained graduate students in Educational Psychology with experience in scoring postsecondary academic writing.

Précis quality. Writing responses to the regular writing probes were scored according to modifications made to the 18-point scheme developed by Hatcher et al. (2002) in the York Adult Assessment, a brief screening battery used to identify postsecondary-level adults with reading and writing difficulties. The précis task of this battery exposes participants to one short newspaper article, taken from the *Independent* newspaper**.** Using their SR technology of choice, students were then required to write a brief and succinct summary of the key points and supporting information in the article. As participants wrote in response to a series of 12 probes modeled after this task, each scoring guideline tracked whether the participant identified the key content of the article (12 points). Participants were also graded on structure, specifically their use of succinct words and phrases, and the use of correct grammatical structures (3 points). Hatcher

et al. (2002) have argued that this task is an ecologically valid measure, as it requires students to create cogent summaries of others' work, a core academic task for postsecondary writers. In the modified précis scoring in the present study, marks are also awarded for maturity and specificity of vocabulary (3 points). As per the vocabulary scoring criteria in the WIAT-II (Wechsler, 2002) paragraph writing task, students are awarded more marks for the use of specific, mature words. A score of 0 represents vocabulary that is immature, redundant, non-specific and simplistic. A score of 3 represents vocabulary that is rich, expressive, exceptional and mature.

In this modified précis task, participants could obtain a maximum score of 18 points for their representation of key terms, information and supporting points, grammatical accuracy and vocabulary quality.

Correct-incorrect word sequences. Correct and Incorrect Word Sequences (CWS, IWS) were tabulated according to the WIAT-III scoring manual for essay composition in grammar and mechanics (Wechsler, 2009). This rating system directs scorers to follow rules in spelling, capitalization, punctuation, grammar and semantics to calculate the sequencing of correct and incorrect words in a piece of writing. Converted to percentages (based on total sequences), these two measures provide indices of correct words and incorrect words generated by a participant in a given writing assignment. Converting errors and correct sequences to percentages based on the writer's total sequences generated also protects from over-penalizing writers who generate more word sequences (and potentially more errors) in a composition.

Fluency. Word count provided an index of text fluency. Other studies in this area have found that fluency, as measured by word count, is reduced in the writing of postsecondary students with writing difficulties in comparison to their peers without writing difficulties (Harrison, 2009; Harrison & Beres, 2007). More broadly, researchers have identified that,

compared to non-LD peers, students with writing difficulties may be less likely to complete timed writing assignments (Gregg, Coleman, Davis, & Chalk, 2007).

Additional Measures

Technology and strategy use checklist. A 10-item checklist was created for the purposes of this case study. During the participant's writing probe activity, the researcher noted the participant's use of specific technologies, strategies and materials during the writing process. The checklist requires the researcher to indicate whether the student used the PREP, TALK, and CHECK think-sheet materials. It also includes items specific to technology (i.e. whether the student uses a graphic organizing or concept mapping program for planning, speech-to-text for composition, text-to-speech or contextual spell-checking options for revision). Furthermore, the list requires the tutor to reflect on potentially relevant information for instructional design, such as whether the student emphasizes lower-level or higher-level writing strategies, or whether the student deviates from a planned argument schema. The checklist also involves a field for examiner comments. This data informed the case summary answers to questions 2 and 3, about student strategy use and student determinations about the usefulness of SR software. The data also informed the personalized design of explicit instructional support that met each student's specific needs and concerns. A copy of the checklist is included in **Appendix H Technology and Strategy Use Checklist.**

Results

The following section presents results, first with a review of the writing measures for all participants, and then the synthesis of observational and interview data collected over the course of the study. All writing probe measures were scored by two different raters, both graduate students in Educational Psychology. The author was a rater. Any inconsistencies in scoring were resolved through discussion. Interrater reliability, as calculated by Pearson's r, was at or above .9 for spelling, CIWS and précis quality scores, and .77 for punctuation. Small inconsistencies in punctuation scoring did not impact the incorrect word sequence reliability (which includes punctuation errors) because the two raters flagged the same errors, but sometimes categorized them differently within the punctuation scores. Subsequently, these errors were penalized equally in the IWS scoring. Program fidelity was measured through the use of itemized checklists (see Appendix A, B and C) completed by the researcher during the sessions. Fidelity adherence scores were 92%.

In the design of the study, the researcher asked: (1) when using SR and accompanying strategies for its use, do postsecondary students with LD and writing difficulties produce higher quality writing (along dimensions of word count, spelling, punctuation and correct-incorrect word sequences) that evidence lower error rates across the named dimensions and higher writing fluency? An adapted précis-quality measure was also used to determine whether participants expressed more information, used more sophisticated vocabulary, and made fewer grammatical errors. In the sections that follow, the writing-probe measures are first evaluated individually in order to answer this question. Analyses involve the visual inspection of graphed data points across and within phase shifts to determine whether there is a pattern of change that meets the requirements of the design, including demonstration of experimental effect at three different time

points (Horner et al., 2005; Kratochwill et al., 2010). Specifically, the analysis focused on the level, trend and variability of scores (Horner et al., 2005) along with the immediacy of the effect from baseline to post-instruction (Freeman & Sugai, 2013). The analysis also involved the proportion of overlap between baseline and post-instruction scores (Kratochwill et al., 2010). Guidelines for interpreting this percentage of non-overlapping data points (PNDs) are as follows: when 90% of data points in the intervention do not overlap with the baseline phase, it is considered a large effect. When 70% to 90% of data points do not overlap with baseline scores, the intervention is considered moderate, and 50% to 70% is considered small. When fewer than 50% of scores do not overlap with the baseline score, the intervention is considered not effective (Scruggs & Mastropieri, 2013; Rogers & Graham, 2008). Next, the pre- and post-test writing tasks and the maintenance probes are reviewed as additional sources of information about each participant's response to the intervention. A final sub-section in the analysis of these writing measures addresses any threats to the design, including measurement effects, passage of time and uncontrolled variables (Horner et al., 2005; Kratochwill et al., 2010); it also looks at the staggered baselines between participants to consider whether the DVs covaried with the manipulation of the intervention.

The second research question was: (2) did students determine SR technology to be a valuable support for their academic writing, alleviating mechanical difficulties such as spelling, grammar and punctuation? The final research question was: (3) how do students use a collection of assistive technologies to help support the writing process through planning, composition and revision stages? In order to answer these questions, results are synthesized across cases, using transcribed participant responses to the Exit Interview, themes from the researcher's notes (completed during and following each session) and the Technology and Strategy Use Checklist

(completed by the researcher during each session). Using the information in the checklist, the researcher created a summary of each participant's technology and strategy use, and then asked each participant to confirm or correct that information during the Exit Interview.

Writing-probe measures

The following section reports on the writing-probe measures over the course of baseline and post-instruction phases for all participants as well as maintenance probe phases for Angie, Samantha and Amber (Tyler did not complete a maintenance probe). Scores include word count, spelling and punctuation (both expressed as a proportion of error based on word count), correct- and incorrect-letter sequences, and précis quality.

Table 4 *Participants' Average Scores for Selected Writing Measures*

Participant	Word count			Spelling error rate (%)			Punctuation error rate (%)			Correct-incorrect word sequences			Précis quality		
	B	PI	M*	B	PI	M	B	PI	M	B	PI	M	B	PI	M
Angie	59	129.6	88	6.6	1.9	0	11.1	4.1	3.4	46, 17.3	125.6,12	86, 8	5.1	8.6	8.5
Samantha	100.3	145	179	9.9	<1	1.1	4.1	1.4	1.6	80, 27.3	146.1, 8	179, 8	8	9.3	12.5
Tyler	148	200.3	--	5.7	<1	--	3.5	1.2	--	129, 24.3	205.8, 5.8	--	10.3	11.9	--
Amber	118.5	202.5	224	9.4	<1	<1	4	<1.7	4	95.5, 29.5	205.5, 8.1	213,19	8.7	12.2	11.5

B = Baseline; PI = Post-instruction; M = Maintenance
**Maintenance probe scores represent scores from a single prompt.*

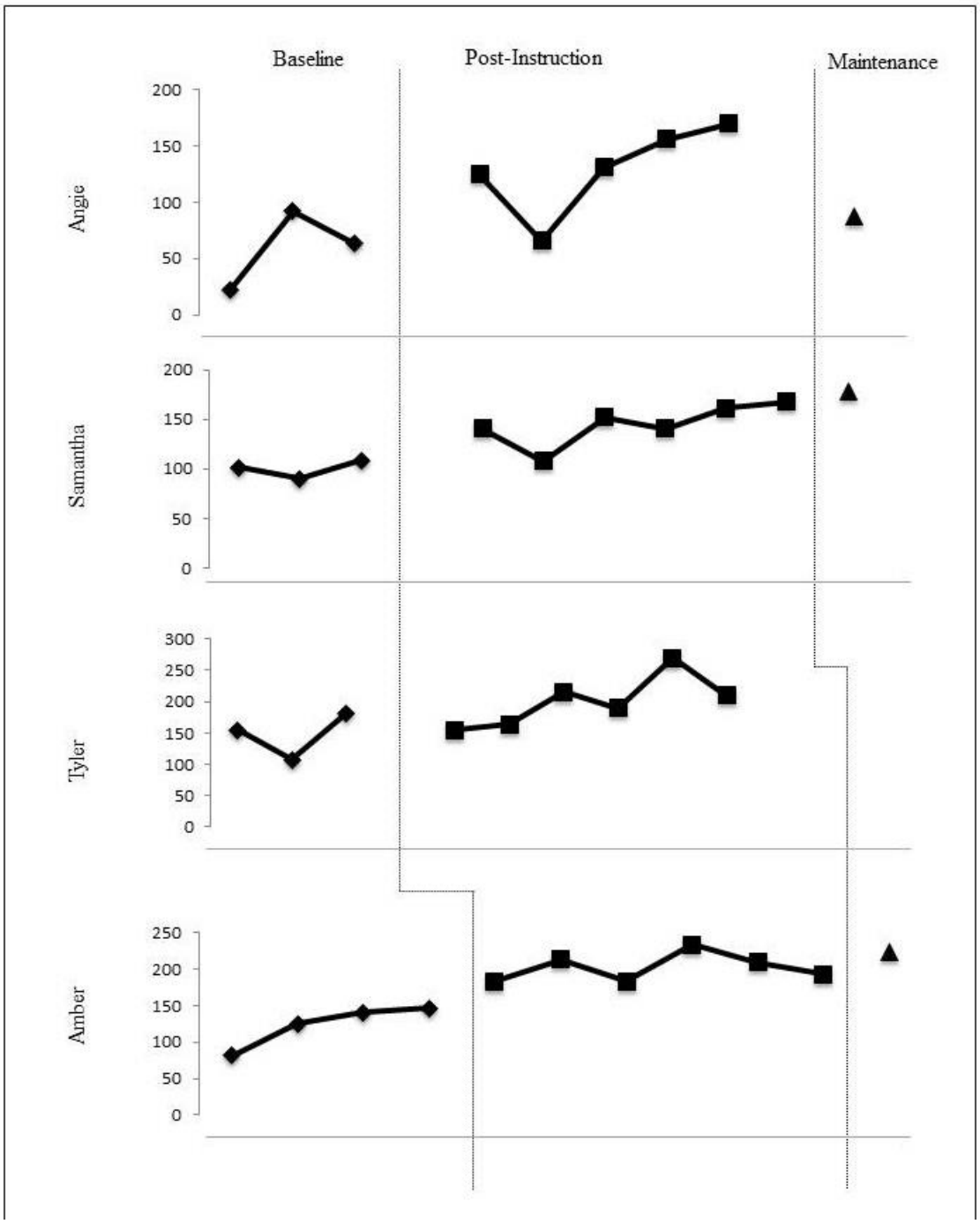

Figure 1. Graph of word count scores in baseline, post-instruction and maintenance phases.

Word count. Three participants wrote more words with the use of SR technology and the accompanying writing strategies, demonstrating either strong (>90% PNDs) or moderate effects (>70% PNDs). One participant demonstrated a slightly delayed response, showing increased scores after two post-instruction probes, and a small effect for this measure (<70% PNDs). Table 4 displays the writing scores for all participants across baseline, post-instruction and maintenance phases. *Figure **1*** displays the graphed results for all four participants, and demonstrates a general trend across three participants (Angie, Samantha and Amber) of an immediately identifiable effect upon the phase shift from the baseline phase. Angie and Samantha both demonstrated increasing scores across the post-instruction probes. Amber did not show the general trend of continually increasing scores across the post-instruction phase, as seen in the other three participants, but she did show a trend of dramatic increase from baseline across post-instruction. Unlike the other participants, Tyler did not show an increased word count upon the first post-instruction phase shift. The possible reasons for these scores are discussed below. PNDs for this measure were 82%, considered a moderate effect.

Angie. *Figure **1*** displays an immediate effect from the baseline to post-instruction phase, with word count more than doubling, increasing from 59 to 125 words. When Angie used SR technology and the three writing strategies (PREP, TALK, and CHECK), the percentage of non-overlapping data points was 80% for this measure, considered a moderate effect. It is also important to note the magnitude of change in scores, as Angie increased her word count by nearly 100 words between the baseline and the fifth post-instruction session.

Throughout the post-instruction phase Angie showed a general trend in increasing words, with the exception of the second data point. During the second post-instruction session, a construction crew began sustained and heavy work directly outside the window where the

session took place. Angie complained that the noise was distracting during the dictation portion of the session. It is possible that this interference could have impacted Angie's performance negatively, and could be responsible for this lower word count (66), which is an anomaly in comparison to the other post-instruction word count scores.

Samantha. *Figure **1*** displays the immediate effect upon the post-instruction phase, with word count increasing approximately 30% from the last baseline probe when the participant used SR technology combined with the three writing strategies. By the sixth post-instruction session, word count had increased by nearly 70% compared to the baseline average. Throughout the post-instruction phase there was a general trend in increasing words, with the exception of the second data point. During this testing date Samantha also complained about loud and distracting construction noises (both Angie's and Samantha's second post-instruction sessions occurred on the same day). It is, unfortunately, possible that this disturbance could have impacted Samantha's performance negatively, and could help contextualize the only data point that does not conform to this general trend of dramatic increase. PNDs were 83.3% for this measure.

Tyler. *Figure **1*** demonstrates some variability in scores for this participant, with word count increasing from baseline average only minimally (increases of 7 and 15 words) in the first two post-instruction probes but substantially (increase of 67 words) in the third. PNDs for this participant were approximately 67%, considered a small effect. It is important to note that, in the initial interviews, Tyler stated he was writing too many words on tests and exams, and, by emphasizing volume, his quality suffered: his written assignments were neither concise nor articulate. In the race to generate as many words as possible, he often made many spelling and grammatical errors. In his work with the researcher, Tyler aimed to focus more on organization and structure, and to stop using his past method of writing every idea that came to mind. His

lower scores in the first two post-instruction probes could also indicate his efforts to write less; however, according to Horner and colleagues (2005) a delayed response to the intervention upon a phase shift can compromise the ability to document an effect; therefore, design threat variables such as practice effects or the passage of time cannot be ruled out for this participant in the evaluation of word count scores. Nevertheless, the participant's goals to write less also temper and contextualize this information.

Amber. *Figure **1*** demonstrates an immediate effect in the shift from baseline to the post-instruction phase, with a 54% increase in words upon use of the SR software and the accompanying writing strategies. Amber's word counts continued to be dramatically higher than her baseline scores. PNDs were 100%.

Spelling. In comparison to their baseline averages, all four participants evidenced lower rates of spelling errors in the post-instruction phase. *Figure **2*** demonstrates the immediacy of the effect for all four participants between baseline and post-instruction phases. The graphs also demonstrate a consistent trend of reduced error rates across the post-instruction phase. For Angie, spelling errors fluctuated slightly around the 2% range with the use of the writing strategies and the assistive technology. For Samantha, Tyler and Amber, spelling errors dropped immediately and remained either at or below 1% of produced text. PNDs for this measure were 100%, considered a strong effect; therefore, based on the data provided, it appears that the use of these higher-level writing strategies combined with the assistive technology supported a dramatic and consistent reduction in the rate of spelling errors. The following paragraphs detail the results, case by case.

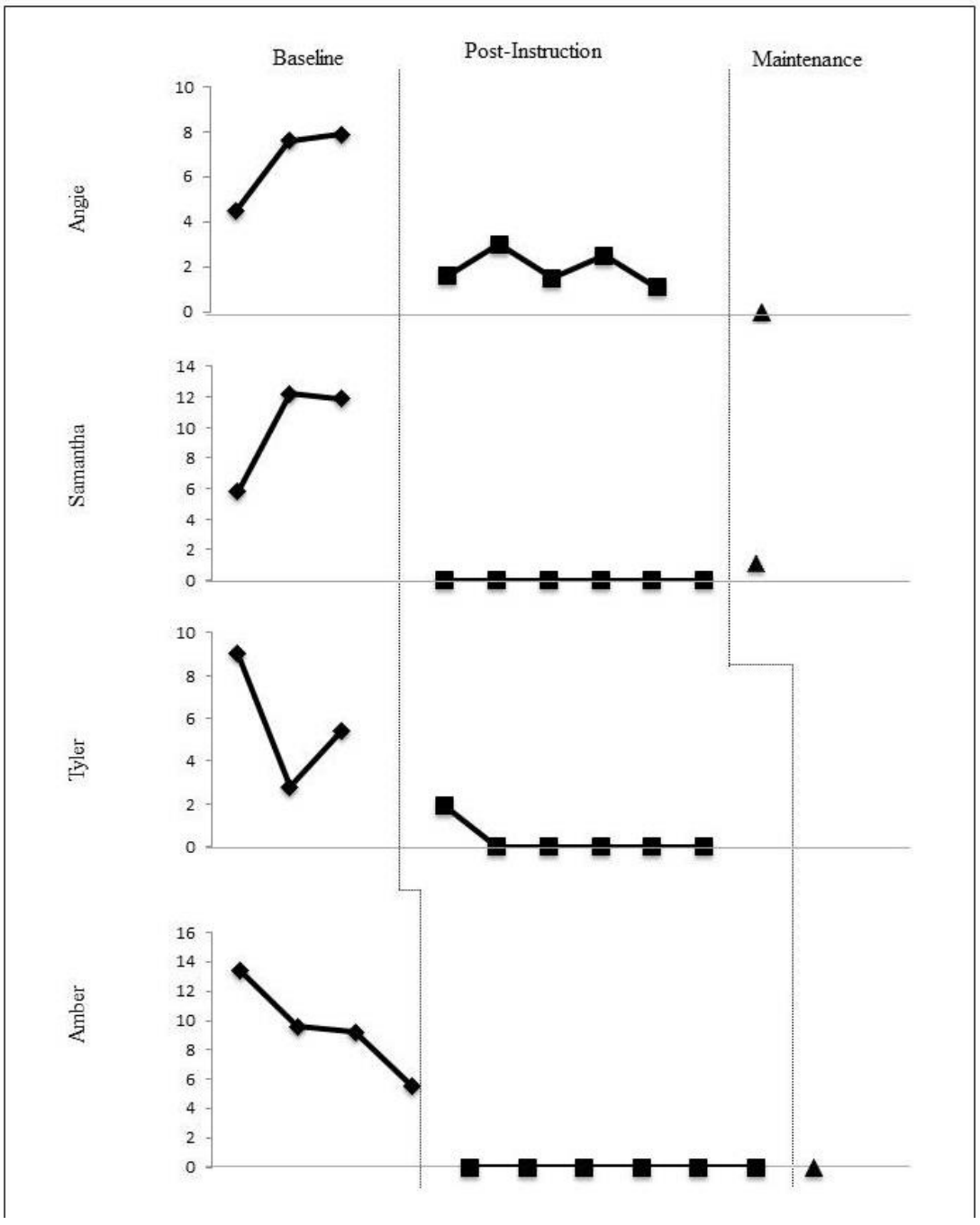

Figure 2. Graph of spelling error rates in baseline, post-instruction and maintenance phases.

Angie. *Figure **2*** demonstrates the immediacy of the effect for Angie's spelling error rate from baseline to post-instruction, where errors promptly dropped to 1.6% upon the introduction of SR technology and the combined writing strategies. There was some variability in the post-instruction scores, as they ranged between approximately 1% and 3%. For this participant, the overall trend for this measure showed increased spelling accuracy with the use of SR software and the accompanying writing strategies. The PNDs for this measure were 100%.

Samantha. In the post-instruction phase, spelling error rates dropped dramatically, ranging between less than 1% and zero errors per writing prompt. *Figure **2*** demonstrates the immediacy of the effect for Samantha's spelling error rate from baseline to post-instruction, as well as the dramatic and consistent trend in reduced or eradicated spelling errors. PNDs for this measure were 100%.

Tyler. *Figure **2*** demonstrates the immediacy of the effect from baseline to the post-instruction phase and a sustained trend of dramatically reduced errors. By the second post-instruction session, errors remained at less than 1%. PNDs for this measure were 100%.

Amber. Across the four baseline prompts, Amber's rate of spelling errors averaged 9.4%. It is also important to note that this participant's handwriting was often inconsistent or illegible, and often certain letters were indistinguishable from one another, such as the letters 'r' and 'v.' A second spelling-error rate was calculated to determine the error rate with the inclusion of these handwriting problems, and these inconsistencies brought Amber's baseline rate of spelling error to 19.1%. For the purposes of graphing, the lower error rate (9.4%) was used. In the post-instruction phase, Amber's spelling error rates dropped below 1%. *Figure **2*** demonstrates the immediacy of the effect from baseline to post-instruction. As in the results for this measure

across other participants, a trend of dramatically reduced errors continued across the post-instruction phase. PNDs for this measure were 100%.

Punctuation. In comparison to their baseline averages, participants demonstrated different response patterns to the intervention, as revealed by an examination of punctuation scores. For Tyler, punctuation scores showed strong effects from baseline to post-instruction. Angie demonstrated a small effect, and Samantha demonstrated no clear effects. Amber's scores were just at the cutoff between a small and a non-effect. *Figure **3*** demonstrates these mixed results. PNDs were 60%, considered a small effect. In summary, it appears that, to a small degree, the use of the SR software and the accompanying writing strategies helped three participants to make fewer punctuation errors proportional to their word counts as they composed and revised their writing, although the drop in error rates is less dramatic and consistent than the reduced error rates observed in the spelling measure.

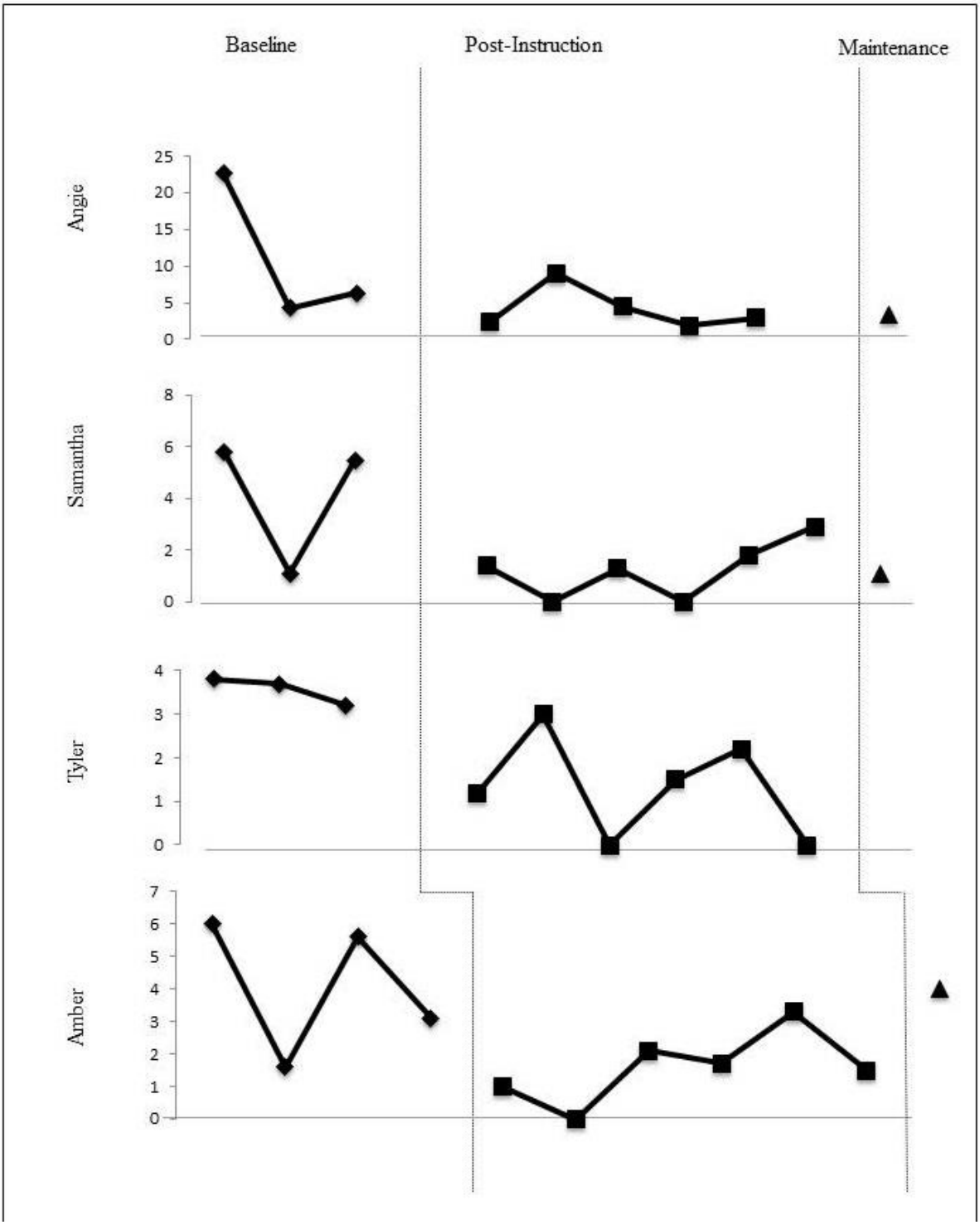

Figure 3. Graph of punctuation error rates in baseline, post-instruction and maintenance phases.

Angie. *Figure **3*** demonstrates the immediacy of the effect from baseline to post-instruction, with the error rate dropping upon the introduction of SR technology and the combined writing strategies; apart from two post-instruction scores that overlap with baseline, the graph shows a general trend in reduced errors from baseline to post-instruction but also a variability in those scores not seen in Angie's other writing measures. For this participant, PNDs for this measure were 60%, considered a small effect.

Samantha. *Figure **3*** demonstrates the immediacy of the effect from baseline to post-instruction phases when considering averages, but not individual data points. PNDs were 33.3% for this measure, a non-effect. Variability in Samantha's punctuation scores overlapped with one of her baseline data points.

Tyler. *Figure **3*** demonstrates the immediacy of the effect, where Tyler's error rate dropped to 1.2%. For this participant, a continued trend of reduced errors was apparent, with some fluctuation over post-instruction prompts. PNDs were 100%.

Amber. Amber's punctuation error rate saw an immediate reduction in the post-instruction phase, but variability across this phase as well, as shown in *Figure **3*** PNDs were 50%, at the cusp between a small effect and a non-effect.

Correct-incorrect word sequences. In comparison to their baseline averages, all participants evidenced a similar pattern for the CIWS measures: upon the introduction of the SR software and the use of the accompanying writing strategies, they wrote more correct word sequences and demonstrated lower rates of error as represented by incorrect word sequences.

Figure 4 displays the graphed results for this measure and demonstrates an immediate effect from baseline to post-instruction for all participants. In general, the trend was for dramatically increased correct-word-sequence scores upon the first post-instruction prompt, as

shown for Angie, Samantha and Amber. Tyler's gains were less dramatic, from a rate of 84% correct word sequences to 93% in the phase shift to post-instruction. Generally, the graphs display a trend of slightly increasing gains across the post-instruction phases, with consistently lower rates of error in comparison to baseline. Angie and Samantha's scores show dips in correct word sequences in the second post-instruction prompts, likely as a result of the decreased word counts discussed in earlier sections.

An additional graph is presented in *Figure **5***, which expresses the incorrect word sequences as an error rate, similar to the graphing for spelling and punctuation scores (incorrect word sequences/total word sequences X 100). This method was selected for the same reasons as the spelling error and punctuation error rates – so that participants who wrote more words would not be penalized disproportionately for any errors in text; therefore, the PND calculation for the IWS measure included the rate of error, not simply the total error sequences. These error-rate graphs clearly demonstrate the dramatic reduction in errors for all participants – across the dimensions of spelling, punctuation, capitalization, grammar and semantics. PNDs for CWS were 91.3%, and PNDs for IWS were 100%, considered strong effects. In summary, the introduction of the SR software and the accompanying writing strategies appears to have helped these participants write more words and fewer incorrect word sequences, supporting the accuracy of their prose along dimensions of spelling, punctuation, capitalization, grammar and semantics. The paragraphs below summarize the results, case by case.

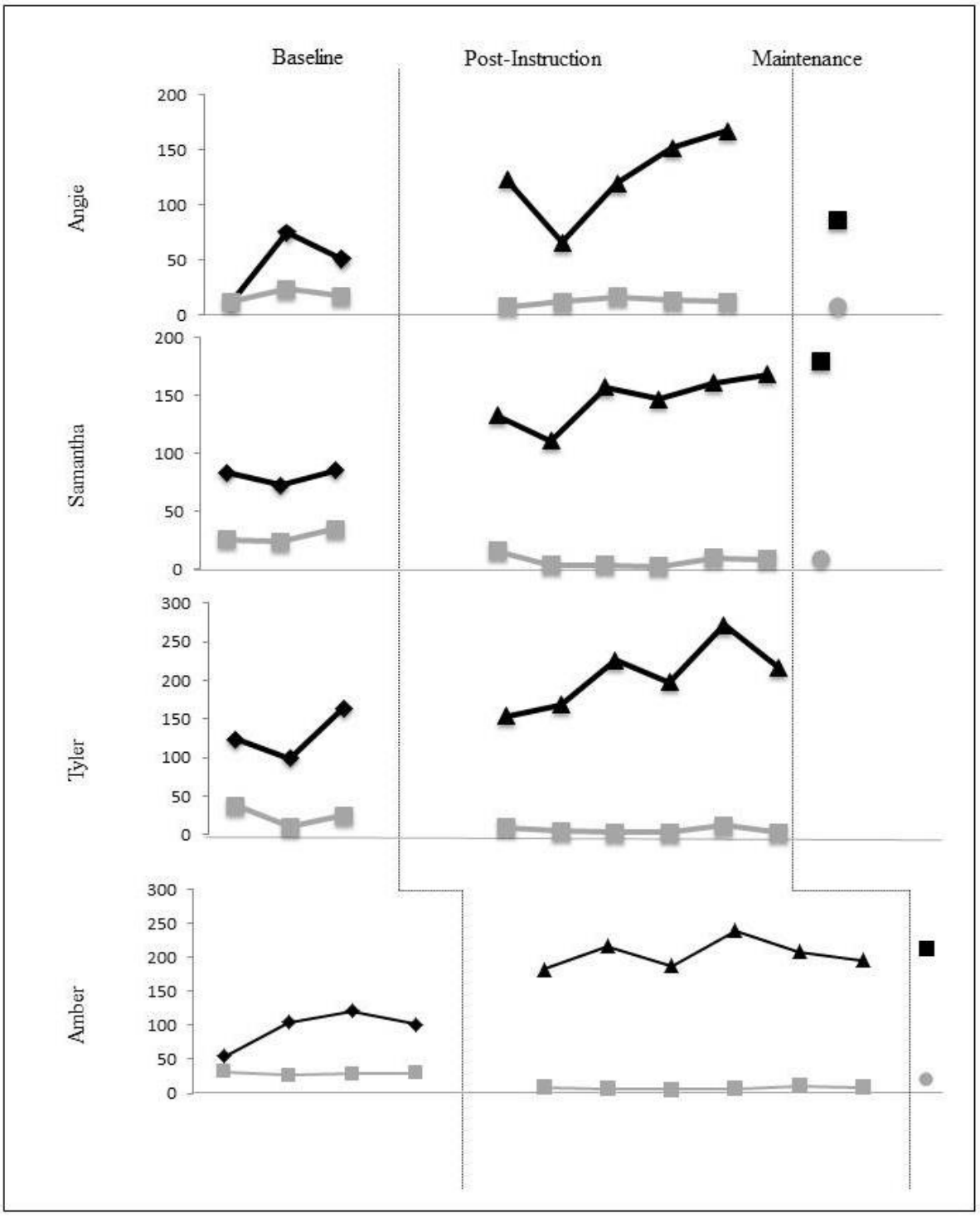

Figure 4. Graph of correct and incorrect word sequence scores. Correct word sequences shown in black, and incorrect word sequences show in grey.

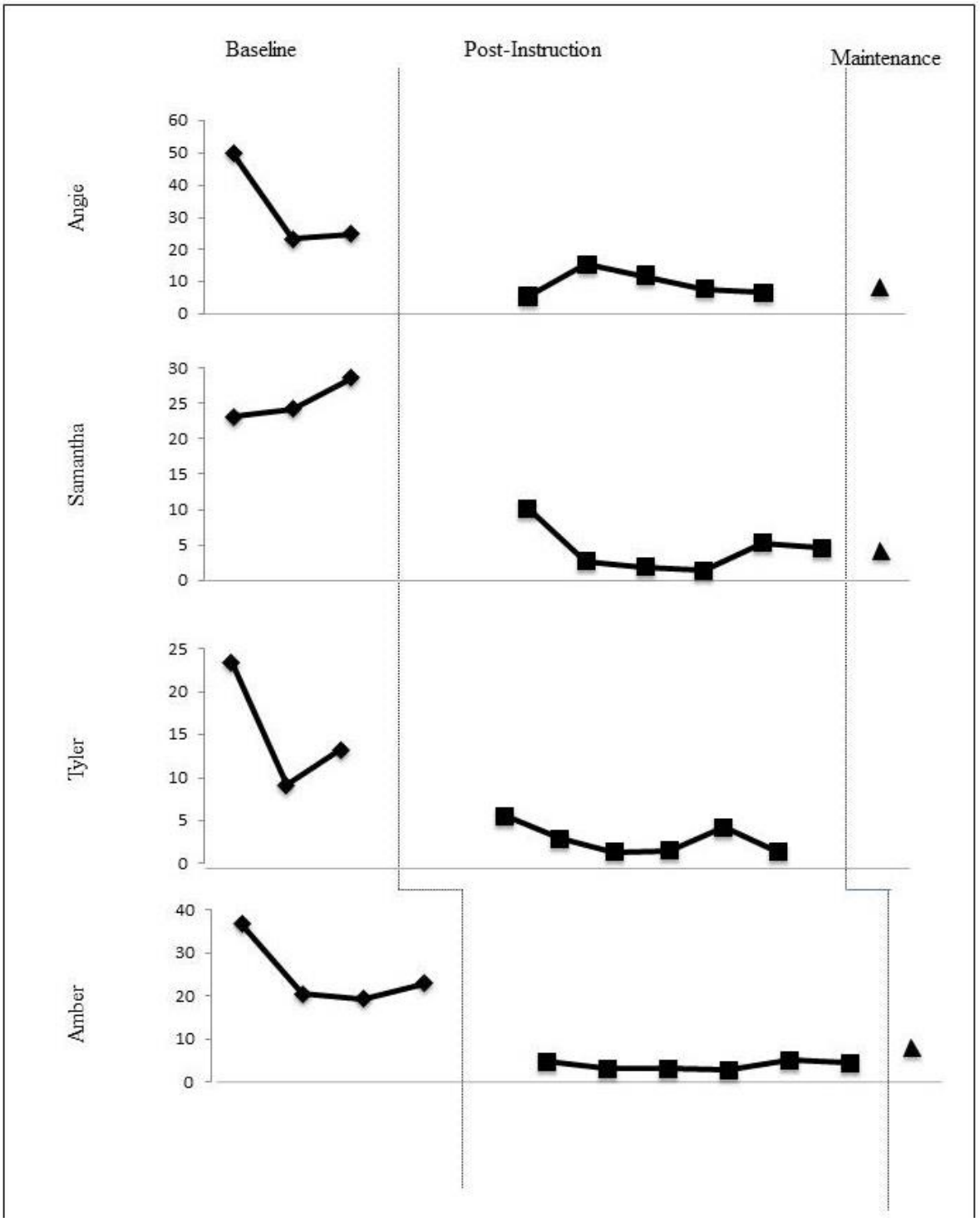

Figure 5. Graph of incorrect word sequence rates in baseline, post-instruction and maintenance phases.

Angie. *Figure **4*** displays the graphed results for correct and incorrect word sequences, and *Figure **5*** displays the graphed results for the error-sequence rate alone. Taken together, these scores demonstrate an increase in both writing fluency and accuracy across the combined dimensions of spelling, grammar, punctuation, capitalization and semantics, especially over time. The correct word sequences demonstrate a steady increase in scores, with an exception of the post-instruction second session (66), which dipped well below the post-instruction average (125.6). Again, this particular score may be linked to the loud construction activities outside the window that may have contributed to the lower word count for this writing probe. Otherwise, these scores demonstrate an immediate effect from pretest to post-instruction, increasing from 43 to 126 correct sequences, or nearly tripling. The rate of error dropped from between 50% and 23.4% in the baseline phase scores to below 15.3% in the post-instruction phase, demonstrating an immediate effect that remained consistent. PNDS were 80% for CWS (a moderate effect) and 100% for the incorrect-word sequence error rate (a strong effect).

Samantha. *Figure **4*** shows an immediate change in correct word sequences from pretest to post-instruction, and a general upward trend throughout the post-instruction phase. The possible effects of disruptive construction activities during the second post-instruction prompt may be seen in the slight dip in CWS scores from post-instruction session one to two. Incorrect word sequence error rates (*Figure **5***) also show an immediate change from baseline to post-instruction, with the decrease in error rates from baseline scores ranging between 23.1% and 28.5% and holding consistently below 10.1% for the remainder of the post-instruction phases. These scores speak to the increasing fluency and accuracy of the participant's composition, with a steady trend in more correct word sequences and a steady trend in lower error rates. PNDs for both correct and incorrect word sequences are 100%.

Tyler. *Figure **4*** demonstrates a delayed effect in correct word sequences with the first two post-instruction scores near or below the highest baseline score. *Figure **5*** demonstrates the immediacy of the effect from baseline to post-instruction for error sequence rates, which dropped from baseline scores ranging between 9.1% and 23.4% to post-instruction rates that remained at or below 5.5%. Tyler's trend was a general increase in words over time and a fairly consistent number of incorrect word sequences across the intervention. PNDs were 83.3% for correct word sequences and 100% for error rates as captured by incorrect word sequences. In sum, this measure demonstrates a moderate effect for greater fluency and a strong effect for greater accuracy in the participant's writing.

Amber. *Figure **4*** demonstrates the immediacy of the effect from baseline to post-instruction for both correct- and incorrect-word-sequence scores, where Amber wrote more correct and fewer incorrect word sequences upon the introduction of the SR software and accompanying writing strategies. Her trend was for an elevated CWS increase, with some small fluctuation throughout the post-instruction phase, where her highest correct word sequences occurred during the fourth writing prompt. She consistently generated few incorrect word sequences across the intervention and lower rates of error, with baseline scores ranging between 19.3% and 36.7% and post-instruction scores at or below 5% (shown in *Figure **5***). PNDs were 100% for both correct and incorrect word sequences. In sum, this CIWS measure demonstrates greater fluency and accuracy in the participant's writing. It is also important to note that, including this participant's handwriting problems, initial baseline scores were 79 correct and 52 incorrect word sequences, an even poorer ratio than that used for the purposes of graphing. In the case of timed, handwritten assignments such as exams, this participant could possibly see important changes in writing quality with the regular use of SR software.

Précis quality. Three participants demonstrated a general trend of increased quality scores along combined dimensions including: core information and facts included in the précis, succinctness, grammatical accuracy and vocabulary. *Figure **6*** displays the graphed results for all participants, and demonstrates varying effects for Angie (moderate), Samantha (small) and Amber (moderate), but not Tyler, the majority of whose post-instruction scores overlapped with baseline data points

It appears that participants' responses varied considerably to the academic intervention as measured by their précis-quality scores. Samantha demonstrated the smallest average précis-quality gains in the post-instruction phase, with averaged scores increasing 1.3 points compared to baseline. Angie and Amber, on the other hand, both appeared to benefit more dramatically, each with scores increasing 3.5 points on average between baseline and post-instruction phases. PNDs were 56.5%, considered a small effect, but excluding Tyler's data, Angie, Samantha and Amber demonstrated combined effects on the cusp of the moderate range (70.5% PNDs).

Angie. *Figure **6*** demonstrates an immediate increase in scores from baseline to the first post-instruction prompt. As with word count and correct word sequences, Angie's précis quality scores also demonstrate a second post-instruction score that does not follow the general trend for scores collected during this phase. This drop coincided with the earlier mentioned noise outside the window. The highest score (11.5) occurred in the fourth post-instruction session, but the final post-instruction score of 10 still represents considerable improvement from the pretest average – three points above the highest baseline score. PNDs for this measure were 80%.

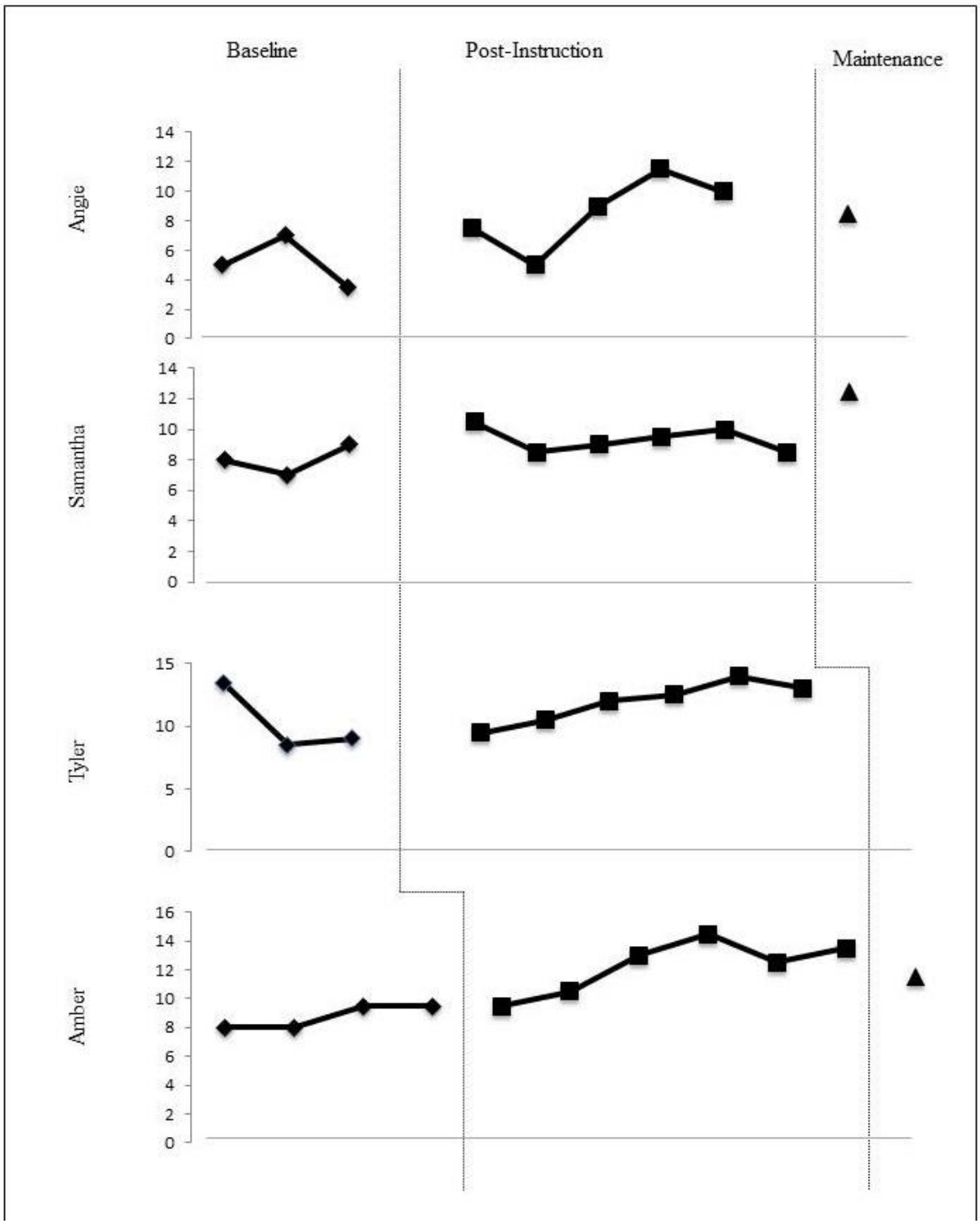

Figure 6. Graph of précis quality scores in baseline, post-instruction and maintenance phases.

Samantha. *Figure* ***6*** displays a general trend for this measure that was not as dramatic as word count, spelling, or CIWS. Over the course of the intervention, it appeared that Samantha increased quality scores through decreased rates of error in the areas of copy-errors and increased evidence of succinctness. She did not show a sharp trend in including more detailed information, which was weighted more heavily in the précis-quality scoring. These features of her writing could explain the gentler trend in these scores compared to the other fluency scores discussed above. PNDs were 50%, considered a small effect.

Tyler. There is no demonstration of immediate effect as shown in *Figure* ***6***, nor was there any effect at all (PNDs were 16.6%). One thing to consider: this measure most heavily weights the participant's inclusion of important information from the reading (12 out of a possible 18 points). Tyler noted that he did not have a difficult time writing enough words, or including enough details in his academic writing. In fact, he wanted to cut down his use of examples and details; therefore, this participant did not demonstrate difficulty including enough information, but rather organizing it to meet the demands of the assignment. He also aimed to write less, particularly in the earlier post-instruction sessions. Tyler also demonstrated the highest baseline average compared to the other three participants, with average pre-intervention scores of 10.3. This was only 1.6 points below his post instruction average of 11.9. It is possible that Tyler had less need for improvement along this dimension of his writing.

Amber. *Figure* ***6*** demonstrates the immediacy of the effect, with increased scores by the second post-instruction prompt, as well as a strong trend in increasing scores over the course of the intervention. With a gain in approximately 3.5 points for this measure between phases, it appears that the combined SR software and the accompanying strategies helped the participant to

express more details and information. As with the CIWS scores discussed above, this change in her writing could represent not only an important tool for term papers, but for the quality and quantity of materials expressed during timed exam scenarios. With PNDs at 83.3%, this measure demonstrates important changes in the participant's writing that could quite possibly support efficiency, accuracy, more information conveyed and, therefore, potentially higher grades in her academic writing.

Trends in Pre- and Post-Test Measures, Maintenance Probes

All four participants wrote the WIAT-II Essay at the beginning (Prompt A; handwritten) and conclusion of the study (Prompt B; with speech recognition software). Table **5** displays the results for each participant by sub-score. Norm-referenced comparisons are not available, as participants did not complete the sentence tasks of this subtest in the interest of time; however, several important observations about their writing performance before and following the intervention are apparent based on this data. First, three participants greatly improved their mechanics scores, as evidenced by five-point gains for Angie, Samantha and Amber. All four participants also showed reduced rates of error as measured by the proportion of incorrect word sequences in relation to their total word sequences. This suggests that, according to a combined measure of spelling, punctuation, capitalization, grammar and semantics, participants made fewer errors in their post-test essays following the intervention.

All four participants also increased their total essay scores at post-test, ranging in gains from one to 11 points. Two participants, Samantha and Amber, increased their scores greatly (by 11 and 5 points respectively). The other participants, Angie and Tyler, each remarked during the post-test task that midterm exams, commitments, and personal matters had left them feeling

fatigued. Tyler even confessed that he felt "distracted" and "off his game." This information should be taken into consideration in the evaluation of the post-tests for these two participants.

The WIAT-II Essay task is a persuasive writing exercise, and it is a different genre from the academic summaries that the participants completed during the regular writing probes. Based on these results, it appears that two participants (Samantha and Amber) evidenced more global quality gains (as measured by overall scores) and the successful transfer of their new writing routines for using AT. In the measurement of error rates alone, all four participants demonstrated reduced rates of error in their post-test writing. Therefore, to differing degrees, it appears that the intervention helped the participants attain a higher degree of writing quality in their persuasive writing.

Three participants, Angie, Samantha and Amber, completed maintenance probes following the conclusion of the post-instruction sessions after approximately six and eight weeks, respectively. **Table 4** displays the results for these maintenance probes along with baseline and post-instruction scores. Angie demonstrated lasting gains from baseline in reduced spelling and punctuation error rates, reduced rate of incorrect word sequences and précis quality. This participant wrote 88 words, overlapping with baseline performance for the word-count measure. Samantha demonstrated gains from baseline word count, reduced spelling error rate, reduced rate of incorrect word sequences, more correct word sequences generated, and précis quality. This participant's maintenance-probe punctuation error rate overlapped with a baseline score. Amber also demonstrated lasting gains at maintenance, with reduced rates of spelling error and incorrect word sequence rates that were comparable to her post-instruction scores. She also continued to write more words and more correct word sequences at maintenance. Précis quality scores showed continued improvements but punctuation error rates did not. In conclusion, these

three participants showed some lasting gains in their writing quality at maintenance, although visual inspection of the graphs indicates a general dip in performance compared to baseline levels for Angie but not Samantha or Amber.

Table 5 *Pre and Posttest Comparisons (WIAT II Essay Prompts A, B*)*

	Angie		**Samantha**		**Tyler**		**Amber**	
	A	B	A	B	A	B	A	B
Mechanics (8)	3	8	0	5	1	1	3	8
Organization (17)	8	7	11	15	11	11	14	12
Theme Development (3)	4	3	5	6	5	6	4	4
Vocabulary (3)	2	2	2	3	3	4	2	4
Total Essay	17	20	18	29	20	21	23	28
Words	116	45	189	223	306	311	109	126
CWS	104	42	164	219	269	305	97	126
IWS	17	4	36	18	52	28	13	4
Spelling error rate (%)	2.5	2.2	7.4	<1	7.8	1.2	2.7	0
Punctuation error rate (%)	6	2.2	4.2	1.3	1.6	1.6	7.3	<1

**A=Pretest (Prompt A); B=Post-test (Prompt B)*

Summary and Threats to Design

In summary, participants demonstrated several strong effects in response to the intervention. Specifically, PNDs indicated strong effects for spelling error rate (100%), correct word sequences (91.3%) and error rates as represented by incorrect word sequences (100%). Effects were moderate for word count (PNDs = 82.6%) and small for punctuation (PNDs = 60%) and précis quality (PNDs= 56.5%). One participant's (Tyler's) scores pushed the précis quality effects from the cusp of moderate to small. Taken together, these results suggest the intervention was strongly effective for reducing errors in participants' writing, particularly rates of spelling error and rates of incorrect word sequences along the dimensions of spelling, punctuation, capitalization, grammar and semantics. The intervention was also strongly effective at increasing participants' sequences of correct words generated.

Studies involving multiple-baseline, multiple-probe within-subject designs require a consideration of whether dependent variables covaried with the manipulation of the intervention (Horner et al., 2005). Visual inspection of the graphs reveals immediate effects for words, spelling error rate, correct word sequences and rates of error as captured by incorrect word sequences. Immediate effects were not as dramatically apparent for précis quality, and punctuation scores showed changes in the post-instruction phase shift, but more fluctuation and variability than other writing scores. No strong claims can be made as to the intervention's effectiveness for these two aspects of writing at this time.

It is possible to conclude that the dependent variables of spelling, correct word sequences, word count and rates of error as captured by incorrect word sequences changed as a result of this intervention combining metacognitive strategies for writing and assistive technology. Threats to the design such as measurement effects, the passage of time, and

uncontrolled variables may be ruled out with a few small exceptions. First, during Angie's and Samantha's second post-instruction prompt, loud construction activities occurred directly outside the window. These noises may have impacted word count and correct word sequence scores for these two participants, as addressed earlier. One other possibility is an instrumentation effect (such as a more difficult second prompt); however, as the dip in scores was not observed in a visual inspection of either Tyler's or Amber's data, it is likely the noise contributed to the scores and not any inconsistencies in instrumentation. Practice effects and the passage of time may also be ruled out, as a visual inspection of the graphs shows a pattern of change across phase shifts that occur after three (Angie, Samantha and Tyler) and four (Amber) baseline probes, also referred to by Horner et al. (2005) is a demonstration of the effect at different time points. These effects were also observed across four different participants.

Social Validity Check

The second research question addressed whether participants determined SR software was a valuable support for their academic writing, including support for mechanical difficulties such as spelling, grammar and punctuation. Upon the conclusion of their last session with the researcher, participants completed the Exit Interview, and audio recordings were transcribed verbatim. Participants' answers revealed some nuances. Specifically, while all four participants agreed that SR software helped reduce their rates of mechanical errors in text, only two people determined that this AT was a valuable tool for their ongoing academic writing. Tyler and Amber determined that the software would support their regular coursework, and each had acquired and trained their own software package by the conclusion of the study. In the Exit Interview, Amber reported that using SR software helped her to reduce her "anxiety" about spelling grammar and punctuation. She reported that this anxiety had led to her past routine of

frequently deleting and rewriting what she had written before reaching a first draft, a process that she described as lengthy and exhausting. "Being able to speak to the computer – I feel like it takes (away) a few steps that have taken energy for my ability to write more freely – putting into words what was in my head," she explained. Amber also noted that she found the PREP, TALK and CHECK strategies helpful tools for regulating her use of the SR technology: "all three of them (the strategies) are going to be very beneficial. I'll be using them as fundamental tools for the future." Tyler reported that SR technology, combined with the TALK strategy, helped him to focus his composing goals more clearly. He explained, "The whole point (of the strategy) is to allow you to have more flow when you're writing." According to this participant, Dragon helped him to express his ideas because he wasn't as worried about finding mechanical errors as he wrote. He also found SR technology was an important research tool for taking notes about his readings, particularly the Cornell note structure he developed with the researcher.

Conversely, Angie and Samantha chose not to continue using the software in their academic writing, although for different reasons. Angie expressed distaste for speaking her ideas aloud. She preferred to write silently with a pen or pencil, next typing out her drafts. Early in the study, she explained, she thought she was uncomfortable speaking in front of an "audience" (the researcher); however, after booking several quiet, private sessions to test out the technology at the campus disability services office, she determined that the act of speaking interfered with the expression of her ideas. Angie reported feeling more "centered" when seated on a couch and engaged in free writing activities that she had developed in her earlier schooling. Although this participant conceded that the SR technology helped reduce her mechanical errors, she found it extremely uncomfortable. "I can see how this (technology) *could* help me," she often reported,

but she could not tolerate the frustration and distraction caused by dictation errors (e.g., homonyms).

Like Angie, Samantha reported distractions specific to the technology. She found the occasional recognition errors frustrating. In the Exit Interview, she revealed that she would only purchase SR technology if word recognition were more accurate. This is an important consideration, as, even with the occasional recognition errors (e.g. “my career vehicles” instead of “micro air vehicles”), Samantha's error rates improved dramatically from baseline to post-instruction and continued to improve over the study and into the maintenance phase. This participant also emphasized the value of the writing strategies over the specific technology. As a result of incorporating PREP, TALK and CHECK activities into her academic writing processes, Samantha said she set more specific structural goals, had developed a more comfortable drafting process, and was more satisfied with her finished product. She determined the three writing strategies were more beneficial than the SR software, because the strategies in helped regulate her writing activities so that they unfolded in a regular, coordinated fashion. As a result, she determined that she was developing clearer and more detailed plans for writing assignments and seeing higher grades as a result. In summary, although all four participants concluded SR software help them to reduce mechanical errors, only two opted to use this technology regularly in their postsecondary coursework at the completion of the study.

Technology Profiles and Strategy Use

The third research question concerned how students used a collection of AT to support the writing process through planning, composition, and revision stages. Sources of data included: (1) the researcher’s observational notes completed during and following each session, (2) the completed Technology and Strategy Use Checklists, which tracked participants’ AT use, and (3)

the transcribed recordings of the Initial Interview and the Exit Interviews. The researcher compiled a technology and strategy profile for each participant, and also asked each participant to either corroborate or correct the information before the completion of the study. Technology and strategy profiles for each participant are displayed in Appendixes I, J, K and L, comparing their planning, composing, and revision activities through baseline post-instruction and following maintenance phases. Three participants (Samantha, Tyler and Amber) demonstrated evidence that they had adopted the use of new AT and strategies to support its use in their academic writing as a result of their activities in the study. Specifically, Tyler and Amber each reported obtaining Dragon and Kurzweil to support their academic writing. Samantha reported using concept maps and graphic organizers. One participant (Angie) did not adopt new AT and did not alter her writing strategy use as a result of her participation in the study.

Samantha, Tyler, and Amber each demonstrated some common themes. First, all three of these participants focused on the importance of planning their assignments, noting they had been unsure about how to carry out this process before the study. "Before [participating in the study] I wouldn't know where to start, really, and I'd dive into it [writing assignments]," Samantha explained. "I get stuck… I was less organized." Samantha emphasized the importance of planning, specifically the use of the blueprint to guide her research composing activities. Using Inspirations software, Samantha developed a routine for generating plans that divided her papers into clear blocks or sections. According to this participant, this strategy helped make her writing process more efficient, comfortable and effective. Tyler emphasized the value of the PREP strategy in helping limit his copious research activities (reading upwards of thirty journal articles for a first-year midterm paper) and helping change his disorganized writing routines. He used the SR software to generate structured notes about his readings, thus focusing his planning activities.

This participant also began to use SR software to plan his papers, which he found more efficient in his past system of taping sticky notes to the kitchen table. Amber also valued the PREP strategy and the use of concept mapping software as it helped her to reshape past disorganized planning activities. She would often type out specific questions in her writing assignments into her graphic organizer, and these prompts would help focus her research goals.

All three of these participants independently noted the importance of metacognitive strategies to regulate the use of assistive technology for writing. According to Samantha, the PREP, TALK and CHECK strategies helped her to stay focused on the purpose of her writing assignments. They also helped her to follow a regular routine: "I never knew where to start really. I had trouble with making a plan and sticking to it. So the PREP, TALK, and CHECK – the sheets that had you follow the same steps every single time – was useful." In particular, Samantha explained that the PREP strategy required her to consult her professors' assignment descriptions more carefully, and thus led to more goal-directed behavior during the writing process, often with the help of concept mapping aids. For Tyler, the talk strategy reminded him to emphasize getting his ideas onto the page, and to separate the composing and copy editing processes when he dictated his papers. Amber also valued the TALK strategy and its reminder to leave mechanical concerns for a later phase and to focus on dictating her ideas. All three of these participants concluded that using and personalizing these strategies led to more efficient writing routines.

It is also important to note that Samantha, Tyler and Amber each expressed the value of practice with a new technology. Tyler explained, "I realized partway through [the study] that doing this [the dictated writing exercises] over and over was really helpful… You're able to learn and improve." Tyler explained that working with the researcher helped him to refrain from

getting caught up minor formatting concerns and to focus on using Dragon to capture his ideas. Likewise, Amber valued regular feedback from the researcher, as well as a weekly review of her graphs. She enjoyed discussing the strategies and their possible impact on her writing error rates. In particular, Amber made a goal to reduce the number of times she deleted a sentence and rewrote it. Working with the researcher, she agreed to first verbalize what was wrong with the sentence and why it needed to be changed before deleting it. "That [strategy] really helps me not to second-guess… I noticed especially when I'm more tired, I try and manipulate sentences … I don't notice I'm struggling more. I'm spending a lot more time and I get stuck." Amber explained that it took her several sessions to practice this composition strategy, particularly using Dragon, before she became comfortable with it and felt confident enough to use it independently.

Discussion

Overview and Synthesis of Findings

The purpose of this study was to investigate the effectiveness of a theory-based academic intervention designed specifically to support planning, composing and revision activities in a population of postsecondary students with LD who were learning to use SR software for their academic writing. The technology was an important component of the intervention, conceptualized as a support for lower-level dysfluencies, as suggested in the literature on assistive technologies for students with LD (e.g., De La Paz, 1999; MacArthur, 2009; MacArthur & Cavalier, 2004). Metacognitive routines for core planning, composing and revising processes were also emphasized within the well-validated SRSD intervention model that emphasized direct instruction in the processes and products of writing (e.g. Graham & Perin, 2007; Mason & Graham, 2008), as were strategies for incorporating the technology into the writing process with efficiency. Results indicate that this SRSD intervention was effective, as indicated by the selected writing measures (question 1) and by the participants (questions 2 and 3). Dictation software was a medium or tool for the writing process, but, most importantly, students used the PREP, TALK and CHECK strategies with increasing independence until they had personalized the approach and addressed many of their concerns about overemphasizing mechanical problems in their writing at the expense of their higher-level writing quality. This process of guided support that gradually faded until students performed the tasks independently is consistent with the six phases of SRSD instruction outlined by Mason, Harris, and Graham (2011); therefore, the present study provides a novel approach to writing support for this population, where the focus is so often on accommodation (e.g., technology alone) and not targeted intervention (e.g., Gregg, 2007; Li & Hammel, 2003).

The following discussion reviews the findings for each of the three research questions in more detail, before addressing limitations, suggestions for future research, and final conclusions.

Efficacy of the PREP, TALK and CHECK Intervention as Measured by Writing Quality Indices

The first research question concerned whether the intervention improved participants' writing along the dimensions of spelling, punctuation, word count, correct- and incorrect-word sequences and précis quality. In this multiple-probe, multiple-baseline, within-subjects design, improvements were observed for all measures, with strong effects for spelling, correct word sequences generated, and proportion of incorrect word sequences. Moderate effects were observed for word count, and small effects were observed for punctuation and précis quality. In particular, the gains in spelling, correct word sequences and proportion of incorrect word sequences, as shown in the graphs (Figures 1, 2, 3, 4, 5, and 6), represent important quality gains for the participants as they completed academic tasks to meet the demands for clear, concise, error-free writing that demonstrated their learning about specific topics and information. These findings of strong effects for these three measures, along with the moderate effects observed for word count, are consistent with suggestions in the literature that SR software can help students with writing difficulties to circumvent lower-level dysfluencies such as those caused by encoding difficulties (e.g., Higgins & Raskind, 1995; MacArthur, 2009) and to express their ideas more fluently. No strong claims can be made as to the intervention's effectiveness for précis quality, as immediate effects were not apparent for the latter measure. The précis quality measure is heavily weighted towards the accurate representation and interpretation of facts and details contained in the assigned reading prompt. This task represents an ecologically valid measure of a common task required by students in higher education: to read material, synthesize it, and then represent

ideas in writing (Hatcher et al., 2002). The intervention combined support for planning, composing and revising processes, in addition to the integration of new technologies like SR software, all of which are relevant to précis quality; however, it is possible that the intervention did not target reading comprehension and knowledge representation processes sufficiently to effect changes in participants' précis quality scores. Future writing intervention research should incorporate reading comprehension support, particularly considering the complementary and interconnected skills and processes involved with both reading and writing (e.g., Fitzgerald & Shanahan, 2000; Harris et al., 2009). There is also evidence that writing support can improve students' comprehension of material that they read, including strategies that involve (1) writing about reading and (2) writing instruction, (Graham & Hebert, 2011). Future studies of this PREP, TALK and CHECK intervention could incorporate support for reading comprehension and writing strategies for demonstrating learning, and it is possible that the observed précis quality effects may be stronger with an intervention component that more directly targets this area. Mason (2013) and colleagues have initiated a number of SRSD studies involving "quick writes" or writing tasks that require students to summarize readings in different disciplines, and these types of materials could provide a starting point for SRSD interventions that blend reading and writing support strategies for a postsecondary population.

As in the case of the précis quality measure, no strong claims can be made about the intervention's effectiveness for punctuation, as the effects were small, and because a great deal of fluctuation and variability were present in the post-instruction phase shift; however, it is important to consider why these small effects were present at all. As discussed in the literature review chapter, it has been posited that SR software assists struggling writers by enabling them to draw on strengths in oral expression and circumvent difficulties such as transcription and

spelling (e.g., MacArthur, 2009). In this case, the technology is responsible for the encoding process while the writer focuses on expressing ideas orally. Punctuation usage requires a different level of engagement from the writer, however, as SR software does not insert punctuation unless instructed. In other words, struggling writers must still know where to insert punctuation and they must verbalize it. Considering this difference between support for spelling versus punctuation with the use of this AT, Berninger and Amtmann's (2003) *Functional Writing System* framework may help to conceptualize the small gains in punctuation accuracy observed in the present study. When postsecondary students with LD used SR software, it is possible that a reduced emphasis on already-poor transcription processes (e.g. spelling) enabled the allocation of more working memory resources to detect or avoid punctuation errors that were observed in their earlier handwritten work. It is also worth noting that most of the participants in this study reported using longer, more complex sentences and "experimenting" with sentence structure once they became comfortable with SR, as one participant described. This anecdote is merely self-report information, and the current study did not employ measures of sentence complexity; however, future research could include measures of sentence complexity or punctuation complexity in order to determine whether any such changes are present in the writing of students with LD and WD who transition to SR software. Future research should also consider more sensitive measures of vocabulary sophistication, as one assertion in the literature is that students with LD may limit their written vocabularies to words that they are certain they can spell (e.g., Harrison, 2009; Wengelin, 2007).

These findings of the intervention's effectiveness also add to the very small body of studies supporting the delivery of writing support tutorials and SR in a postsecondary population of students with LD (e.g. Higgins & Zvi, 1995), and a recent call from researchers for more

evidence into the effectiveness of AT for supporting writing difficulties, such as SR software (Holmes & Silvestri, 2012). Furthermore, results indicate that the intervention supported the quality of adult writing, and the current study adds to the small body of literature investigating the effectiveness of the SRSD model with adult writers (e.g. Berry & Mason, 2010; MacArthur & Lembo, 2009). There are, however, some important differences between these three studies. MacArthur and Lembo (2009) and Berry and Mason (2010) investigated the efficacy of the SRSD with struggling adult writers preparing for the GED. In the latter study, some students were identified as having received special education services before dropping out of school between grades 8 and 12, and participants scored one standard deviation below the mean on a standardized measure of written expression. In contrast, the present study was designed specifically and exclusively for adult postsecondary students with LD and writing difficulties. Furthermore, the latter two studies investigated different writing variables such as essay parts, transition words and descriptive words (Berry & Mason, 2010), or holistic quality and structural elements (MacArthur & Lembo, 2009), whereas the present study investigated the nature of the participants' response to the intervention across dimensions of lower-level transcription and higher-level translation qualities, consistent with guiding theory in literacy-based learning disabilities (Berninger & Amtmann, 2003). Lastly, all three studies of adult learners investigated the efficacy of an SRSD intervention for increasing the length of student writing. Berry and Mason (2010) found moderate effects for length during post-instruction (e.g., PNDs=77), as did the present study. Conversely, MacArthur and Lembo (2009) found no stable increase in length. More research is needed to investigate the efficacy of the SRSD approach for increasing adult writing length; however, researchers should compare the types of strategies and mnemonics employed, as all three studies varied in the strategies presented.

In summary, the present study adds to the literature by providing additional evidence that the SRSD approach may support literacy activities in adult writers. Most importantly, this study provides a focus on the specific population of adults with documented learning disabilities, particularly evidence that the instructional approach can support a more balanced focus on mechanical concerns and metacognitive routines for writing, both identified as areas of difficulty in the profiles of students with LD (e.g., Harrison, 2009). Given the immediacy of the effect, the sustained trend of improved scores, and the maintenance gains, particularly for the three measures where strongest effects were observed (spelling, correct word sequences generated and proportion of incorrect word sequences), it appears that the intervention, combined with the use of the assistive technology, was a powerful tool for improving participants' writing. Pre- and post-test scores on the WIAT-II Essay task also support this conclusion, as participants showed comparable trends of reduced error rates following the intervention delivery, along with substantially higher scores for Mechanics subsections. Two participants, Samantha and Amber, demonstrated more global quality gains, as well. All participants evidenced the transfer of some writing quality gains from a regular précis-writing task to a timed persuasive essay task, suggesting that the technology and intervention tools could help support their writing across a variety of academic tasks.

Participant Evaluations of Speech Recognition Utility

The second research question addressed whether participants found that SR software was a valuable support for their academic writing, including support for mechanical difficulties such as spelling, grammar and punctuation. During the Exit Interview and Social Validity Check, all four participants determined that SR software was useful in helping them to produce more error-free writing, but only two of them concluded it would be a helpful tool for their ongoing

postsecondary coursework. All participants emphasized the utility of the strategies they learned through the SRSD method (PREP, TALK and CHECK) for organizing their writing routines, regardless of whether they adopted the technology. To varying degrees, all four participants noted that they planned to use these strategies in their ongoing coursework activities. Two participants, Tyler and Amber, found that using SR software to research, plan, write and even revise their papers helped them to improve the accuracy of their writing (e.g., spelling) and reduce anxiety and perceived distractions during their writing activities. As Tyler explained, the strategies and the technology helped him to have more "flow" while writing. As Amber explained, the strategies and the technology helped her to emphasize the expression of her ideas and to create a new writing routine that didn't merely focus on spelling-error detection. In other words, SR software enabled them to direct their resources away from an overemphasis on transcription errors and to focus on the translation of their ideas (Berninger & Amtmann, 2003). Both Tyler and Amber noted that their new routines were more efficient and rewarding than their previous writing activities. Both of these participants had already acquired their own copies of the software prior to the completion of the study (in order to mitigate cost and hassle, participants temporarily used a demonstration copy paid for and provided by the researcher during the course of the study).

Conversely, upon conclusion of the study, the other two participants, Angie and Samantha, reported feeling distracted and frustrated by technical difficulties such as recognition errors and incorrect homonyms. They each reached these conclusions in spite of compelling evidence that SR software and the accompanying strategies helped them to reduce mechanical inaccuracies in their writing, which they noted as areas of great academic concern. Mull and Sitlington (2003) reviewed reasons for high rates of AT abandonment among postsecondary

students with disabilities (rates estimated at nearly one third). When students determine that the technology creates more work than it supports, they are likely to stop using it, particularly if they perceive that technology requiring onerous or complicated commands, or if they perceive inconsistencies and unpredictable outcomes from their use of the technology, as both Angie and Samantha described, to some degree. Consider Angie's concern that her ideas didn't "flow" onto the page in the same way when she spoke into a headset, compared to her familiar, comfortable routine of writing with a pen and paper. It appears that she had already found preferred conditions for expressing ideas, and learning a new transcription mode was cumbersome in that routine. Samantha noted that she found it too distracting to review her writing for recognition errors (e.g., "my career vehicles" in place of "micro air vehicles"). It is likely that, for these two students in particular, learning a new technology may have added to the cognitive burdens of the writing process, which require the writer to reconcile sometimes competing demands, processes and skills (McCutchen, 2000; Torrance & Galbraith, 2005). Future research should include measures of technology proficiency and AT satisfaction to further investigate participant decisions to adopt or abandon a studied AT. Future research in this area could also explore the phenomenon of strategy utilization deficiencies (e.g., Bjorklund, Miller, Coyle, & Slawinski, 1997; Gaultney, Kipp, & Kirk, 2005), wherein individuals employ strategies for a cognitive task, but do not see expected performance benefits.

It is also worth noting that Angie and Samantha each raised the concern of cost. With limited budgets, these postsecondary students may not have wished to incur additional expenses in their pursuit of their university degrees (Standing Senate Committee, 2011), even if they found the technology to be helpful in reducing mechanical errors. This concern speaks to the need for

accessible information about technology grants and funding available to address the specific academic barriers experienced by postsecondary students with disabilities.

Participant Technology and Strategy Use Profiles

The third research question addressed how students used a collection of AT to support the writing process through planning, composition, and revision stages. Sources of data included: (1) the researcher's observational notes completed during and following each session, (2) the completed Technology and Strategy Use checklists, which tracked participants' AT use, as well as (3) the transcribed recordings of the Initial Interview and the Exit Interviews. As noted above, only two of four participants incorporated SR software into their writing routines outside of the study; however, three participants began to reshape their writing routines to use a collection of AT options strategically at different stages of the writing process. Technology Profiles outline these routines for each participant in Appendixes I, J, K and L. For instance, Samantha adopted concept-mapping software along with the PREP strategy to help identify the argument schemas required for her term papers (e.g. genres that included close readings, research papers, and critical reflections). Additionally, she used the concept mapping software to help identify and organize her ideas as she began to gather her research. Samantha also began to use text-to-speech options more strategically. At the beginning of the study, she reported using text-to-speech to review and edit her sentences while she was writing them. At the conclusion of the study, she employed the materials developed with the use of the CHECK strategy to delineate revision and editing from the drafting process. She determined that this approach helped her to focus on her professor's suggestions that she emphasize ideas and logic in her revision activities, not simply the detection of spelling and grammatical errors. Also, as the Technology and Strategy Use profiles demonstrate, three participants (Samantha, Tyler and Amber) reorganized their planning,

composing, and revising stages to follow predictable routines. These same three participants iterated that opportunities for practice and tutor feedback were pivotal in their developing comfort and confidence with the technologies and writing strategies. They spoke about the value of regular writing practice, where they could ask questions about error patterns in grammar, or build experience planning out arguments. These comments are consistent with writing researchers' suggestions that postsecondary students should be afforded opportunities to build writing fluency in academic help environments (e.g. Gregg, 2007; Gregg et al., 2007).

Three students (Samantha, Tyler and Amber) also spoke about the importance of using the new technology in a supportive environment, particularly while they were just learning to use the technology. These comments are consistent with suggestions from Higgins and Zvi (1995) who suggested that postsecondary students with writing difficulties will benefit from supportive interactions with writing tutors and regular discussions about the writing process, but also regular direct instruction and practice with a new technology. These results are also consistent with suggestions by Parker and Banerjee (2007) that this same population of students should be given opportunities to build fluency with new technologies.

Limitations

Due to the immediacy of the effects as well as the demonstration of anticipated effects across four participants and at two different time points (e.g., baseline data collection that spanned either three or four sessions), practice effects and the passage of time do not appear to account for the substantial improvements in quality scores observed across participants between baseline and post-instruction phases, particularly the three measures where strong effects were observed (spelling, correct word sequences generated and rate of incorrect word sequences). One exception may be Tyler' scores on the précis quality measure. This participant did not experience

a meaningful word count increase (e.g., anything greater than 10 words) until the third post-instruction prompt (see ***Figure 1***); however, Tyler was concerned from the beginning of the study that he wrote too much in his writing assignments, and that excessive volume was hindering his writing quality. In the initial interviews, he revealed that he hoped to write fewer words, and instead focus his time on constructing succinct, high-quality arguments. In the past, Tyler's writing challenges had centered on his tendency to write everything he could think of, and failing, as he described, to "trust" himself. A good deal of his work with the researcher centered on selecting and highlighting only his best points in his regular précis writing, particularly in the early intervention sessions; therefore, although practice effects cannot be ruled out for this participant on this particular measure, it is quite likely that the small (e.g., PNDs = 67) delayed effect for word count at least partially represented his goal to truncate his drafts.

Likewise, instrumentation effects cannot be ruled out completely for the second post-instruction prompt, where word count and the number of correct word sequences decreased for both Angie and Samantha. These scores represented an unusual variability in graphs that show otherwise increased improvement across these measures for both participants (see *Figure 1* and *Figure 4*); however, it seems more likely that an uncontrolled variable accounted for these unusual scores rather than a précis-task that, by its design, caused participants to produce shorter summaries. As stated earlier, both participants complained about noisy and distracting construction activities that occurred during the session, and this interference likely played a role in the scores. These distractions may have been particularly problematic for these participants as they were still relatively new to SR software at this point the study. Furthermore, these anomalous effects were not observed in either Tyler's or Amber's second post-instruction prompt.

Implications for Future Research

This study compared handwritten work (during the baseline phase) to writing produced using a word processor with spelling and grammar check as well as SR software (during post-instruction and maintenance phases). Although this study included the investigation of an intervention's effectiveness (PREP, TALK & CHECK), it is important to compare different transcription methods such as (1) handwriting, (2) typing with a word processor with and without spelling and grammar checkers, and (3) SR with and without spelling and grammar checkers, as little research exists in this area. Results could inform much needed future research in accommodation and intervention, and Holmes and Silvestri (2012) have proposed that currently there are too many assumptions about AT effectiveness, particularly in the area of postsecondary writing. MacArthur and Cavalier (2004) found that high school students with LD produced higher-quality essays when they dictated to a computer or a human scribe, contrary to their non-LD peers, when both groups' writing was compared to a handwritten condition. Jalbert (2014) found no quality difference between handwritten essays and typed essays when high school students with LD did not use a spelling and grammar checker. Berger and Lewandowski (2013) found that postsecondary students with LD and their non-LD peers produced higher quality, longer essays when using a word processor in comparison to a handwritten condition. These latter researchers concluded that word processors were a non-specific accommodation that could benefit all students. All of these results, and future comparisons of writing quality across transcription modes, could have implications for technology recommendations, accommodations and intervention design for postsecondary students with LD.

As noted previously, future research should also investigate the efficacy of SR software in supporting the quality of students' writing under timed conditions or the use of SR software as

a testing accommodation. Each of the participants in this study independently noted that SR software could be a powerful tool for the completion of their exams. Some even reported pursuing this option through the testing center at the campus disability office as a result of their activities in the study. While it was beyond the scope of the present study to investigate the efficacy of this intervention in timed testing scenarios, many of the results concerning the writing measures indicate the importance of pursuing this question with further research. In particular, it has been suggested that writing fluency among postsecondary students impacts the higher-level essay performance and quality scores in timed writing scenarios (Connelly et al., 2004), and that a transcription variable like handwriting fluency can constrain knowledge representation in a timed exam. Furthermore, in students with LD, transcription fluency was related to quality on a timed exam (Connelly et al., 2006). In the present study, not only did three participants begin to explore the use of SR for their exams with their campus disability office, but all participants demonstrated important quality gains on pre- and post-test scores on a timed writing assignment, as discussed above (WIAT-II Essay). Also, the decrease in incorrect word sequences (e.g., errors along dimensions of spelling, punctuation, capitalization, grammar and semantics), and the increase in correct words generated observed in the regular précis-writing tasks this study suggest that these postsecondary students who participated in the study may in fact also benefit from the use of SR to write both term papers and timed exams.

Other recommendations for future research concern the design of intervention materials. In the present study the intervention included metacognitive routines, think sheets, and personalized materials to support planning, composing, and revising processes. It may be valuable to include strategic support materials for reading comprehension, and even the use of assistive technology for reading and notetaking, as several participants asked the researcher for

help in this area. For example, as a result of his activities in the study, Tyler worked with the researcher to develop a Cornell notes template, dictating his notes about his readings while preparing to plan his papers. Also, although the participants' campus provides several services in library research help (e.g., workshops, drop-in appointments with library staff, online chats with librarians, and both print and web-based resources), three of the four participants asked for help navigating library resources and identifying practices for conducting academic searches. Citation management and file management were particularly challenging for these students, and future studies in writing support may wish to take this information under consideration. The participants' questions about research also help underscore the importance of promoting accessible library materials and services for students with learning disabilities.

Future case study design testing the efficacy of this intervention or ones like it for postsecondary students with LD may benefit from adding additional information or working with a different population. First, GPA information could be collected in an initial interview, and researchers could compare this data to any available university GPA or campus disability service office GPA information. This information could supplement the small body of knowledge about how postsecondary students with disabilities are performing in comparison to their peers without disabilities. Second, researchers have suggested that high school students with LD should begin preparing for the transition to postsecondary environments well before the completion of their high school diplomas (Connor, 2012; Mull & Sitlington, 2003; Sitlington, 2003). Additional case study research could include high school students preparing to attend universities or colleges, particularly as they become more proficient with technologies that may facilitate their postsecondary performance. Future case study research should look to identify possible group

designs for testing the efficacy of this intervention, perhaps across a number of disability service offices at different campuses.

Lastly, this study investigated changes in writing quality along dimensions of spelling, punctuation, words generated, correct word sequences generated, rate of incorrect word sequences generated, and précis quality. This investigation was an important first step in learning more about the features of students' writing when using SR software, particularly in individuals with LD; however, a more fine-grained error analysis across both drafts and revised copies of participants' writing could reveal important nuances about this transcription mode. MacArthur (2009) suggested the need for specific support and revising documents created with this technology, as students may require help identifying new error categories such as recognition errors. Future research might compare the type and rate of changes that participants must implement in order to correct and polish their writing when using SR software, and could also investigate and rate the nature of these quality improvements between draft versions and finalized copy. These results could inform the design of programming to support this specific population of postsecondary students as they learn to work with the new technology.

Conclusions

Case study research following the multiple-probe, multiple-baseline within-subjects design provided a window into the process of participant change within a specific setting, at a specific point in time, and in individual participants (Freeman & Sugai, 2013; Kratochwill et al., 2010). The results from the present study provide insight into the efficacy of an intervention that combined metacognitive writing strategies with the use of a new AT (particularly SR software) in a population of postsecondary students with LD and writing difficulties attending one middle-sized university in Western Canada. Results are not generalizable to individuals outside of this

study; however, these preliminary results do appear to support suggestions that SR software can help alleviate mechanical dysfluencies in the writing of adults with LD (e.g., Connelly et al., 2004; Higgins & Zvi, 1995; Li & Hammel, 2003). Furthermore, results support assertions that this same population of students can benefit from regular supportive writing practice with a writing tutor or learning strategist (e.g., Gregg, 2007; Gregg et al., 2008) and opportunities to build fluency with new assistive technologies for writing (e.g., Higgins & Zvi, 1995; Parker & Banerjee, 2007). For these four postsecondary students with LD and writing difficulties, the intervention improved their writing along several important dimensions of quality. Interestingly, while all four students determined that these quality improvements were present and observable in their writing, only two opted to use this technology for their ongoing coursework. Three of the four participants stressed that the writing strategies and the regular practice with a tutor were just as important to, and not separate from, their use of SR software; therefore, this study's results are encouraging about the value of designing specific intervention programming for this at-risk population of students, and the value of supporting the use of assistive technologies for writing in the same students. Writing is an important enabler in postsecondary success, timely graduation, participation in the workforce and meaningful, equitable employment for students with disabilities (e.g. Graham, 2006; Gregg, 2007; Harris et al., 2009; Harrison, 2009; Li & Hammel, 2003; Martinez-Marrero & Estrada-Hernandez, 2008). The results can potentially inform both research and educational practices for those dedicated to supporting this population of students, namely professionals employed in psychological services and academic help centers.

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Appendixes

Appendix A PREP Fidelity Checklist

Emphasize the value and importance of an argument schema

- Be sure to emphasize the difference between the *topic* or the content (info, ideas, issues) and the *type of paper* (genre conventions and expectations).
- If necessary, produce examples of blueprints from other disciplines. Compare and contrast the content versus the textual and structural characteristics. Discuss the difference between *what* you write about and *how* you write about it.
- Identify and use the important terminology for textual and structural characteristics in the student's assigned genre (e.g. purpose statement, topic sentence, rebuttal, discussion section, footnotes).
- If necessary, have the student analyze an example of writing in their assigned genre. Help them to identify, circle and highlight the textual characteristics and structural components. Discuss whether those same components must appear in the student's writing assignment.
- Communicate the value of mapping genre expectations before the writing process begins. It means you have a clear idea of how you are expected to present your information. It also means it helps guide the research phase and it is the first step in generating the student's outline or pre-composition plan.
- Communicate the importance of researching with a purpose (e.g. knowing they need five sources and knowing how the instructor expects them to fit them together in a compare and contrast essay).
- If necessary, identify the course/program/disciplinary specialists who can help the student get clear on the blueprint expectations for this assignment (e.g. course TA, professor, department writing help, etc.)

Create an argument schema

- Using Inspirations, a white-board or a piece of paper (use the student's preference), refer to the student's assignment description to collaborate on a blueprint for their assignment.
- Have the student identify the textual and structural characteristics of their assignment independent of the content of their writing assignment.
- Encourage the student to identify the components that require follow up (e.g. do they know how to construct a counter argument? If not, what needs to happen next? E.g. visit professor, read textbook, read more examples from their discipline. Have the student schedule these activities in the workbook.)
- Discuss how the blueprint guides the planning phase, once research is completed. Use the blueprint or skeleton to help the student construct a detailed outline or plan using their own research and arguments.

Make a research plan

- Now that the student has begun to prepare a blueprint, have the student outline a research plan.
- Have the student answer these questions (in the workbook):
    - How many sources will I consult?
    - What kind of sources will I consult?
    - How will I know when I have enough research?
    - How will I keep track of my research?
- Schedule the research activities.
- Emphasize importance of tracking citations immediately in the note-taking phase.
- Review the following pages in the instructor's workbook for examples of research journal templates and pre-formatted concept maps.

Set specific goals for the next session

- Identify the materials activities the student should complete in order to compose by dictation the next time you meet. Write the materials into a checklist. Schedule these activities and if necessary, help the student to set sub-goals.

Appendix B TALK Fidelity Checklist

Dictation Goals

- Discuss the value of drawing on oral language skills to write.
- Emphasize the goal of getting ideas from the plan into fully formed sentences and statements.
- Discuss any past "error hunting" editing behaviours (e.g. mid-sentence pauses to fix spelling, attention to the "red lines" in spell check at the expense of coherence); also discuss why these activities are: (a) not necessary in dictation and (b) distracting.
- Review the worksheet and challenges (TALK: Prioritizing Your Writing Goals) and discuss the students' answers. Ask the student to reflect on how they will set composition goals.
- If necessary, adapt the scales (p. 23) to identify how the student will attempt to balance higher- and lower-level concerns and activities while they compose.
- Point to the PREP-TALK-CHECK writing wheel and review where composition fits in the process of planning, writing and revising an assignment (emphasize that editing will occur later, but during composition, heavy editing may be inefficient and ineffective in supporting text quality).

Use of Plans and Materials

- Discuss how the student will use/is using the argument schema and research notes to guide the composition process.
- Ask the student to refine or troubleshoot the process of using plans and dictating sentences.
- Encourage the student to mark their place on the argument schema at all times (e.g. place a pin in the purpose statement when the student is dictating that portion of the document). Review how following the argument schema (knowing what and why you are writing something) supports a quality assignment.

Dictation Style and Strategies

- Discuss the student's in-the-moment decisions about errors specific to dictation (e.g. homonyms or special vocabulary not recognized).
- Discuss any of the student's issues or concerns with the software, hotkeys or developing process.

Appendix C CHECK Fidelity Checklist

Use of assistive technology

- Identify the student's preference for the first "check" for spelling, grammar, punctuation and capitalization. Discuss how this process is merely to "clean things up" and pave the way for the first critical read for ideas and meaning.
- Emphasize why the student will focus on mechanics after strengthening the higher-level aspects of the paper (e.g. thesis, purpose, argument, structure). Once the higher-level changes are made, then it's time to proof and edit for lower-level changes – discuss why and how this could work for the student.
- Discuss the use of the student's chosen technology (e.g. Ginger, Kurzweil, Read and Write GOLD) and collaborate to determine any potential ways to streamline the processes.

Creating the checklist

- Identify and discuss past feedback from professors and writing instructors.
- Ask the student to categorize feedback about strengths and weaknesses into higher-level and lower-level framework.
- Ask the student to reflect on how past strengths, weaknesses and writing goals contributed to grades and feedback themes (e.g. comments about underdeveloped evidence due to time spent checking spelling, strong focus on purpose in research phase led to well-developed argument, etc.).
- Ask the student to identify the important components of the writing assignment description, the blueprint and the course instructor directions. Represent the highlights in the revision list (e.g. a counterargument in the last part of the essay body, a two-sentence thesis, five sources).
- Discuss how the student will use the checklist to guide revision and editing processes.

Using the checklist

- Discuss the student's decision making where necessary.
- Develop any necessary resources or reminders that will support the checklists (e.g. vocabulary lists or charts, writing resource links, grammar tutorials, citation quick guides).
- Ask the student to describe and categorize the nature of their changes (higher-level or lower-level) during the revision and editing processes.

Evaluating the effectiveness of the checklist

- Make any notes for next time (e.g. about helpful checklist elements) or about goals for the next checklists.

Note:

While developing the checklists, it may also help for the strategist to transcribe while the student thinks aloud. Many students enjoy having the freedom to sift through their materials while they talk through their concerns. This scribing process can also help open up dialogue about speech-to-text software if the student is beginning to explore assistive technology.

Appendix D Intake Interview and Inclusion Criteria

Inclusion Criteria

Student must have a documented learning disability and a reported history of writing difficulties

Student must be registered in courses during the data collection

Intake Interview Questions

1. Do you have a documented learning disability? If so, can you provide details about the nature of the disability and the academic domains impacted?
2. Do you have difficulties with academic writing? What are they? When did your difficulties begin?
3. Are you registered with the campus disability office?
4. Are you registered for University of Victoria courses in the fall semester (2013)?
5. Are you currently using any speech-to-text technologies in your writing process? If yes, what are they? If no, are you interested to try using speech-to-text in one-on-one sessions with a qualified writing tutor?

B. If student meets criteria for inclusion in the study, proceed with the questions below at the first in-person meeting.

1. Based on your past feedback from instructors, T.A.'s tutors, learning strategists or any other helpers, what are some of the difficulties you and others notice in your writing?
2. What types of technologies do you use in the writing process? Do you use any assistive technologies? How long have you been using them and how do you use them? Do they help support your writing process?
3. What types of assistive technologies are you interested to use or try in your writing process?
4. What do you do well as a writer? How would you like to build on those strengths?
5. What would you like to learn or improve about your writing?
6. How have you worked with a tutor or learning strategist in the past? Was that approach helpful? How would you like to work with a writing tutor in this study?

Appendix E Strategic Knowledge Interview

"Today I am going to ask you about some of your experiences writing assignments at university. I will be audio-recording your answers to these open ended questions. You may decline to answer any question."

1. What kinds of papers have you written while you've been at university?

2. Think about the writing task and the writing process. What is the first thing that you might do to start the task?

3. What are some important things you can do to help you write your paper?

4. If you need to pay more attention to certain aspects of your writing, what are they?

5. Once you're done writing your paper, what are some of the things you do to make it better?

6. How do you know when you are done writing a paper? How do you know when you're ready to hand it in?

7. Are there any other strategies or techniques that you know would help you when you're writing? Do you use those strategies? Why or why not?

*Interviews to be audio recorded and transcribed verbatim.

Appendix F Retrospective Strategy Report

**Participants will be asked to review and discuss an assignment from their experience as a university student (administered at pretest and maintenance). The maintenance interview should involve a writing assignment that the student completed during the course of the study.*

"Today I am going to ask you some questions about the writing assignment you have brought with you. I will be audio-recording your answers to these open ended questions. You may decline to answer any question."

1. Tell me about how you wrote this paper, from start to finish. Begin with the day you received the details of the assignment to the moment you handed it in. (If the student asks to be prompted, tell them, "*Try to tell me everything that you did to complete the assignment. Do your best to remember it all from start to finish.").*

2. Why do you think you had difficulty with this assignment?

3. Are there any strengths or skills you possess as a writer that you didn't demonstrate in this assignment? If so, can you tell me about them?

4. Did you find the instructor's feedback to be useful? Why or why not? Did you draw on any of this feedback in your other writing assignments?

5. Does this paper accurately reflect some of your strengths and weaknesses in academic writing? Why or why not?

*Interviews to be audio recorded and transcribed verbatim.

Appendix G Exit Interview and Social Validity Check

"Thank you for your participation in this study. Your work and your feedback will help us to learn more about how students work with tutors at the university level. It will also help us to make recommendations about the design of specific supports for adults with writing difficulties. I'm going to ask you some questions about your experience in the program. If you choose to provide feedback today, in person, please feel free to comment freely about the strengths and weaknesses of our work together with the PREP, TALK and CHECK strategies. I will be audio recording your answers to these open ended questions."

1. At the beginning of this project, you noted some aspects of your writing that you hoped to improve. Do you feel that these sessions have helped you work towards improvement in these areas? Please elaborate.
2. Can the strategies and tools you used in these sessions support your future work in academic writing? Please elaborate.
3. Please comment on the written materials (PREP, TALK, CHECK) that you used together with your tutor in these sessions. Do you have any constructive feedback about their accessibility or their strengths and weaknesses?
4. At the beginning of this project, you noted a typical progression through the stages of your writing process. Have this process changed in any way as a result of these sessions? Please elaborate.
5. Do you have any other comments or suggestions that you would like to share?

*Participant answers will be audio-recorded and transcribed verbatim.

Appendix H Technology and Strategy Use Checklist

Completed by examiner while the student completes the weekly writing probes.

Y/N	Technology	Strategy Use	Examiner Comments
		PREP strategy sheet consulted?	
	Inspirations or other concept mapping software used?		
		TALK strategy sheet consulted?	
	Speech-to-text technology used?		
		Does the student pause to fix and look for lower-level (spelling, grammar, punctuation) errors while writing the first draft?	
		Does the student change or deviate from the argument schema while writing?	
		CHECK strategy sheet consulted?	
	Text-to-speech options used for review and revision?		
	Spell check or contextual spell check options used?		
		Emphasis on higher- and lower-level strategies? (e.g. identifying elements of thesis, purpose, ideas as well as spelling, grammar, punctuation)	

Appendix I Angie's Technology and Strategy Profile

	Planning	Composing	Revision and Editing
Baseline	Draw out mind maps with paper and pen. Free write or brainstorm full sentences and phrases with paper and pen. Make notes about ideas from the readings and research.	Draft sentences and paragraphs by hand or using computer, often a combination. Delete and rewrite full paragraphs and sentences while creating the first draft. Frequently review the material written so far.	Use of text-to-speech and Microsoft Word spell check to identify errors in grammar, spelling and punctuation. Review written work with a tutor or learning strategist to identify additional errors or awkward phrasing.
Post-instruction	Unchanged.	Review visual aid/diagram about the structure or blueprint of a paragraph. Read from handwritten notes and paragraphs using SR technology. Add and rephrase additional points and statements. Frequent pauses to review and revise the text written so far during the creation of a first draft.	Initial review of paragraph for ideas, meaning, sentence structure. Second review for spelling and punctuation errors. Frequent deletion and rephrasing of entire paragraphs and sentences.
Maintenance	Unchanged.	Return to baseline strategies.	Return to baseline strategies.

Appendix J Samantha's Technology and Strategy Profile

	Planning	Composing	Revision and Editing
Baseline	Create a rough outline of ideas – typed or handwritten.	Draft in MS Word or Kurzweil. Review text written so far frequently for spelling and grammatical errors.	Review document in Kurzweil or MS word, e.g. focusing on the red and green underlining for errors.
Post-instruction	Review PREP worksheets create personalized genre blueprints (Inspirations or hand-drawn diagram). Create an outline to organize information.	Organize information in a planning document – dictated via Dragon or in bullet points on a whiteboard. Use TALK strategy to emphasize higher – order expression. Dictate the essay using Dragon.	Use CHECK strategy to review for ideas, meaning, structure before checking for errors. Find spelling, punctuation and grammar errors using MS Word. Listen to composition using Dragon's text-to-speech option or other screen reader option.
Maintenance	Create a blueprint for the genre of the assignment (Inspirations or hand-drawn diagram). Create an outline to organize information and citations. Tape planning materials to the wall beside computer to guide writing process.	Type out the essay in Kurzweil to hear the words read back while composing. Use the Inspirations blueprint as a guide for structure (especially at the paragraph level).	Review document using Kurzweil, possibly reviewing simultaneously in MS Word. Use MS Word as the last step for formatting and detecting any final errors in spelling, punctuation and grammar. Include citations.

Appendix K Tyler's Technology and Strategy Profile

	Planning	Composing	Revision and Editing
Baseline	Track quotations and information with sticky notes, assemble notes at kitchen table. Type out all pertinent quotes into a long document, begin adding transitions to draft an essay.	Write out all relevant quotations, facts and details in MS Word. "Cut down" the document to meet assignment word count. Review frequently for spelling and grammar errors.	Ask sister, friend or tutor to identify undetected errors in the text. Revise the draft up to ten times. Rewrite the draft several times completely.
Post-instruction	Using PREP strategy, develop an initial blueprint for the assignment (Inspirations). Dictate reading notes into Cornell format (and reduce note length). Dictate an outline in MS Word to organize information and citations.	Use TALK strategy to emphasize higher – order expression in drafting activities. Dictate the essay using Dragon.	Use CHECK strategy to review for structure, conciseness and lower-level errors. Find spelling, punctuation and grammar errors using MS Word and Voice Dream. Review document using Dragon's text-to-speech option.
Maintenance	Same as post-instruction.	Same as post-instruction.	Review document using Kurzweil, to "hear" errors.

Appendix L Amber's Technology and Strategy Profile

	Planning	Composing	Revision and Editing
Baseline	Consult research materials, but make few systematic notes or plans.	Draft in MS Word. Frequent review and deletion of composed material before completion of a draft.	Review document in MS word, e.g. focusing on the red and green underlining for errors. Delete and rewrite most sentences.
Post-instruction	Using PREP strategy, create blueprint for assignment (Inspirations for iPad). Reduce number of articles consulted for term papers (e.g. from 40 to five or six). Dictate an outline to organize information, citations, using Dragon.	Consult plan and dictate essay in paragraph-chunks (Dragon). Use TALK strategy to emphasize higher – order expression. Leave mechanical concerns for later. Use the Inspirations blueprint as a guide for structure (especially at the paragraph level).	Use CHECK strategy to review for ideas, meaning, structure before checking for errors. Find spelling, punctuation and grammar errors using MS Word. Listen to composition using Dragon's text-to-speech option or other screen reader option.
Maintenance	Same as post-instruction, plus the inclusion of Kurzweil for reading activities.	Same as post-instruction.	Same as post-instruction, plus review document using Kurzweil.

Appendix M Personalized Instructional Materials

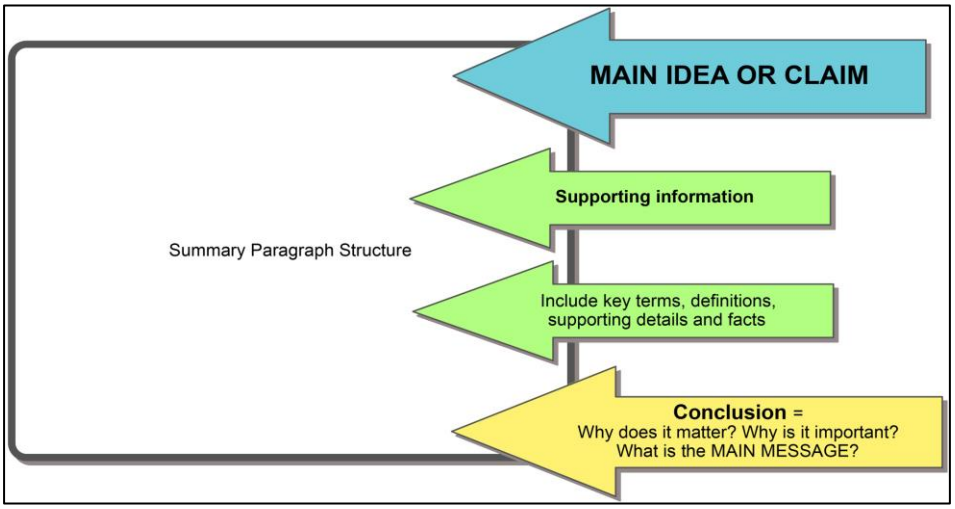

Figure 7. Tyler's Personalized Planning Goals (PREP)

The diagram accompanies the PREP strategy mnemonic and was created using concept-mapping software and stored in Tyler's folder of mnemonic strategies and writing tools, which he accessed throughout the intervention.

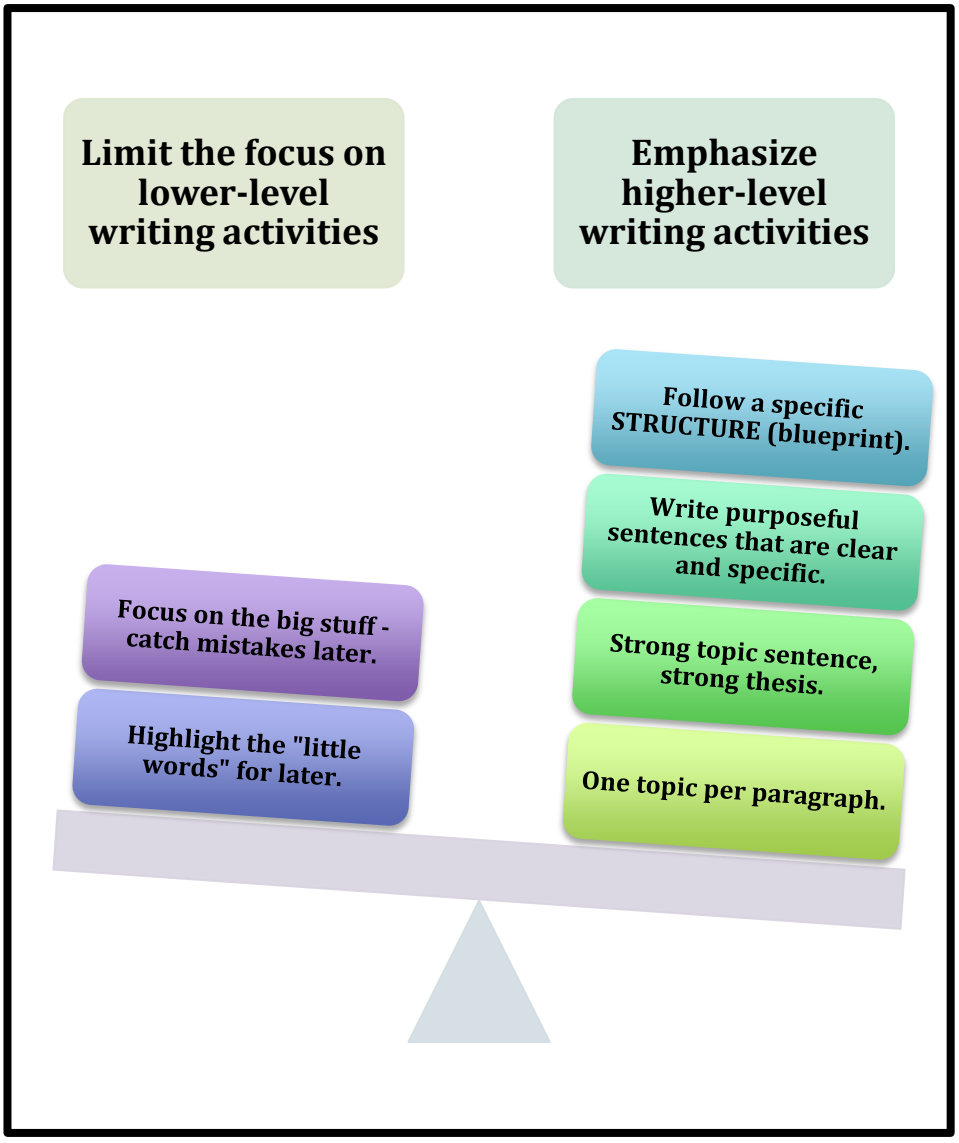

Figure 8. Samantha's Personalized Dictation Goals (TALK)

The diagram accompanies the TALK strategy mnemonic and was stored in Samantha's folder of mnemonic strategies and writing tools, which she accessed throughout the intervention.

	REVISE FOR HIGHER-LEVEL ELEMENTS (thesis, purpose, ideas, etc.)
	Paragraph unity
	• Make sure the paragraph is about only one topic
	Strong topic sentences
	• Strong topic sentence that conveys the "job" of the paragraph?
	Flow
	• Do the ideas flow naturally and logically? • Any inferences or choppy, abrupt statements?
	Transitions
	• Do "signpost" words and phrases help connect ideas across sentences? • Is it easy for the reader to identify my blueprint or structure?
	Clarity
	• Does the "articulation of content" meet the professor's standards? • Explain it, be specific, and make sure the sentence is appropriately structured to suit the sophisticated audience (e.g. ENGL readers?)

	EDIT FOR LOWER-LEVEL ELEMENTS (spelling, grammar, punctuation, etc.)
	Spelling
	• Use MS word Spell Check to identify problems
	Homonyms
	• Did Dragon hear any words that I didn't mean to say? • "Their/there/they're" • "Been/bean"
	Fragmented sentences
	• Can the statement stand on its own? • Am I missing anything important?
	Double check the "little words"
	• Look for words like, *and, to, in, from, for, about, the...* • Read the sentence aloud and listen for anything that doesn't sound right.

Figure 9. Samantha's Personalized Revision Goals (CHECK)

The checklist accompanies the CHECK strategy mnemonic and was stored in Samantha's folder of mnemonic strategies and writing tools, which she accessed throughout the intervention.