

DESIGNING AN ONLINE REVISION TOOL TO SUPPORT REVISION AND REVISION
INSTRUCTION IN SECONDARY CLASSROOMS

by

KALIANNE L. NEUMANN

(Under the Direction of Theodore J. Kopcha)

ABSTRACT

The research for this dissertation is presented in manuscript format with an introduction and literature review that precedes three manuscripts and a conclusion that follows the third manuscript. The first manuscript is a mixed methods study about peer and teacher revision in Google Docs; this manuscript served as a pilot study that identified the need for an intervention that distinguishes surface and text-based errors. The second manuscript is a design case that describes the design decisions behind the development of an intervention, *Revision Assistant*, that distinguishes surface and text-based errors. The third manuscript, which is the dissertation study, is a mixed methods study that investigates the role of *Revision Assistant, too* in developing a revision task schema over multiple writing assignments. Individually, each manuscript presents a different phase of development and research on the intervention, and together the manuscripts illustrate the iterative process of using a design-based research approach.

INDEX WORDS: Design-based research, Intervention, Revision, Revision task schema, Mixed methods research, Secondary education, Revision Assistant

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DEDICATION

I dedicate this dissertation to the students at the International Baccalaureate and district charter school in the Pacific Northwest who were members of the Class of 2019 and Class of 2020 during the 2013-2014 school year. Your participation in my first research study shaped the trajectory of my research and inspired the design and development of *Revision Assistant*. For this reason and so many more, you all will always hold a very special place in my heart.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Prior to beginning my Ph.D. in Learning, Design, and Technology at The University of Georgia in Fall 2014, I travelled down a winding road that led to the three-way intersection of English, technology, and teaching. I was not totally convinced that teaching was the profession for me until I entered the M.A.T. English Education program at Kennesaw State University in 2008. It was there that my love of English and growing love of technology became integrated with teaching in a way I never thought possible.

Upon the completion of my M.A.T., these integrated interests led me to working for three years as a brick-and-mortar middle school and high school English Language Arts (ELA) teacher and five years as an online high school English teacher. Those teaching experiences allowed me to teach and support students through both ubiquitous and online technologies, design and evaluate curriculum, and map curriculum to state and national standards. Despite feeling prepared and effective as a teacher because of the opportunities I had, I still felt unfulfilled. I wanted to know more about effective technology integration, and I also wanted to contribute to my professional community by becoming a leader that could assist others in their technology integration efforts.

After my admission to The University of Georgia but prior to the start of my first semester, I conducted a research study under the advisement of my major professor about my middle school students who were writing argumentative letters and undergoing several rounds of revision in Google Docs. The decision to study writing was almost instinctual for me; as a

secondary ELA teacher, writing was my favorite ELA foundation to teach. Writing was a topic that I knew would be important for students whether they went into college or into the workforce after high school, but I was troubled by the frequency in which I noticed students failing to revise and edit their writing. After observing this with both middle school and high school students, I wanted to take a deeper look at how students revise in the classroom. Little did I know that this study would be a springboard for both my dissertation research and overall research agenda.

Introduction

“Writing in the 21st century is defined by its frequency and its efficiency. It is clear that the ability to use written language to communicate with others – and the corresponding need for effective writing instruction and assessment – is more relevant than ever.” (National Center for Education Statistics, 2012, p. 1)

The ability to communicate written material and convey information in writing are necessary skills for students leaving K-12 education whether they aspire to go to college or into the workplace (National Commission on Writing for America’s Families, Schools, and Colleges, 2004; Office of Career, Technical, and Adult Education, n.d.). Additionally, students need to be fluent in using a variety of technologies to successfully communicate (Office of Career, Technical, and Adult Education, n.d.). Despite the obvious need for these writing and technological skills, only 24% of twelfth-grade students performed at the proficient level and 3% at the advanced level in writing on a computer-based assessment administered by the National Assessment of Educational Progress (NAEP) in 2011 (National Center for Education Statistics, 2012). Being proficient in writing in twelfth grade means that students “are able to produce well-structured responses that fully accomplish the communicative purpose” (p. 42). Ensuring that

students leave K-12 education with proficient abilities in writing is a national concern that needs to be addressed in the classroom.

The advent of technological tools like smartphones, social media apps, and chat messages promote instantaneous publication, satisfaction, and gratification. Because of this, people seem to revise their writing less than they ever have before; however, students engage in strategies of both revision and editing in their outside of school lives to portray themselves in certain ways on social media and other online spaces. According to Madden et al. (2013), “Pruning and revising profile content is an important part of teens’ online identity management” (p. 9). Students participate in these online spaces to create interconnections with other learners (Greenhow, Robelia, & Hughes, 2009), and the norms of their interactions online are similar to the norms they experience at school (Boyd, 2014). Teachers need to capitalize on the skills that students are practicing outside of school to improve writing ability and written work submitted by students inside of the school building.

The purpose of this dissertation project is to address the national concern about writing ability through sustained research on and development of a cognitive tool that supports secondary student revision task schema. Using design-based research (DBR), I began by analyzing secondary student use of an online collaborative tool, Google Docs, during revision. The analysis of their practices (see Chapter 2) led to the design and development of an intervention to support the revision phase of the writing process (see Chapter 3). The intervention, called *Revision Assistant*, is a free add-on for Google Docs that visually distinguishes surface and text-based feedback. The tool was developed by drawing heavily on schema theory and, more specifically, revision task schema. The intervention is the focus of the

dissertation study (Chapter 4), which examines the role of the intervention in the development of secondary students' revision task schema over several writing opportunities.

Literature Review

The literature review for this dissertation begins with research on revision. This will serve as a preface for a conceptual framework on schema theory, cognitive models of revision, and revision task schema. Because this is a multiple article dissertation, the information covered in this literature review and conceptual framework ultimately appears in other chapters.

Research on Revision

Research on revision accelerated during the 1980s due to new methods and ideas about revision in writing. Some of this acceleration was due to the impact of Murray's (1978) work on revision. Murray distinguished two different types of revision: internal and external. Internal revision includes the processes a writer goes through to understand their work and develop what they have to say; the audience is only the writer. External revision includes the processes a writer goes through to prepare their writing for an audience beyond themselves, such as proofreading and editing. Murray's seminal work and the research on revision that followed yielded a redefinition of revision, which defined revision as any changes made throughout the writing process (Fitzgerald, 1987).

Sommers (1980) found that beginning writers viewed revision as an activity that allowed them to eliminate repetitive ideas in their writing; it was seen as a time for them to be a wordsmith. Other research has indicated that students make two types of changes during the revision phase: surface changes and text-based changes (Faigley & Witte, 1981). Surface changes are both changes to the grammar/mechanics of writing and changes that preserve the meaning of a text. Text-based changes are additions, omissions, and reorganizations that alter the

meaning of the writing. In a research study exploring the revision processes of her middle school students, Harper (1997) noticed that her students only made these surface-level changes. She came to the conclusion that their focus on making surface changes was due to their lack of skills in the area of revision. To Harper's students, revision was a place to change a few words before ending the writing process, which validated Sommers' (1980) finding.

In the early 1990s, researchers studied the impact of word processors on the writing process (Grejda & Hannafin, 1992; Owston, Murphy, & Wideman, 1992). As word processors and the Internet became more readily available to teachers and students, research on revision began to focus on writing tools, feedback, and the types of feedback given to writers. Some of this research compared student use of word processors versus handwritten essays (Owston et al., 1992). Other research compared overall writing quality when students used a handwritten method, word processors, or a combination of the two (Grejda & Hannafin, 1992).

One way teachers can capitalize on the revision skills students are practicing outside of school is to integrate Web 2.0 technologies that promote collaboration between students and teachers. For instance, Google's G Suite for Education (previously Google Apps for Education Suite) tools (e.g., Docs, Slides) afford multiple people to work simultaneously on documents from any location while saving in real-time (Dekeyser & Watson, 2006; Oishi, 2007; Zhou, Simpson, & Domizi, 2012). If incorporated into peer revision activities, Google Docs could allow students to receive more frequent feedback that encourages active participation in learning about both writing and revision (McVey, 2008). Scardamalia and Bereiter (1986) found that student writers revise more with the help of others because it helps them to consider an audience outside of themselves.

Conceptual Framework

The conceptual framework for this dissertation is developed around schema theory, cognitive models of revision, and revision task schema. The full framework around revision task schema is presented in Chapter 4. Below I present a literature review for schema theory more broadly. In it, I trace the development of schema theory in the field of Learning, Design, and Technology; it serves as a preface for the use of revision task schema in Chapter 4 and the implications and recommendations for practice and future research in Chapter 5.

Over the past 60 years, the instructional design and technology field has evolved in its application, use of learning theory, and methodology. Instructional design emerged during World War II when the U.S. military asked psychologists to develop training materials and conduct evaluative research on the instructional films developed for the British and American Armed Forces (Molenda, 2008; Reiser, 2012). Evaluative research on these training programs continued after the war, and programmed instruction and formats of media became a focus of educational research. In the 1960s and 1970s, educational technology researchers were primarily guided by behavioral learning theory (Lowyck, 2014), and the term instructional design was adopted by researchers for continued use in military training and additional use in other fields, such as academia, business, healthcare, and K-12 education (Reiser, 2012; Richey, Klein, & Tracey, 2011a).

Cognitive learning theory emerged in the late 1950s from the field of cognitive science (Ertmer & Newby, 1993), and it came as a response to behaviorism's focus on stimulus-response research and its "inability...to account for much human activity" (Winn, 2004, p. 82). Educational researchers began to shift their focus from observable behaviors to complex, mental processing (Ertmer & Newby, 1993; Winn, 2004) because they believed this complex, mental

processing was “the major factor explaining learning” (Richey, Klein, & Tracey, 2011b, p. 56). As a result, researchers started studying learning in terms of “what” a learner knows and “how” they know it (Jonassen, 1991). “What” a learner knows was studied in terms of mental representations, and “how” learners know what they know was studied in terms of the mental processes that operate the mental representations (Winn, 2004).

While cognitive learning theory gained prominence in the late 1950s and early 1960s, the field of instructional technology did not gain interest in it until the 1980s (Reiser, 2012). Instructional design researchers began to investigate more complex questions dealing with the instructional goals of “comprehension, understanding, decision-making, and problem-solving” (DiVesta & Rieber, 1987, p. 215). These questions were addressed by focusing on a learner’s prior knowledge, the strategy used by the learner to acquire knowledge, and the appropriateness of that strategy for acquiring knowledge. According to Winn (2004), the selection of these instructional strategies were “on the basis of their likely ability to modify schemata rather than shape behavior” (p. 103). For example, DiVesta and Rieber (1987) and West, Farmer, and Wolff (1991) recommended that cognitive strategies for instruction should align with the learner’s current state of knowledge to guide them in learning new content, such as rehearsing (e.g., mnemonics) and organizing/bridging (e.g., concept mapping).

Schema Theory

Schema theory started gaining the attention of cognitive researchers in the 1970s (McVee, Dunsmore, & Gavelek, 2005); it focuses on the development and modification of schemata (Richey et al., 2011b; Winn, 2004). A schema is an organized mental structure of knowledge stored in memory (Fleming, 1987; Gagné, 1985; Richey et al., 2011b; Winn, 2004). The origins of schema can be traced back to Kant’s 1929 conceptualization of schema, Bartlett’s

1932 application of that conceptualization in the study of memory, and Piaget's 1952 use of it as a central construct in theory about cognitive development (McVee et al., 2005).

Winn (2004) summarized the four characteristics of a schema: (1) when combined with all other schemata, it is an organized mental structure of knowledge that represents the total of our knowledge; (2) it is an abstract representation; (3) it is a dynamic structure that can be modified by instruction and experience; and (4) it provides context for new learning and interpretation. The dynamic nature of a schema's structure allows people to attempt to match the features of new information to schemata and assimilate the information by confirming the identification of those features with further information in schemata or accommodate the information if our schemata does not confirm the identification of the new information. Schemata changes occur when people assimilate new information or accommodate to new information.

As previously mentioned, learners use schemata as context for interpretation when they encounter new information, and new schema can form to develop more complex schemata (Driscoll, 2012; Richey et al., 2011b; Winn, 2004). Rumelhart and Norman (1978) detailed three ways people learn by developing and modifying schema: accretion, tuning, and restructuring. Accretion is a gradual process that is composed of daily experiences and exposure to new concepts; it adds new concepts to existing schema without disturbing the organizational system. Tuning occurs when there are changes in the schemata used to organize information; this process modifies the existing schemata until they are aligned with the demands put on the schemata by the learner. Restructuring takes place when new schema is developed to interpret new information, and the new schema forces stored knowledge to reorganize; these reorganized

schemata allow for changed interpretations and “therefore the acquisition of new knowledge” (p. 39).

Schema theory in Learning, Design, and Technology. Schema theory and aspects of its stance on knowledge structure and construction have been applied in the field of Learning, Design, and Technology in conjunction with cognitive learning theory, cognitive load theory, information processing theory, conditions-based theory, and constructivism. Since the beginning of its instructional technology application in the late 1970s and early 1980s, schema theory primarily has been used in the study of external cognitive strategies and artificial intelligence (West et al., 1991; Winn, 2004); however, direct research on schema theory and schema in the field of Learning, Design, and Technology has declined over the last decade as new theories have expanded upon the accommodation and assimilation of schemata. The acceptance of learners building upon prior knowledge to construct new knowledge is a promising result of the early work on schema theory. Research on how external cognitive strategies help students develop schemata resulted in important implications for teachers of all levels. It not only provided ideas for the design of effective instructional materials and methods, but also it helped support the idea that students could learn with media. Additionally, the research on schema theory and artificial intelligence provided a structure for these systems that was widely seen as unsuccessful (Winn, 2004); however, it eventually led to research on how intelligent tutoring systems (ITSs) could support the development of schemata.

To expand the cognitive research on instructional technology, Richey et al. (2011b) called for scholars using cognitive theories, such as schema theory, to address problem-solving. Some researchers have started this work on problem-solving using the concept of schema with hypermedia, ITSs, cognitive tools, as well as other software programs. In addition to a

continuation of problem-solving research, scholars should continue to study how the use of a cognitive tool helps learners not only develop schemata but also apply it in future learning situations. This dissertation provides new implications for instructional interventions that assist learners in the accommodation and assimilation of new schemata.

Cognitive Models of Revision

Scholars have defined the cognitive process of revision in a variety of ways; however, Fitzgerald (1987) summarized these definitions to redefine revision as any changes made during the writing process. Thus, revision has been situated as a problem-solving process that allows a writer to identify a problem, evaluate the problem, and resolve the problem (Allal & Chanquoy, 2004; McCutchen, 2006). Several cognitive models of revision have been proposed and elaborated upon to explain revision (e.g., Hayes, 1996; Hayes & Flower, 1980; Hayes, Flower, Schriver, Stratman, & Carey, 1987; Scardamalia & Bereiter, 1983). The models provide explanations of the cognitive processes associated with revision, and research has been conducted to validate the models and provide implications for how an inexperienced writer can become a better reviser.

Two early cognitive models of revision have been influential in understanding the cognitive processes involved when students undergo the revision phase (Becker, 2006; MacArthur, 2012, 2016). Scardamalia and Bereiter's (1983) model of revision was composed of three parts: compare, diagnose, and operate (CDO) (Alamargot & Chanquoy, 2001; Becker, 2006; MacArthur, 2012, 2016). According to the model, a writer first compares the written text to their intended version of the text. Then if a problem between the written and intended version is detected, the writer diagnoses the problem. Finally, the writer operates by choosing a revision strategy that will help them make a change. While this was proposed as a cognitive model of

revision, it was more of a procedural model that could facilitate revision (Alamargot & Chanquoy, 2001).

The other influential cognitive model of revision initially was proposed by Hayes and Flower (1980). They indicated that reviewing, which is what they called revision, was dependent on the processes of reading and editing; reading was an intentional activity that included evaluation of text, whereas editing was an automatic process of detecting problems that could occur at any time. After continued research, they revised this model to include the processes of task definition, evaluation, and strategy selection (Hayes et al., 1987). The task definition included a writer's goals for revision and the scope of revision. Evaluation included applying the goals of the task definition to the text being revised. Finally, strategy selection included either strategies that guide the revision process or strategies that modify the text.

In a continued elaboration of the previous models he developed with his colleagues, Hayes (1996) revised their model of revision again to include three components: the control structure, fundamental processes, and resources. The control structure, the revision task schema, guided the fundamental processes of text processing, reflection, and text production. According to Hayes (1996), a task schema is "a package of knowledge, acquired through practice, that is useful for performing the task and is retrieved as a unit when cues indicating the relevance of the schema are perceived" (p. 16). A task schema is the same as the concept of schema from schema theory in that it is an organized structure of knowledge (Winn, 2004). Hayes (1996) described his concept more specifically by using the term "task" to portray the procedural knowledge needed for revision. A person's revision task schema could include goals, activities to be performed, subgoals, criteria for quality, and strategies to fix specific types of problems. The inclusion of the task schema replaced "task definition" from the previous model (MacArthur, 2012).

The fundamental processes in the new model replaced “processes” proposed in the previous model (MacArthur, 2012). Within those processes, evaluation was replaced by text processing and included critical reading to evaluate and discover ways to improve a text (Hayes, 1996). The reflection process replaced strategy selection (MacArthur, 2012), and it included the processes of problem solving and decision making (Hayes, 1996). Text production became its own process within the model because of its importance in producing successful revision (MacArthur, 2012).

Finally, the last component of resources included both the working memory and the long-term memory (Hayes, 1996). The working memory retrieves information from the long-term memory and is responsible for executing the fundamental or cognitive processes of revision. The long-term memory stores schemata about tasks, topics, and audiences. In addition to detailing the components involved in revision, Hayes asserted that practice using these components to revise could provide writers additional knowledge about writing, effective writing strategies, and additional skills in evaluation. However, this model does not include ways for writers to develop, activate, or manage the processes associated with revision (Alamargot & Chanquoy, 2001; MacArthur & Graham, 2016).

Revision task schema. Through practice and the assimilation or accommodation of new information, a revision task schema can guide a writer to make changes during the revision process. Faigley and Witte’s (1981) taxonomy of revision distinguished two types of changes made during revision: surface changes and text-based changes. Surface changes were classified as superficial changes made at the sentence level that did not change the meaning of the text (i.e., grammar, mechanics). Text-based changes were more substantial additions, omissions, and reorganizations that changed the meaning of the text. The revision task schema for beginning or

inexperienced writers tends to focus on surface changes because identifying text-based changes is more challenging, and these novice writers have little experience using the interpretive and reflective strategies to identify and correct these problems (MacArthur, 2012, 2016; McCutchen, 2006). Text-based changes require a writer to critically read to evaluate their text, reflectively identify a problem, and reflectively decide how to change the text to produce text that aligns with their intended meaning (Alamargot & Chanquoy, 2001; MacArthur, 2012; McCutchen, 2006). To become more effective revisers, beginning writers need more experience in writing and revision to develop schemata that are activated during the writing process (Hayes, 1996).

Context of the Project

As previously mentioned, the first study I conducted (Chapter 2) has driven my dissertation research. The analysis of the data from that study indicated that my middle school students focused their writing feedback on matters of conventions – despite my intentional instruction on providing feedback about the content of their peer’s writing. While I was initially annoyed by this result from my former students, I quickly went into problem-solving mode. I needed to find or design a solution to this problem, so I started reflecting on my revision habits during middle school and high school. The one thing that I immediately thought of were the proofreading marks I learned as a student, which were frequently used by my teachers to provide conventions-related feedback. These proofreading marks visually represented the location of errors in conventions, while questions or comments about the content of my writing were written in the margins – usually in cursive. As a result of these memories, I started designing an intervention that would allow a user to digitally insert proofreading marks so conventions feedback would be visually distinguished from content feedback like they were for me when I was a secondary student.

Philosophical Framework

Pragmatism is a perspective that emphasizes experiences and focuses on outcomes to find meaning (Johnson & Onwuegbuzie, 2004; Patton, 2015); additionally, this perspective commits to using the methods that are best suited for answering the research questions (Feilzer, 2009; Johnson & Onwuegbuzie, 2004). In taking these pragmatic beliefs into account, my ontology as a pragmatist is truth is movable and relative to the current situation. As a pragmatist, my epistemology is that knowledge is fallible, constructed, and a function of organism-environment transactions. Finally, my pragmatist axiology values utility; that is, the variety of ways that action and thinking can be used to find solutions to problems. These philosophical beliefs ground the research in this dissertation.

Multiple Article Structure

The purpose of this dissertation is to study how secondary students engage in the revision phase of the writing process through the design and development of a cognitive tool to support revision. Through the articles, I employ a design-based research (DBR) approach. According to Wang and Hannafin (2005), DBR is “a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories” (p. 6). DBR aims to develop theory within the context of real-world practice while producing findings that are useful and can transfer into classrooms to improve instruction (Anderson & Shattuck, 2012; Reinking & Bradley, 2008).

While guided by theory, DBR studies intend to develop theories that are “humble and local in contrast to more grandiose, overarching explanatory theories” (Reinking & Bradley, 2008, p. 18). They have an overall goal of improving instruction and learning, and researchers

often explain the specific goals of the intervention. DBR studies are iterative in nature because an intervention adapts throughout the research to improve the intervention. The interventions studied have the potential to positively transform learning environments. There are no specific research methods for DBR studies; they use the methods that are most appropriate for studying the effects of the intervention, its implementation, and the theory. Finally, DBR studies are pragmatic because they seek to find out what works with an intervention and how emerging theories can be useful and relevant for practitioners; truth and reality are considered movable processes that can help us generate knowledge to achieve the goals of the research.

With this in mind, this dissertation uses a multiple article structure that includes five chapters: an introduction and literature review, three articles, and a conclusion. The multiple article structure mirrors the DBR process that guided this dissertation - each chapter presents a different phase of development and research on the intervention, *Revision Assistant*. Table 1.1 displays the title and purpose of each of the three articles; each of the three articles is described in more detail below.

Table 1.1

Multiple Article Dissertation Using a DBR Approach

Article	Title	Purpose within the Context of DBR
1	Peer and Teacher Feedback on Argumentative Writing during the Revision Phase	To identify the need for an intervention that distinguishes surface and text-based errors.
2	Designing a Revision Tool to Distinguish Surface-level and Text-based Writing Feedback	To describe the design and development of the intervention that distinguishes surface and text-based errors.
3	Fostering the Development of a Revision Task Schema with an Online Revision Tool	To investigate the role of the intervention in developing revision task schema over multiple writing assignments.

The first article (Chapter 2), “Peer and Teacher Feedback on Argumentative Writing during the Revision Phase,” presents the results from the pilot study that was conducted in 2014. The article, a convergent mixed methods study, investigates the revision phase of the writing process for 21 middle school students who underwent a round of peer and teacher review in Google Docs. Analysis revealed that the students focused their advice on grammar and conventions, which led to surface changes; feedback from the teacher more frequently led to text-based changes. The results subsequently led to the design and development of *Revision Assistant* (see Chapter 3 description below for more detail). This article is currently being revised for submission *Computers in the Schools*.

The second article (Chapter 3), “Designing a Revision Tool to Distinguish Surface-level and Text-based Writing Feedback,” is a design case depicting the design story of *Revision Assistant*. The article explains that the intervention was designed as a result of the findings from Chapter 2. Because some students received so many conventions-focused comments about their writing, the advice provided to them on the content of their writing was often lost in a stream of conventions-related comments. There seemed to be a need to distinguish surface-level feedback from text-based feedback so students could effectively engage in the cognitive processes of revision; *Revision Assistant* aims to do just this. This article depicts the design decisions leading to the development of *Revision Assistant*, secondary teacher and student feedback about improving the functionality and usability of the add-on, and the design failures that led to the updated design, which was published as a new add-on called *Revision Assistant, too*. This article is currently under review with the *International Journal of Designs for Learning*.

The third article (Chapter 4) titled, “Fostering the Development of a Revision Task Schema with an Online Revision Tool,” presents the results from the dissertation study. This

mixed methods study that uses a design-based research (DBR) approach examines how repeated use of *Revision Assistant, too* impacts writing achievement and affects the development of revision task schema for 17 middle grades students. Analysis revealed that the students in this study not only saw a reduction in the amount of surface feedback provided to them through the tool and improved their rubric scores from first to third essay, but also students transitioned from only making surface changes to also making text-based changes during revision. The data suggest that the visual cues from *Revision Assistant, too* may have supported the reduction in surface feedback as well as the fundamental process of text processing by helping students distinguish between surface and text-based feedback. The journal being considered for the submission of this article is *Educational Technology Research and Development*.

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CHAPTER 2
PEER AND TEACHER FEEDBACK ON ARGUMENTATIVE WRITING DURING THE
REVISION PHASE ¹

¹ Neumann, K. L., & Kopcha, T. J. To be submitted to *Computers in the Schools*

Abstract

As technology becomes more accessible to students, educators are using collaborative technologies to improve the writing process. This convergent mixed methods study examines how feedback provided through collaborative online technologies affected the writing of 21 middle school Language Arts students from a rural school in the Pacific Northwest. Students wrote argumentative letters in Google Docs that underwent two rounds of revision; a peer provided feedback on the first draft and an expert, the teacher, provided feedback on the second draft. Repeated measures analysis of variance revealed statistically significant changes due to both peer and teacher feedback in multiple areas of an argumentative writing rubric. Student reflections on their writing confirmed that more substantive revisions (i.e., organization, language and vocabulary) were due to teacher rather than peer feedback. A critical case was identified to illustrate how peer feedback can move beyond surface-level changes during the revision process. Implications for research and teacher practices with peer revision using Web 2.0 technologies are discussed.

Introduction

Beginning in the sixth grade, students are asked to write arguments that support claims instead of opinion pieces about texts and topics; this entails forming a cohesive structure to an argument rather than examining topics and explaining ideas (Common Core State Standards Initiative, 2010). To support students with this form of writing, teachers commonly incorporate a peer review process to support revision (MacArthur, 2013). During peer review, students exchange their written work with a peer so that the peer can provide suggestions for improving the written work. Traditionally speaking, this process takes place within the classroom. Student and peer meet face-to-face to exchange and discuss feedback; feedback can take a variety of forms and generally addresses issues with mechanics, organization, and/or content (Cho, Schunn, & Charney, 2006). This can benefit both the student and peer; students are exposed to evaluative feedback from peers, while peers have an opportunity to identify and potentially improve the writing of another person (MacArthur, 2012, 2013; Trupiano, 2006).

As access to technology increases, teachers are moving away from a paper-based, face-to-face process towards an online process of peer review. While static documents (e.g., Microsoft Word documents) were previously popular for sharing and revising work, a good deal of time was spent sending the documents back and forth between contributors (Dekeyser & Watson, 2006). Web 2.0 tools like Google Docs are becoming more appealing for the peer review process because such tools help reduce the time and effort needed to share written work and provide feedback. Students can easily connect and communicate with both peers and teachers to receive valuable feedback on their writing in a timely fashion (Suwantarathip & Wichadee, 2014). This can increase students' exposure to peer and expert perspectives on their

writing (Blankenship & Margarella, 2014), which can help them develop stronger revision skills over time (Nelson & Schunn, 2009; Scardamalia & Bereiter, 1986).

The move towards Web 2.0 technology creates a renewed opportunity to study and more deeply understand the peer review process. Although peer review has been studied in the past, the focus has primarily been on identifying improvements in writing achievement or comparing the medium to traditional forms of peer review (Goldin, Ashley, & Schunn, 2012). Overall, those studies have found that students often lack the ability to be critical of another student's work, resulting in feedback that fails to improve text-based issues (e.g., organization, structure) with writing (see also Patchan & Schunn, 2015). However, it is not clear how students can move beyond surface-level errors (e.g., grammar, punctuation) while using Web 2.0 technology to support the peer review process. Few studies examine the specific types of feedback that peers and teachers provide and the impact of that feedback on student writing in Web 2.0 environments; those that do have reported inconsistent findings (see Cho & MacArthur, 2010; Nelson & Schunn, 2009). Using Web 2.0 to facilitate peer review creates an opportunity to document and analyze the feedback that is provided by peers and teachers and determine the impact of that feedback on students' writing achievement. Additional research about the role of feedback that peers and teachers provide on student writing would help inform scholars and educators of the value of these collaborative tools (i.e., Google Docs) on the process of revision and provide insight on how to further improve student achievement when using these tools.

The purpose of this study was to examine the role of feedback from peers and the teacher and its effects on the writing of middle school students' argumentative letters. Feedback was provided using the comment feature within Google Docs in two distinct phases: from a peer after the first draft of writing and from the teacher after the second draft. Rubric scores were generated

after revisions were made to each draft and compared using repeated-measures ANOVA. In addition, student reflections were analyzed to better understand student perceptions about the impact of peer and teacher feedback on the revision process. The questions guiding this study were:

1. How does peer and teacher writing feedback provided within Google Docs differ?
2. How does the peer and teacher feedback provided using Google Docs affect the writing achievement of middle school students?
3. How do middle school students perceive the impact of feedback given to them by peers and a teacher using Google Docs during the revision stage?
4. How do middle school student perceptions about the impact of peer and teacher feedback corroborate or contradict the typical pattern of feedback and the impact that feedback has on their writing achievement?

Theoretical Underpinnings

The dominant perspective on revision was established in the 1980's. Murray's (1978) seminal work distinguished two different types of revision: internal and external. Internal revision encompasses a writer's understanding of their work in order to fully develop it. External revision is marking a document up and making changes to it before submitting it to others. This distinction between internal and external revision was evidenced in a number of studies on the revision process following Murray's work (see Faigley & Witte, 1981; Scardamalia & Bereiter, 1986; Sommers, 1980). These studies largely found that revision can happen at any time during the process of writing and that writers used a variety of skills to effectively revise their work.

Other researchers used Murray's work to begin studying revision through the types of errors and changes made during the writing and revision process. For example, Sommers (1980)

found that beginning writers viewed the revision stage as an activity that allowed them to eliminate repetitive ideas in their writing; beginning writers saw this as a time for them to be a wordsmith. Faigley and Witte (1981) found that the revision stage was used as a time for students to focus on making surface changes to their writing. Surface changes were defined as both changes to the grammar/mechanics of writing and changes that preserved the meaning of a text. Faigley and Witte contrasted surface changes with text-based changes, which were defined as additions, omissions, and reorganizations that altered the meaning of the writing. Both surface changes and text-based changes can be categorized as an external revision process.

Regardless of the type of change, more recent perspectives suggest that the external process of revision is a culmination of several complex internal processes. McCutchen (2006) described how the act of revision is a form of task schema. A person's revision task schema directs or guides three cognitive processes: text processing (i.e., critical reading), reflection (i.e., problem solving and decision making), and text production (Hayes, 1996; McCutchen, 2006). Development of these three processes can vary based on differences related to a writer's prior knowledge and experiences (MacArthur, 2012; McCutchen, 2006). Young children in particular typically possess stronger schema for detecting and making surface changes (e.g., punctuation, mechanics) rather than text-based changes (e.g., structure, organization) because text-based changes are more conceptually complex (MacArthur, 2012; McCutchen, 2006). McCutchen (2006) and MacArthur (2012) explained that text-based changes require a child to first critically read to identify an issue with what is written in the actual text. Then they must reflect to compare that writing to an intended form of the text, identifying the ways in which the current writing falls short of the intended and constructing a revised version of writing that better matches the intended form. This can be difficult for children to accomplish because they often lack the

language and skills needed to produce the intended text in a way that improves it and is distinctly different from what is actually written.

Peer Review

One way to support the development of these revision schema is peer review. Peer review is a process in which students review the writing of a peer and provide feedback on how to improve it. Incorporating peer review during revision activities can be helpful because students tend to do little revision without feedback from their peers and teachers (Scardamalia & Bereiter, 1986). Students can also provide feedback more frequently than the teacher can (MacArthur, 2012, 2013, 2016). Additionally, peer review becomes a reciprocal process; students learn about revision from giving feedback to another student as well as from receiving feedback (MacArthur, 2012, 2013; Trupiano, 2006).

The bulk of research on peer review has taken place among language learners (e.g., Lundstrom & Baker, 2009; Paulus, 1999; Rahimi, 2013; Tsui & Ng, 2000) or college students (e.g., Cho et al., 2006; Herrington & Cadman, 1991; Patchan & Schunn, 2016; Zhu, 1995). Those studies have varied in nature, from examining the effects of training students for peer review (Rahimi, 2013; Zhu, 1995) to the effect of the student's role during peer review (Herrington & Cadman, 1991; Lundstrom & Baker, 2009) to students' perceptions of peer review (Cho et al., 2006; Tsui & Ng, 2000) to the effect of peer feedback on student performance (Patchan & Schunn, 2016; Paulus, 1999). Generally, those studies indicate that peer review is mutually beneficial for student and peer. Additionally, training students for peer review not only yields higher quality feedback but also positively affects student writing quality; likewise, students tend to prefer teacher to student feedback.

While the results of research on peer review with language learners and college students yields encouraging results, the research on peer review with mainstream K-12 students is less prevalent. In his review of literature, MacArthur (2016) found that most peer review studies set in the mainstream K-12 classroom generally suggest that peer review has the ability to improve writing quality when coupled with effective instruction. For instance, Boscolo and Ascorti (2004) found that 64 fourth, sixth, and eighth grade students who were taught to conduct peer review were able to improve their skills of identifying clarity problems and produce writing without clarity problems better than students in their control group who received teacher correction only. Additionally, Olson (1990) investigated the revising process of students with and without peer feedback and found that peer feedback helped students write better rough and final drafts than those working without a peer; those working with a peer and also receiving instruction wrote better rough and final drafts than students in the control or other experimental groups.

Advances in technology have renewed interest in the study of peer review. Early studies on technology for peer review often used word processing tools to insert comments or annotate PDFs (Goldin et al., 2012); however, the collaborative aspects of newly accessible Web 2.0 technologies, like Google Docs, offer new opportunities for studying and improving peer review in the classroom. Multiple layers of feedback from different sources, including the teacher as the expert, encourage students to actively participate in learning about their own writing (McVey, 2008). Feedback from peers and experts can help students more easily develop the skills needed to identify areas of the actual text that are problematic (Nelson & Schunn, 2009). Peers likewise benefit from peer review because it helps expose them to the writing of others and create a task schema that more consistently identifies issues with their own writing (McCutchen, 2006).

Students can also take the time to reflect on the feedback that is provided, ask follow-up questions for clarification or additional guidance, and preserve the communication and layers of feedback for future use (Ishtaiwa & Aburezeq, 2015). Because this process takes place online, both the feedback and interactions among student, peer, and teacher can be preserved and analyzed to better understand how feedback affects student writing.

Several recent studies on the feedback provided when using Web 2.0 technologies for peer review suggest that peers may focus on surface errors. Zheng, Lawrence, Warschaur, and Lin (2015) examined how 257 middle school students from Colorado began using Google Docs as a collaborative writing tool. While students had positive attitudes about using Google Docs for editing, providing feedback, and receiving feedback, their tool use was not associated with writing achievement on standardized assessments. The researchers found that the majority of feedback, both peer and teacher, focused on grammar and mechanics. Ruegg (2015) similarly found that, without training, peers are likely to provide general feedback, whereas teachers are more likely to provide specific feedback. These findings are not new; research conducted prior to Web 2.0 indicated that children are more likely to focus on surface-level issues when engaging in peer review (Faigley & Witte, 1981; Harper, 1997; McCutchen, 2006; Sommers, 1980). Overall, these studies indicate that the affordances of Web 2.0 alone may not be powerful enough to overcome the proclivity of students to focus on surface-level issues rather than addressing deeper issues with writing.

Yet current research offers little insight into capitalizing on the affordances of Web 2.0 to move peer review beyond surface-level issues; studies more often focus on whether the medium (i.e., Web 2.0 vs. paper-based) affects student writing (e.g., Nobles & Paganucci, 2015; Suwantarathip & Wichadee, 2014) While comparison studies are undoubtedly important in

establishing if Web 2.0 can make a difference, they lack attention to the qualities and characteristics of the review and revision processes that occur. Far fewer studies attempt to more fully examine the way specific aspects of peer review using Web 2.0 tools can affect student achievement. The current study sought to better understand the role of peer and teacher feedback as middle school students wrote and revised argumentative letters. Research of this nature is needed to better understand when and how to make the best use of Web 2.0 for writing and, in particular, the external revision process.

Material and Methods

Participants

Twenty-six middle school Language Arts students from a rural International Baccalaureate public charter school in the Pacific Northwest engaged in three weeks of argumentative writing instruction; however, five students were omitted because they did not complete all drafts of the assignment. This left 21 participants (11 sixth grade; 10 seventh grade). As an International Baccalaureate school, students regularly engaged in collaborative learning as part of inquiry-based activities and reflection on their own learning. Additionally, students were 1:1 with MacBook Air computers, and the school was situated in a Google Apps for Education District. While the students had previously conducted self-evaluation on their own writing, this was the first time they underwent peer and teacher review in a web-based format. Furthermore, this was only the first or second time students were asked to write an argumentative letter for school purposes.

Instructional Program

The instructional program focused on argumentation and lasted three weeks. During weeks 1 and 2, students learned about persuasive appeals (ethos, logos, pathos) and how to use

those appeals to persuade an audience. After practice with identifying persuasive appeals and writing them to support claims, students were tasked with writing an argumentative letter to an adult about a topic of the student's interest. The topics are displayed by student in Table 2.1. A variety of in-class activities provided opportunities for students to practice planning, writing, providing feedback, and revising. Throughout the instructional program, each student wrote reflections about their planning, writing, and revision processes.

Table 2.1

Participants by Writing Topic, Ability, and Mean Rubric Score

Argument and Audience by Student ^a		Draft		
		1	2	3
A	Persuading parents to purchase her a new camera because of her interest in photography, involvement in photography courses, and use of photos in her artwork.	2.6	2.6	3.4
B	Persuading parents to purchase her an iPhone because it will help her wake up on time, complete her schoolwork, and get in touch with family.	1.4	1.6	2.0
C	Persuading her mother to allow her to get a new wardrobe because it will help her get better grades, give her more time in the morning, and yield a better mode.	2.2	2.2	3.0
D	Persuading the principal to reinstate break time in order to provide a brain break, give teachers a break, and allow students to work on homework when they have a lot.	2.2	2.4	3.0
E	Persuading the school's governing board to add additional world language options because many students do not need to know the current option, the students that do not like the current option do not try in class, and the school should not force a single world language path on its students.	2.6	2.6	3.0
F	Persuading the principal to increase the amount of P.E. time because middle grades students do not have recess, students with ADHD need to relieve energy, and it will create healthier students.	2.6	3.0	3.0
G	Persuading the school faculty that students should be allowed to skate in school because it will decrease the amount of time it takes to change classes, improves balance, and improves resilience.	2.0	2.0	2.8
I	Persuading the principal to reinstate the middle grades break time because students are too off-task without it, 50% of students want it back, and teachers deserve a break too.	2.8	3.0	3.0
J	Persuading parents to purchase him an iPhone because of three usability features: internet, photos, and phone calls.	2.0	2.0	2.4

K	Persuading the principal that middle grades students need lockers in order to keep track of their belongings, improve transition time between classes, and decrease stress on bodies.	3.4	3.4	3.8
M	Persuading parents to buy her a turtle for her birthday because it will improve her mood, decrease her stress levels, and teach her responsibility.	2.2	2.4	3.2
O	Persuading the principal that middle grades students should have chairs at assemblies because their backs hurt when they sit on the floor, they are the oldest in the school, and students at other schools sit on bleachers or chairs.	2.0	2.0	2.8
P	Persuading the principal that boys should have mirrors in the bathroom because the girls have mirrors, they are not allowed to access the locker room mirrors if they are not in P.E., and boys like to look good too.	1.6	2.0	2.8
R	Persuading his father that he should be allowed to shoot his gun because he has been working hard to take ownership of his grades, improve his attitude, and be helpful around the house.	1.6	1.8	2.0
S	Persuading a teacher that middle grades students should be allowed to have chairs at assemblies because the floor is dirty, they are the oldest in the school, and they would pay better attention if they were not uncomfortable.	3.0	3.0	2.0
T	Persuading the principal that students shouldn't have a community service requirement because it isn't voluntary, students will do a poor job, and students are doing it to meet a requirement instead of supporting a cause.	2.6	2.8	3.6
U	Persuading parents to purchase a dog because it will teach her and her sibling responsibility, keep the family safe, and act as a family companion.	2.6	2.6	2.6
V	Persuading her barn owner that beginning equestrians should start with bareback because it is easier, improves balance, and is painless for the horse.	3.0	3.6	4.0
W	Persuading parents to purchase a pet rat because they have experience, rats are intelligent, and they are great companions.	3.4	3.6	3.8
Y	Persuading the principal and teachers that the addition of outdoor classes would provide needed nutrients, improve attitudes, and connect to the IB curriculum.	3.0	3.0	3.6
Z	Persuading parents to purchase another hamster in order to teach about the life cycle, teach about responsibility, and provide a companion for her current hamster.	2.0	2.0	3.0

^a Students A through M were in sixth grade; students O through Z were in seventh grade.

The activities associated with providing feedback and revising occurred after students wrote their first draft but before they worked with a peer. Students were given a researcher-generated peer review checklist (see Appendix 1.A) to guide them through the process of peer review. The checklist included seven text-based concepts, two surface-level concepts, and one concept regarding proper business letter format. The teacher provided direct instruction on

reviewing and providing feedback, which was focused on definitions and examples of text-based errors to identify in writing (e.g., elaboration of evidence, organization, purpose). The teacher followed the direct instruction using think alouds where she modeled the process of identifying text-based errors in writing. Additionally, students worked in small groups to practice identifying text-based errors in the writing of others.

In total, students engaged in two rounds of revision on their letters. This generated three drafts of the letter: a first draft, second draft, and final draft. Students submitted their first draft at the end of the first week of the instructional program. After practicing the identification of text-based errors, students worked with a randomly-assigned peer to conduct peer review. Although peers were randomly assigned, they were not unknown or unfamiliar to the participants. Peers were students from within the same class who had previously worked together throughout the school year. In addition, the majority of students were assigned a peer of similar or equal ability. Scores on the state assessment of reading for this group of students indicate that all students met or exceeded expectations. Reading ability has been theoretically and empirically linked with writing ability (Shanahan, 2016), suggesting that the students in this study were strong writers.

The peer review process was reciprocal in that a student reviewed a peer's writing and the same peer reviewed their writing. To guide the peer review process, students used the peer review checklist to provide feedback (surface and text-based) on their peer's first draft via comments in Google Docs. During the second week of instruction, students revised their writing based on peer feedback and submitted the revised draft to the teacher for expert review. Then the teacher provided feedback (surface and text-based) to students via comments in Google Docs. During week three, students revised their writing based on teacher feedback before submitting their final draft.

Data Collection

Comment types. Evaluating the comment types from peers and the teacher provided insight into the frequency and nature of feedback provided to students on each draft of their essays. The comments provided to students on their written work were categorized into each of the criterion on the Smarter Balanced Argumentative Writing Rubric (2012). For example, comments associated with Statement of Purpose varied but were always situated in the first paragraph where the statement of purpose was made; in cases where the statement was absent, comments suggested adding a statement of purpose. Comments associated with Organization suggested improving the progression or flow of the argument (e.g., “How does this connect with your thesis?” or “This sounds choppy; try using transitions”), whereas those associated with Elaboration of Evidence called for improving the amount or type of evidence used to support the argument (e.g., “Do you have facts to back this up?” or “Use more detail here to explain what you mean”). Comments associated with Language and Vocabulary called for effective expression of ideas and greater specificity (e.g., “Try to find a more formal word” or “Please specify what you mean here [referring to highlighted text]”). Finally, comments associated with Conventions typically suggested fixing usage, punctuation, capitalization, and spelling (e.g., “This is misspelled” or “Watch your tense agreement”).

Rubric scores. Each draft of the essay (first, second, and final) was scored using the four-point Smarter Balanced Argumentative Writing Rubric (2012). This is a rubric used by the school district that corresponds with the Common Core State Standards and the Smarter Balanced Assessments. The rubric consists of five criteria related to argumentative writing: Statement of Purpose, Organization, Elaboration, Language and Vocabulary, and Conventions. Statement of Purpose deals with the clarity and focus of argument’s claim while also addressing

its counterclaim. Organization evaluates the clarity and effectiveness of the argument's organizational structure. Elaboration of Evidence examines the depth, variety, and convincing nature of the argument's evidence. Language and Vocabulary assesses the use of appropriate and effective academic and domain-specific vocabulary in the argument. Finally, Conventions analyzes the use of proper conventions (e.g., usage, sentence formation, punctuation, capitalization, spelling). Each criterion is scored on a scale from zero (0) to four (4). Internal consistency for the argumentative writing rubric in this study, reported as a Cronbach's coefficient alpha, was .93.

Journals. Students responded to a total of seven open-ended prompts throughout the instructional program. The prompts were developed for participants to reflect on their experiences picking a topic, writing their letters, working with a peer, and using Google Docs to complete the revision process. Examples of those prompts include: "How did your letter change from your first draft to your final draft? Do you think the process of revision helped make your argument more convincing? Explain," and "Compare the revision process on Google Docs to other approaches to revising your paper – for example, working face-to-face with another student. What was better about Google Docs? What was more difficult or worse?"

Design and Analysis

This study employs a convergent mixed methods design; the quantitative and qualitative data collection and analyses were conducted separately, and the results were merged during analysis (Creswell, 2015). Descriptive statistics were calculated on the rubric scores. Rubric scores were generated by scoring the first, second, and final drafts of the essay. Two trained evaluators scored each essay independently; both evaluators were teachers of English Language Arts at the secondary level. A Cohen's kappa coefficient was calculated to establish inter-rater

reliability; the coefficient for our raters was .76. Viera and Garrett (2005) suggest that a kappa coefficient greater than .60 indicates strong agreement between reviewers. Thus, the evaluators in this study achieved similar levels of accuracy and agreement in their scores. In the few cases where the scorers disagreed, scores were averaged to generate a single score.

To examine research question 1 (difference between peer and teacher feedback on student writing), the two researchers first separated comments into three types: Single, Comment with Reply, and Thread. Single comments consisted of a single comment from a peer. A Comment with Reply consisted of a comment from a peer with a follow-up reply from the writer. Overall, follow-up replies consisted of a short acknowledgement of the suggested revision (e.g., “Thanks!” or “Ok, I will”). Threads consisted of a conversation about a suggested revision. This typically occurred in one of two ways. The first was an initial comment or suggestion followed by a series of clarifying questions and responses. The second was an initial comment or suggestion followed by a revised version of text; here, peer and student would work to refine the revised text until the peer acknowledged it was improved.

Next, peer and teacher comments were categorized by rubric criteria. To establish reliability, the researchers began by individually examining the comments on the first, second, and final draft of one student. The researchers then met to compare results. Overall, there was a relatively high level of agreement between researchers (90% or more) on each draft; because of this high level of agreement, the researchers divided the remaining drafts and independently categorized the comments. Frequencies and mean scores were then calculated by comment type and rubric criterion; these were separated by first, second, and final draft. Frequencies and mean scores were calculated for peers and teachers separately to fully examine how peer and teacher review differed.

To examine research question 2 (how peer and teacher feedback affect writing achievement), separate repeated-measures ANOVAs were conducted on the mean rubric scores for each rubric criterion (e.g., Statement of Purpose, Organization) to examine the difference in scores at three points in time: first draft, second draft, and final draft. Follow-up pairwise comparisons were conducted using a Bonferroni correction to determine the exact nature of the differences within criteria that exhibited a statistically significant repeated-measures effect. Additionally, the number of positive changes in rubric scores after each round of revision were tallied to assess when and how peers and the teacher positively influenced the revision process. Positive changes were defined as any rubric criteria score that increase by at least one point.

To examine research question 3 (student perceptions of impact of feedback from peers and the teacher), journal responses were analyzed using thematic analysis. Rather than establish inter-rater agreement using statistics, the researchers underwent a consensus-building process. The consensus-building process allowed all members to establish a voice and play a role in reaching an agreement about the nature of the themes identified in the data (Baxter & Jack, 2008). The researchers first reviewed the journals independently, met to define themes commonly seen across journals, and then reviewed the journals again in order to refine the themes and definitions further. The researchers then met again to finalize the themes and organize the data within the journals by theme.

The results of the quantitative and qualitative analyses were merged to answer research question 4 (how do student perceptions confirm or differ). During this analysis, we compared student perceptions of feedback provided by peers and the teacher to the type of feedback provided and the impact it had on student writing achievement. After identifying overall class trends, we purposefully selected a critical case that helped inform our understanding of the

relationship between the perception of feedback, type of feedback, and the impact on writing achievement. Critical cases allow the selection of participants that meet specific characteristics (Flyvbjerg, 2006; Onwuegbuzie & Collins, 2007; Patton, 2015). In this study, the critical case is critical because it contradicts the overall pattern of results. For most students in the study, peer feedback did not result in substantial text-based changes in student writing. Our critical case is a single case of a student where both the peer and teacher helped improve text-based issues during revision. The critical case is presented as a descriptive narrative that brings together student performance and reflection.

Results

In the following section, the results of our analysis are presented by research question.

Peer and Teacher Feedback (Research Question 1)

As shown in Table 2.2, peers made an average of 12.52 comments. On average, the majority of comments made by peers were in the criteria of Conventions (5.76) and Organization (3.10); Language and Vocabulary (2.29), Elaboration of Evidence (0.67), and Statement of Purpose (0.71) were among the least frequently made comment types. Single peer comments (31) were the least frequent type of comment, threaded comments were slightly more frequent (42), and the most frequent type of peer comment were comments with replies (190). Comments with replies occurred most in three criteria: Conventions (90), Organization (53), and Language and Vocabulary (31). Threaded discussions were most associated with the criteria of Conventions (22) and Language and Vocabulary (12).

Table 2.2

Peer Comments by Rubric Criteria

Criterion	Comments ^a			Total	M ^b	Sample Thread
	S	CR	T			
Statement of Purpose	6	8	1	15	0.71	<p>Peer: what does this have to do with your argument?</p> <p>Student F: i'm trying to show how we could be productive with more PE time because our brains will be more active.</p> <p>Peer: but how do you know they will turn in their homework if they get more PE time?</p> <p>Student F: They might not, but if they get more exercise time, they might think of their home work to turn in and get better grades.</p> <p>Peer: i understand what you're saying but i don't think you're making this point very clearly. try to think of some other good results of having more PE time. something that really relates to your thesis.</p> <p>Student F: ok. i'll work on making it connect.</p>
Organization	10	53	2	65	3.10	<p>Peer: switch this paragraph and the one before.</p> <p>Student I: why? oh. so it's the same as my thesis?</p> <p>Peer: yea. you talked about being off task first in your thesis statement but your first body paragraph is about us wanting break back.</p> <p>Student I: that flows better.</p>
Elaboration of Evidence	1	8	5	14	0.67	<p>Peer: How do you know? Have you had experience with those riders? Were you one?</p> <p>Student V: I was one of those riders that had very poor balance. I also help with lessons sometimes and I see a lot of beginners hanging on with their legs or just staying stiff, which makes them have poor balance.</p> <p>Peer: That's good information that you can include. Talking about your personal experience with poor balance can establish pathos and helping with lessons can add ethos.</p> <p>Student V: Good point. I'll work on adding that in.</p>
Language and Vocabulary	5	31	12	48	2.29	<p>Peer: maybe you could change this to "improve".</p> <p>Student A: yeah that sounds better then help</p> <p>Peer: it makes it sound more formal.</p> <p>Student A: i like the way that sounds. thanks</p>
Conventions	9	90	22	121	5.76	<p>Peer: your 5th paragraph is just a sentence (not really a paragraph) so it is a run on. Maybe fix that by adding periods.</p> <p>Student P: ok i combined it into another paragraph</p>

						Peer: that reads better but try making it two sentences instead of one. i think it's still a run on Student P: ok. ill do that. thanks.
Total	31	190	42	263	12.52	

^a Comments are classified as Single (S), Comment with Reply (CR), and Thread (T), which is a comment with reply plus at least one additional response.

^b Mean number of comments

As shown in Table 2.3, the teacher made an average of 23.91 comments. The majority of teacher comments were associated with Conventions (10.14) and Organization (6.23); Language and Vocabulary (2.10), Elaboration of Evidence (4.33), and Statement of Purpose (1.10) were among the least frequently made comment types. The majority of teacher comments were single comments (418). Comments with replies (82) occurred primarily in the criterion of Conventions (46); the next-highest number of comments with replies occurred in Organization (13) and Language and Vocabulary (9). There were only two threaded discussions with the teacher, which occurred around Elaboration of Evidence.

Table 2.3

Teacher Comments by Rubric Criteria

Criterion	Comment ^a			Total	M ^b	Sample Thread
	S	CR	T			
Statement of Purpose	17	6	0	23	1.10	Teacher: This sounds a little informal. Make it more formal by stating your claim; this will tell your audience exactly what the purpose of this letter is right from the beginning. Student T: Okay thanks. That would sound better.
Organization	118	13	0	131	6.23	Teacher: This can be used in your body paragraphs instead of your introduction; otherwise it reads like filler in this paragraph. Student J: I'm sorry. It's a bad habit of mine.
Elaboration of Evidence	81	8	2	91	4.33	Teacher: Consider adding something before jumping in. Maybe a personal experience of how you felt the first time you rode bareback? By doing this, you can develop pathos from the beginning.

						<p>Valerie: Maybe I could add in both personal experience and people telling me after they learned how to ride bareback, they would never ride in a saddle again because they loved riding bareback so much? They also told me that its the easiest way to ride because its a technique that you can master.</p> <p>Teacher: Yes, this would provide context for why you are writing the letter that you're writing.</p>
Language and Vocabulary	35	9	0	44	2.10	<p>Teacher: This sounds somewhat childish and contradicts the ethos you built. Try rephrasing it to sound more formal; you want to appeal to [the principal]. Let me know if you need help.</p> <p>Student O: I will make it sound more formal</p>
Conventions	167	46	0	213	10.14	<p>Teacher: Should abbreviations have punctuation after all letters? Can you sometimes use abbreviations without punctuation? Whatever you decide to do, make sure to be consistent. You use "[school abbreviation without punctuation]" in the line above this and "[school abbreviation with punctuation]" here.</p> <p>Student E: right, ill fix that</p>
Total	418	82	2	502	23.91	

Note. A sample comment with reply is provided in the “Sample Thread” column if no evidence of a thread during teacher review.

^a Comments are classified as Single (S), Comment with Reply (CR), and Thread (T), which is a comment with reply plus at least one additional response.

^b Mean number of comments.

Effect on Writing Achievement (Research Question 2)

Table 2.4 displays mean rubric scores by criterion after each draft of argumentative essay. The increase in scores was greater from second to final draft (i.e., after feedback from the teacher) than from first to second draft (i.e., after feedback from peers) in four of the five rubric criteria: Statement of Purpose, Organization, Elaboration of Evidence, and Language and Vocabulary. In the area of Conventions, scores increased somewhat similarly after both peer and teacher feedback. Individual repeated-measures ANOVAs by each rubric criterion revealed statistically significant differences in three of the five criteria: Organization, Wilk’s Lambda = 0.73, $F(2, 19) = 3.60$, $p < .05$, $\eta^2 = 0.28$; Language and Vocabulary, Wilk’s Lambda = 0.61, $F(2,$

19) = 6.05, $p < .01$, $\eta^2 = 0.39$; and Conventions, Wilk's Lambda = 0.40, $F(2, 19) = 14.29$, $p < .001$, $\eta^2 = 0.60$.

Table 2.4

Mean Rubric Scores for Each Draft by Rubric Criteria

Rubric Criterion	First draft (before review)	Second draft (after peer review)	Final draft (after teacher review)
Statement of Purpose	2.71	2.76	3.19
Organization ^b	2.43	2.48	2.95
Elaboration of Evidence	2.52	2.57	2.90
Language and Vocabulary ^b	2.29	2.43	2.90
Conventions ^{a,b}	2.14	2.52	3.05

^a Statistically significant from first to second draft, $p < .05$.

^b Statistically significant from second to third draft, $p < .05$.

With regard to peer feedback, follow-up pairwise comparisons revealed a statistically significant difference in the area of Conventions from first ($M = 2.14$) to second ($M = 2.52$) draft, $p < .001$. Follow-up pairwise comparisons also revealed that the differences from first to second draft in each of the remaining rubric criteria were not statistically significant. With regard to teacher feedback, follow-up pairwise comparisons revealed a statistically significant difference in the areas of Organization from second ($M = 2.48$) to final ($M = 2.95$) draft and Language and Vocabulary from second ($M = 2.43$) to final ($M = 2.90$) draft, $p < .05$. In the Conventions criterion, the difference from second ($M = 2.52$) to final ($M = 3.05$) draft was also statistically significant, $p < .01$.

Table 2.5 displays the number of positive changes in rubric scores from draft to draft. From first to second draft, the most frequent number of positive changes occurred in the area of Conventions. From second to final draft, over half (10) of the participants experienced positive

changes in the areas of Organization, Elaboration of Evidence, and Language and Vocabulary. Additionally, over half (12) of the participants showed growth in the Conventions criterion.

Table 2.5

Number of Students with Positive Changes in Rubrics Scores after Each Round of Review by Rubric Criteria

Rubric Criterion	Number of students with positive changes after peer review	Number of students with positive changes after teacher review
Statement of Purpose	1	8
Organization	1	10
Elaboration of Evidence	1	10
Language and Vocabulary	2	10
Conventions	7	12

Note. A positive change is defined as any rubric criterion score that is at least one point higher than a previous draft.

Perception of Feedback (Research Question 3)

Analysis of student journal reflections uncovered three themes: fluency, grammar, and ideas and content. Each theme reflects an area in which students perceived their peer helping them improve their writing. Fluency refers to the students believing the peer helped make their writing sound better by pointing out choppy sentences, upgrading vocabulary, and rewording awkward sentences. Ten students perceived that their peer helped them improve their writing in the area of fluency. For instance, Student Y reflected, “My partner helped me with small edits like rewording sentences.” Similarly, Student A believed, “There were a few places where [my partner] pointed out awkward sentences or stuff that doesn’t make sense.” The reflections associated with this theme were most closely associated with the Language and Vocabulary and Conventions criteria of the rubric.

Grammar refers to the student believing the peer helped correct comma splices, run-on sentences, capitalization errors, punctuation errors, and usage errors. Ten students indicated that they believed their peer helped them improve in the area of grammar. Student M considered, “My letter has changed little by little. It is only the small things though. Sometimes I forgot to put a comma in or a semicolon.” Student R remembered, “[My partner] pointed out there was run-on sentences and non-capital I’s and I have changed these mistakes.” The reflections associated with this theme were most closely associated with the Conventions criterion of the rubric.

Ideas and content refers to the students believing their peer helped to improve their writing by helping the student reorganize ideas, expand upon ideas, and omit content. Five students believed their peer helped them improve in the area of ideas and content. Student I commented, “My editing partner mainly pointed out the confusing parts or sentences...I changed up some parts, switched some words, and completely redid my counter argument paragraph. I completely agree with the constructive comments.” Another, Student G, noted, “I’ve both stretched and shortened my paper in places because of the suggestions that my peer gave me and I think it’s looking better. My peer editor pointed out several flaws in my examples which believe it or not really helped me see what I should change around and add.” The reflections associated with this theme were most closely associated with with the Organization and Elaboration of Evidence criteria of the rubric.

With regard to teacher feedback, three themes emerged about how the teacher helped students improve their writing: strengthen their argument, correct errors in conventions, and make their letters sound more professional. The strengthen their argument theme was defined as the student believing the teacher’s feedback helped them make their argument more convincing

by providing clarity for their reasoning, focusing their argument, and strengthening their use of persuasive appeals. Ten students believed that the teacher helped them strengthen their argument.

For instance, Student J wrote:

After working with [my teacher], I noticed that my first draft was barely anything compared to my final draft. The final draft is more clear, a little shorter, and my argument is stronger. Even though it's a small testament, it's a strong one.

This theme is most closely associated with the Statement of Purpose and Language and Vocabulary criteria.

Correcting errors in conventions was defined as the students believing the teacher helped them correct comma splices, run-on sentences, punctuation errors, spelling errors, and usage errors. Ten participants mentioned that they believed the teacher helped them correct errors in grammar and conventions. Student D reflected, “[My teacher] noticed the tiniest details. Like what I needed to capitalize, among other things like a strange sentence, or a wrong letter maybe even a very wrong paragraph, line spacing, the list goes on and on.” The reflections associated with this theme are aligned with the Conventions criterion of the rubric.

Finally, the professionalism theme was defined as the students believing that the teacher assisted them in making their writing more professional and presentable by helping them reorganize ideas, expand evidence, omit unnecessary details, and use appropriate business letter format. Seven students believed that the teacher assisted them in making their letters more professional. Specifically, Student A wrote, “My argument now is worded better, has more details to convince my parents, is organized, and is more professional in general.” The reflections categorized in this theme are associated most closely with the Organization and Elaboration of Evidence criteria.

Perceptions and Writing Achievement (Research Question 4)

Research question 4 focuses on integrating the quantitative and qualitative results to understand how students' perceptions of the feedback they received confirm or differ from the comment type and achievement result. Overall, students believed that their peer helped them improve their writing in the areas of Conventions, Organization, Elaboration of Evidence, and Language and Vocabulary. This is mostly consistent with the comments provided by peers, which were greatest in the criteria of Conventions (121), Organization (65), and Language and Vocabulary (48). The only difference between student perceptions and actual comment type was the small number of comments provided that focused on Elaboration of Evidence (14). Despite the high level of consistency between students' perceptions and comment type, the comments made by peers resulted in statistically significant changes in only one rubric criterion: Conventions.

Students perceived teacher feedback to have a greater impact on their writing than it actually did. The students believed that the teacher helped them improve in all rubric criteria; however, the majority of teacher comments were in the areas of Conventions (213), Organization (131), and Elaboration of Evidence (91). Analysis of rubric scores from second to final draft revealed a strong consistency between these comments and student achievement – statistically significant changes were found in the areas of Conventions, Organization, and Language and Vocabulary.

Critical case: Valerie. The following case of Valerie (Student V) illustrates a critical case of revision among the students in this study. This case was considered critical because it did not follow the typical pattern of improvement in writing scores after receiving peer feedback. A typical pattern of improvement after receiving peer feedback was one where writing scores either

improved only in the area of Conventions (9 cases) or did not improve at all (9). In the critical case, peer feedback led to text-based revisions in the areas of Statement of Purpose, Elaboration of Evidence, and Language and Vocabulary but not Conventions (i.e., surface-level revisions) (see Table 2.6). Thus, this case was selected because it reveals the ways in which peer feedback can help students move beyond making surface-level changes during revision.

Table 2.6

Critical Case Rubric Scores for Each Draft by Rubric Criteria

Student	First Draft (before review)					Second Draft (after peer review)					Third Draft (after teacher review)				
	S	O	E	L	C	S	O	E	L	C	S	O	E	L	C
V	3	3	3	3	3	4	3	4	4	3	4	4	4	4	4

Valerie wrote an argumentative letter to the owner of the barn where she rode horses. Her letter explained why beginning equestrians should initially learn by riding bareback: it improves balance, builds confidence, and is less painful for the animal. Although she reported that her peer helped her improve her writing beyond Conventions, she felt feedback from both the peer and teacher was unnecessary at times.

Prior to working with a peer, Valerie was pleased with the letter she composed. She reflected:

In my letter, I used many examples for my reasoning in each of my paragraphs. My letter is pretty long with evidence, advice, and stuff that has a lot of feeling. I do believe that I could add a lot more before I'm done with the final letter.

Valerie was somewhat skeptical of receiving feedback from a peer. She described her previous experiences with revising her writing as one where working individually was more effective than working with a peer reviewer.

In total, Valerie received eight comments from her peer; the bulk of these fell under the areas of Language and Vocabulary (2), Organization (2), and Elaboration of Evidence (3).

Valerie engaged in one threaded discussion about Elaboration of Evidence (see Sample Thread in Table 2.2) and one threaded discussion about Language and Vocabulary when working with her peer; additionally, she replied to all other comments (6) from her peer. Valerie's reflections revealed that she believed her peer helped her strengthen her purpose and elaborate on her evidence. After working with a peer, Valerie reflected, "I think my work has changed a lot and become a lot better. It has a stronger point of view and a lot of good points/examples."

Additionally, she indicated, "I believe that this letter will turn out very well and that I may have a lot of people convinced!" Her rubric scores confirm that her perceptions were accurate; Valerie's rubric scores improved in three criteria after working with a peer: Statement of Purpose, Elaboration of Evidence, and Language and Vocabulary.

Valerie received a total of 22 comments from the teacher; the majority of these were in the areas of Organization (4), Elaboration of Evidence (2), and Conventions (15). When working with the teacher, Valerie engaged in two threaded discussions about Elaboration of Evidence (see Sample Thread in Table 2.3) and replied to the remaining 20 comments. Valerie was worried prior to working with the teacher, stating, "I'm just a little scared for what [my teacher] will say about it. I don't know if she will like it or not." After reviewing the feedback from her teacher and revising her writing, Valerie wrote, "The revision process has helped my paper become better. It has completely changed from the first draft...For instance, I have cut a lot out and added a lot more." Her rubric scores confirm these perceptions; Valerie's rubric scores improved in two criteria after working with the teacher: Organization and Conventions.

Despite the improvements made after working with both a peer and the teacher, Valerie did not always value the advice given to her: “Sometimes I didn’t like the ideas [my peer and teacher] gave me so I didn’t use their advice. Some of the advice was unnecessary, I thought. Maybe that they were suggesting too much for me to change.” In Valerie’s case, she carefully considered which pieces of feedback to use during her revisions.

Discussion

The results of this study suggest that the feedback provided by peers and the teacher does affect the writing achievement of middle school students. With regard to the effects of peer feedback, the difference in mean rubric scores from first to second draft (i.e., after peers gave feedback) was statistically significant in the area of Conventions. Likewise, the difference in mean rubric scores from second to final draft (i.e., after teacher feedback) was statistically significant in three rubric criteria: Organization, Language and Vocabulary, and Conventions. These results are not altogether surprising. Current (Zheng et al., 2015) and prior (Faigley & Witte, 1981) research found younger writers tend to provide feedback that addresses surface errors more than feedback that changes the meaning or organization of the text.

What is more surprising is the level of consistency in the amounts and types of feedback provided to students in this study. Both peers and the teacher provided the greatest amounts of feedback in the areas of Conventions and Organization. Although the overall amount of teacher feedback was greater, the relative agreement between teacher and peer suggests that students were able to detect both surface and text-based errors in the writing of their peers in a way that was consistent with an expert. This is an important outcome. Revision is a complex, cognitive process that relies heavily on the ability to detect an error while critically reading a written piece of text (Alamargot & Chanquoy, 2001; Hayes, 1996, 2004). The fact that students detected both

surface and text-based errors suggests that peers do have the capacity to go beyond providing surface-level feedback during peer review.

Of course, the ability to detect errors in written text is only one step of the revision process. Whether reviewing or revising, a student also needs to be able to reflect on the nature of the identified error by finishing the problem-solving process and making decisions about possible solutions prior to producing a new version of that text that resolves the detected error (Hayes, 1996). It is here in the reflection and text production processes that students in this study appeared to struggle. Peers detected and provided the greatest amounts of feedback in the areas of Conventions and Organization; however, peer feedback led to significant improvement from first to second draft in only one area of the rubric – Conventions. It was not until the teacher provided feedback that Organization significantly improved. Similarly, peer feedback was third-highest in the area of Language and Vocabulary but did not lead to significant changes until feedback was provided by the teacher. One reason for these results is that majority of students were inexperienced with providing feedback. As peer reviewers, they were able to detect errors but likely lacked the task schema associated with providing direct and effective feedback on text-based issues, such as forming a strong, well-supported argument. As a result, the teacher was the one who provided direct feedback that led to substantial text-based changes in student writing.

It is also likely that students struggled to make effective use of the feedback provided by peers. Students engaged in a variety of threaded discussions with their peer reviewers, particularly around Conventions, Language and Vocabulary, and Elaboration of Evidence. In most cases, this consisted of the writer asking for clarification about a suggested revision or additional feedback on an implemented revision. Analysis of students' perceptions about the feedback they received suggests that most students believed that the feedback provided by peers

helped improve their grammar and sentence fluency as well as their overall ideas and content, yet achievement scores from first to second draft (i.e., after peer review) changed very little in areas other than Conventions. This suggests that it may have been more challenging for students to address text-based errors from the feedback provided despite reporting that the feedback helped improve their writing beyond the surface-level.

An immediate implication of this study is that teacher feedback is more effective at improving students' writing achievement scores than peer feedback. Students engaged more frequently with peers than the teacher about the feedback that was provided, and that feedback ultimately failed to result in any significant improvements outside of surface-level errors. In contrast, teacher feedback led to statistically significant changes in both surface and text-based errors. Teacher feedback, then, may be more likely than peer feedback to help improve student achievement scores. However, it is important to consider that improved achievement is not the only goal of peer review. Of equal if not greater importance is to engage novice writers in activities that help develop the revision task schema that they lack (Hayes, 1996, 2004; MacArthur, 2016; McCutchen, 2006). This largely involves exposing students to the writing of others in a way that brings attention to the thinking that accompanies that writing and revision. Doing so can help students develop the revision task schema needed to effectively provide feedback and revise their own work based on the feedback of others (Hayes, 1996, 2004; MacArthur, 2012, 2013, 2016; McCutchen, 2006; Trupiano, 2006).

With that in mind, the peer review process that took place in this study suggests that peer review can be beneficial beyond improved achievement scores. Although teacher feedback may have led to the biggest changes in student achievement scores, it resulted in the least amount of conversation about the revision process. Students in this study engaged in numerous threaded

discussions with their peer reviewer about issues that went beyond the area of Conventions. In those discussions, peers were challenged to provide clarification or additional feedback that improved the writing of another person. For young writers, this type of conversation is essential to developing effective revision task schema. In written form, such conversation provides practice with the skills needed to reflect on and make effective use of feedback to improve their writing (MacArthur, 2012).

The critical case of Valerie exemplifies the contribution of the peer review process to student learning. Valerie did not just follow the suggestions from her peer and teacher as a form of error-correction; she took the time to carefully consider what was being suggested and how it might or might not improve her overall letter. As a result, her written work improved substantially over each draft. Valerie's careful critique of the feedback provided to her suggests that it is important to provide students with the opportunity to see both peer and teacher feedback as more than a list of errors to correct. This has the potential to improve not only students' revision skills but also their writing process overall. Others (Beach & Friedrich, 2006; Christiansen & Bloch, 2016; Patchan & Schunn, 2015) have similarly found that student writing improves when they take time to make sense of feedback as it applies to the document as a whole rather than suggestions to be accepted or followed outright.

Implications

One implication of this study is that an expert like the teacher may need to provide both surface and text-based feedback even when using Web 2.0 to support peer review. Although students in this study were able to detect a variety of issues in the work of their peers, the feedback they provided failed to lead to substantive changes in students' written work. This

suggests that, among middle school students, a teacher may need to dedicate time and energy to reviewing work that has also been reviewed by peers.

This expectation, however, is problematic for several reasons. The first concerns the burden that it places on teachers. If deeper levels of feedback require a teacher to spend an average of 10-15 minutes per document, teachers with a large caseload (e.g., 100+ students) would likely find it untenable to provide such feedback across multiple versions of a document. The second concerns the nature of learning to revise. Revision is a complex, cognitive process that requires young children to develop the ability to identify both surface-level and text-based errors in writing, conceptualize intended improvements for that writing, decide upon which improvement to use, and create new text that improves upon their previous drafts (Hayes, 1996; MacArthur, 2012; McCutchen, 2006). If the teacher provides the bulk of text-based feedback, young writers are deprived an opportunity to practice and cultivate key revision skills.

One way to address both concerns is find ways to improve the feedback provided by peers. In our critical case, the peer was able to provide feedback that helped Valerie make a variety of text-based changes to her writing. This suggests that children of this age are capable of developing schema for providing feedback that goes beyond the surface-level. However, the fact that Valerie was the only case where peer feedback led to text-based changes suggests that such schema may not come naturally for most children. Even though the students in this study were provided a review checklist, the feedback they provided resulted primarily in surface-level changes. Teachers therefore may need to spend time helping children develop proper schema for peer review before they can offload text-based aspects of the review process to peers. Others have found that, with intentional training, students have the ability to provide effective feedback

for peers that goes beyond surface-level (Fitzgerald & Markham, 1987; Harper, 1997; Rahimi, 2013).

The results of this study also suggest that the areas of Organization and Language and Vocabulary are most likely to be challenging for beginning writers. These were areas where the teacher had the most significant effect on students' writing. Teachers therefore may need to spend more time working with students to develop their own understanding of these areas before expecting them to identify issues with and provide feedback on common problems in these criteria. Areas like Statement of Purpose and Elaboration of Evidence may require less training because these are often easier for beginning writers to find and improve – the purpose is either clearly or unclearly stated, and evidence is elaborated upon through examples or not. Students could more easily develop schema for providing feedback in these areas, leaving the teacher with more time to address elements such as organization and language until students are more proficient at identifying and providing feedback that improves deeper issues with argumentative writing.

Limitations

The biggest limitation of the study was the use of a convenient sample with limited subjects. While repeated-measures designs require fewer subjects because the same subjects are used over multiple treatment periods (Minke, 1997), the small sample size makes it difficult to say if the results would be the same for different students at another school with a different teacher. However, the purpose of this convergent mixed methods study was not to generalize to the population but to better understand the role that peers and teachers might play in the process of review when using Web 2.0. To that end, this study provides insight into a gap in the literature. Rather than conduct an experiment (e.g., peer review with Web 2.0 vs. without), this

study identifies the effects of peer and teacher feedback on students' writing. The methods used, such as addressing inter-rater reliability, providing rich descriptions, and triangulating data, improve the credibility and trustworthiness of the study as well as the degree with which the study informs the literature more broadly (Creswell, 2015; Lincoln & Guba, 1986).

Future Research

The current study suggests several areas for future research. While students in this study received intentional training and modeling on how to leave quality feedback, they were relatively inexperienced in both identifying problems in specific rubric criteria and providing feedback on those problems in this digital format. Future research could investigate the ways ongoing training could improve the quality of feedback given or if feedback moves beyond surface-level errors over time. Future research might also examine the sequence of peer and teacher feedback. In this study, feedback was provided by a peer first and the teacher second. While this approach is not uncommon in K-12 settings, results of peer feedback using Google Docs may differ when alternate approaches are used. Additional research could explore if and how young writers benefit from peer and teacher feedback that is provided in a single round of revision as well as the manner in which specific revision task schema develop through the use of online revision tools.

Conclusions

Current research on writing and revision with Web 2.0 tools has produced mixed results. Some studies show an improvement in the quality of feedback provided to students during peer review (e.g., Patchan & Schunn, 2015; Rahimi, 2013) or improved student interaction and collaboration (e.g., Dekeyser & Watson, 2006; Ishtaiwa & Aburezeq, 2015; Lin & Yang, 2011). Yet others who have compared peer review and revision with Web 2.0 to peer review and

revision without Web 2.0 have found that it does not always improve writing scores overall. The results of this study suggest that peers are capable of providing feedback beyond the surface level, yet they may need support in learning how to effectively provide and make use of that feedback. It may be beneficial, then, for scholars to differentiate between and among the different qualities of writing and changes made when studying peer review. This would help move research beyond the focus on determining whether one medium is better than another toward a more nuanced perspective that advances our understanding of the ways in which peer review through Web 2.0 can live up to its potential in today's classrooms.

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APPENDIX

Appendix 1.A

Peer Review Checklist

Reviewed	Peer Review Checklist Item
	The writing is organized; it's clear, uses transitions, and there's a logical progression.
	Word choice is appropriate for the audience, and the writer uses the correct words.
	Includes ethos, logos, and pathos to strengthen the argument.
	Evidence accurately supports the argument.
	The argument includes relevant details.
	Remains focused and on topic throughout the argument.
	The argument makes sense.
	The writer addresses and acknowledges the counterargument.
	Sentences are fluid and do not sound awkward.
	Each sentence uses proper punctuation (period, comma, semicolon, etc.).
	Proper capitalization is used (proper nouns, beginning of sentence, I, etc.).
	Letter uses proper business letter format.

CHAPTER 3

DESIGNING A REVISION TOOL TO DISTINGUISH SURFACE-LEVEL AND TEXT-
BASED WRITING FEEDBACK ²

²Neumann, K. L., & Kopcha, T. J. Submitted to the *International Journal of Designs for Learning*

Abstract

This paper presents a design case that describes the design, development, and user experience testing of a Google Docs revision add-on. The add-on is an instructional, peer review tool intended to help students distinguish surface-level feedback from text-based feedback to support the development of revision task schema. Eleven secondary teachers completed a survey about using the add-on for instructional purposes, and 56 secondary students completed a survey after using the tool to provide feedback to a peer's writing and make changes to their writing based on feedback provided to them through the tool. Thematic analyses revealed recommendations for modifications and additions to the tool. Next steps include researching the effects of the updated add-on on secondary students' revision task schema development.

Introduction

Improving the writing skills of secondary students is a national concern. Despite the obvious need for writing skills in the attainment and completion of jobs in the workforce, many students do not exhibit proficient capabilities in writing. The Nation's Report Card for Writing reported that 73% of twelfth graders exhibit basic or below basic ability in writing, which means they have partial mastery of knowledge and skills required for their grade level (National Center for Education Statistics, 2012). While new, Internet-based technologies afford instant and rapid publication of student writing, they have also encouraged a lack of revision in young writers (Verheijen, 2013). As it is, students tend to do little revision without the help of others (Scardamalia & Bereiter, 1986). This is problematic because research indicates that revision skills can impact student achievement starting in the upper middle grades (Limpo, Alves, & Fidalgo, 2014). It is important for students to understand what revision is and how to employ revision strategies to their own writing.

To better support students in understanding revision and adopting revision strategies in their writing, the authors developed a Google Docs add-on called *Revision Assistant*. The add-on was designed to support the formation of revision task schema among secondary students. According to Hayes (1996), a task schema is “a package of knowledge, acquired through practice, that is useful for performing the task and is retrieved as a unit when cues indicating the relevance of the schema are perceived” (p. 16). Hayes used this definition to identify three cognitive processes associated with revision task schema: text processing (i.e., critical reading), reflection (i.e., problem solving, decision making), and text production. Engaging in these cognitive processes is critical when revising because it not only improves writing quality, but also it supports the development of robust revision task schema (MacArthur, 2012). *Revision*

Assistant was developed to encourage students to engage in these processes, both when making changes to their own writing and also when providing feedback to someone else's writing.

Origin of the Design

The design of *Revision Assistant* was inspired by prior research conducted with middle school Language Arts students (Neumann & Kopcha, Chapter 2). The first author's previous experiences as a high school and middle school English teacher led her to observe that many students struggled with major aspects of formal writing: conventions and clarity of ideas (e.g., content, organization). To test these observations and study the effects of peer and teacher revision of argumentative letters in Google Docs, we conducted the previous study; both peers and the teacher left feedback in the form of Google Docs comments. The results indicated that peers focused on providing surface-level feedback (e.g., conventions), and we hypothesized that the feedback focused on text-based errors (e.g., organization, purpose) was lost in an overwhelming stream of comments. This finding was not surprising of inexperienced writers; they tend to focus on providing surface-level feedback and making surface-level changes during revision because they already have a schema for these types of errors, and text-based errors are more challenging to identify and correct (MacArthur, 2012, 2016; McCutchen, 2006).

Initial Design Decisions

Revision Assistant was developed from an initial set of design decisions. These decisions were based on the practical and scholarly experiences of both authors that included prior K-12 teaching experience as well as the data collected from middle school Language Arts students in the previously mentioned study. The first decision was practical in nature – as former teachers, we (the authors) wanted to build a tool that would be readily and widely available to teachers. Rather than build a proprietary system, we decided that *Revision Assistant* should be built as an

add-on for Google Docs. This decision was based on the increasing popularity of current approaches to K-12 technology integration, such as Bring Your Own Technology (BYOT) and 1:1 Chromebook initiatives. Districts who adopt these approaches rely heavily on the web-based suite of productivity tools offered for free by Google Apps for Education (e.g., Google Docs, Google Slides).

The second decision addressed the revision process more directly – we sought to distinguish surface-level and text-based feedback by visually depicting surface-level feedback, similarly to proofreading marks, on the document so students would not overlook the text-based feedback provided through comments. The intention was to make the revision task schema more manageable for students by instantly distinguishing the two types of feedback provided to them as they prepare to engage in the cognitive process of text processing, which is directed by the revision task schema and involves critical reading of the feedback in the context of their writing. During text processing, writers will critically read their writing and feedback to evaluate the suggestions from their peers and the effectiveness of those suggestions for their writing.

In addition to visually portraying surface-level feedback, we sought to engage users in the cognitive process of reflection, which is directed by the revision task schema and includes both problem solving and decision making. These two components are intricately linked; problem solving occurs when a writer detects a problem based on their goals but is unsure of how to correct it, and decision making occurs when a writer identifies solutions based on their evaluation and decides which solution to use to solve the problem (Hayes, 1996). To ensure that users engage in both the problem-solving and decision-making processes when using the tool, our third design decision was to exclude the ‘accept’ or ‘accept all’ feature that is commonly found in many word processing tools (e.g., Microsoft Word, Google Docs).

The decision to exclude an ‘accept all’ feature and require that users manually accept or reject was a result of our intention to help students internalize surface-level errors through repeated use. The previous research study supported the omission of the ‘accept all’ feature; students in that study tended to arbitrarily accept every suggestion provided to them without considering whether those suggestions were appropriate or made sense. If this were to happen with *Revision Assistant*, students would not learn from common errors made while writing because they would not have the opportunity to engage in the cognitive processes of problem solving and decision making. Thus, the omission of the accept all feature forces users to make a decision about if and how to use the feedback provided to them, which could expand their revision task schema.

Below we describe each design decision in the context of the four phases of development of *Revision Assistant*. Within each phase there were emergent design decisions, which are explained in each of the phases.

Phase 1: Initial Design

Phase 1 involved prototyping user behaviors using mock-ups of the tool that were hand-drawn in a notebook (see Figure 3.1). The design depicts a toolbar at the top of a Google Doc; the toolbar includes images of handwritten proofreading marks, which were to appear on the page when pushed by the user. After developing the initial design on paper, the look and functionality of the tool were mocked up using images created using Paintbrush for Mac. As shown in Figure 3.2, a user would use the add-on by manually inserting feedback. This action would be completed by highlighting the location for the feedback and then pushing the necessary button. The images were then integrated into a brief video clip (~5 min) that demonstrates the intended functionality of the tool (see video, Figure 3.3).

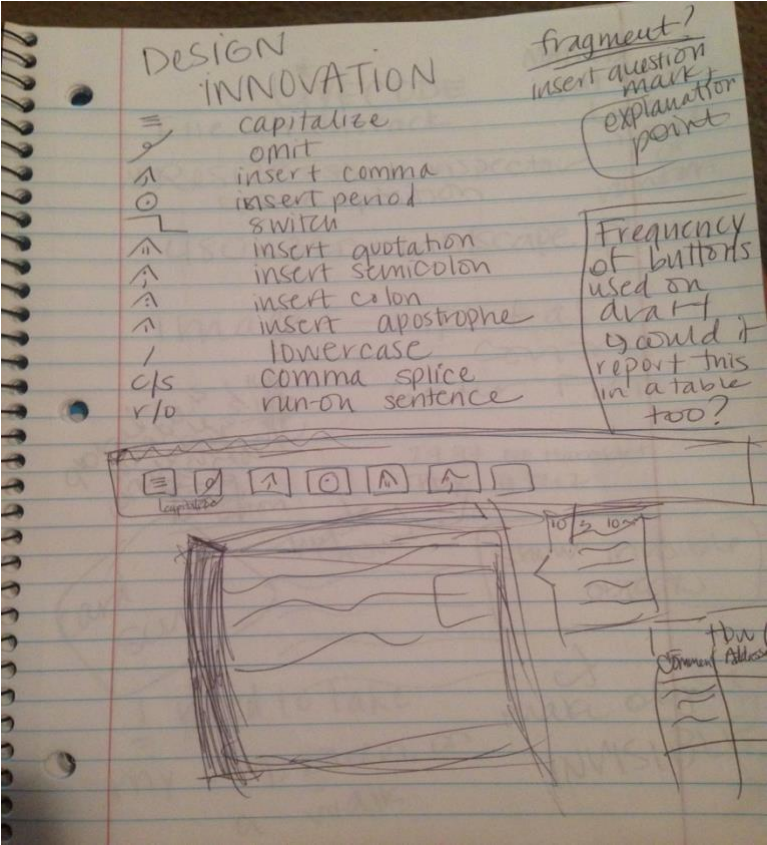


Figure 3.1. Initial hand drawn design for *Revision Assistant*. This figure represents the initial design that was hand drawn in September 2014.

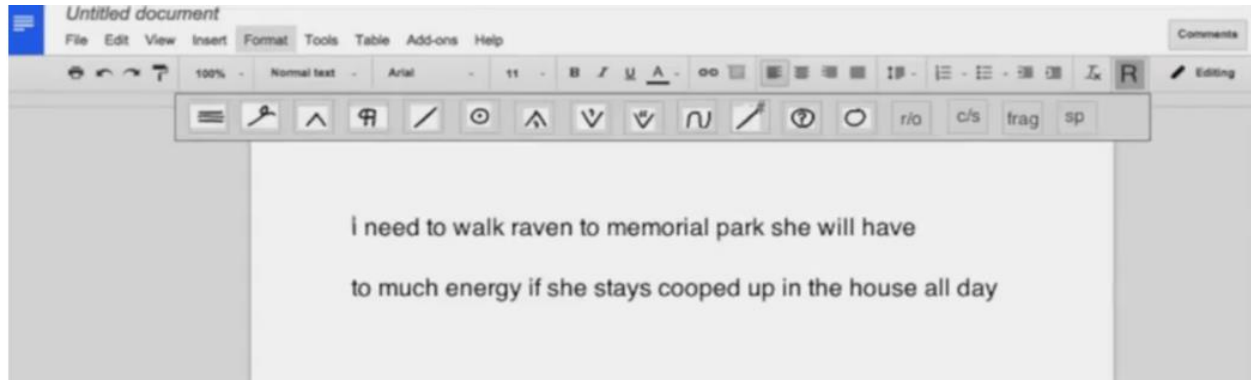


Figure 3.2. Graphical image of the initial design. This figure represents a graphical representation of the initial design that was created in October 2014.

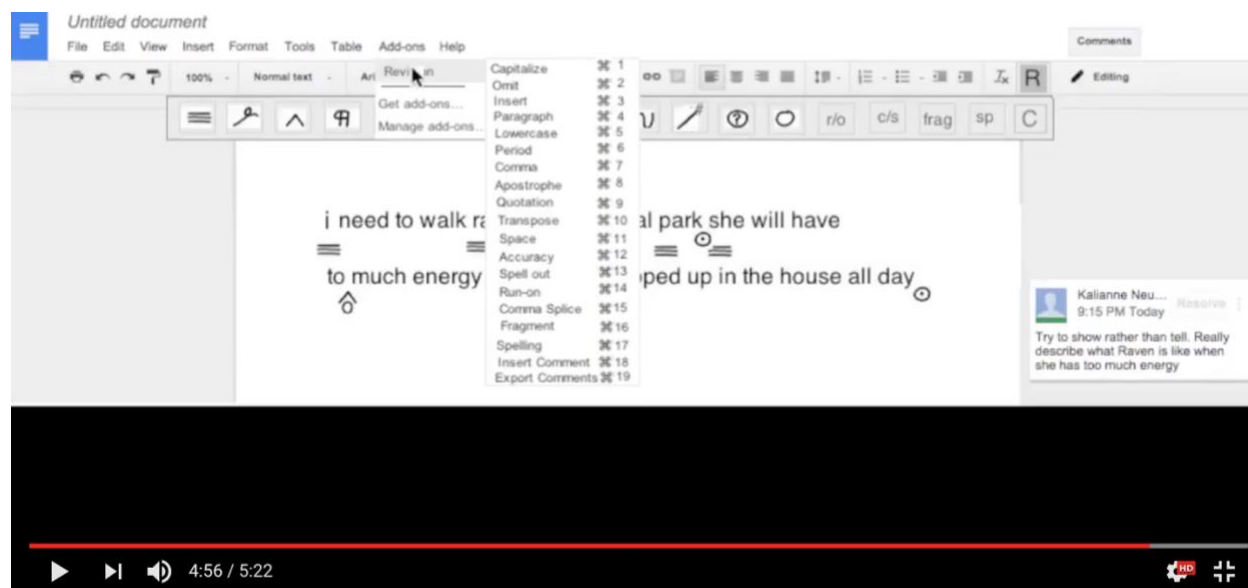


Figure 3.3. Video depicting the intended functionality of the initial design. This video depicts the intended way the initial design should function and was created in November 2014.

One design decision that emerged during this phase was the addition of an export comments feature. The export comments feature was inspired by the academic revision process and the need to explain to reviewers how a comment was or was not addressed in the revision. The intended functionality of the feature was to export the comments made throughout a given document in table form and provide a space for users to explain their changes. The exported comments would allow a teacher or student to analyze those comments collectively and see what types of content-based errors were made most often.

Phase 2: Appearance Compromises

In Phase 2, we began working with a university-based computer programmer to develop a working prototype of the design. The meetings we had with the developer revealed a major logistical flaw in the initial design: the proofreader's marks could not be inserted on the page due to issues related to spacing and formatting. Using images to depict each error symbol required

the use of a double-spaced document; those images would not appear correctly on a single-spaced document. However, the developer noted that there was no way to program a Google add-on to control the line spacing within a given user's document. We therefore modified the design. Instead of the symbol actually appearing on the page, the new design associated a color with each of the errors/buttons, and the color would place a line over the necessary letters or words to indicate the location of feedback. Additionally, we designed a sidebar that would function as a key for the colors associated with each proofreading mark (Figure 3.4).

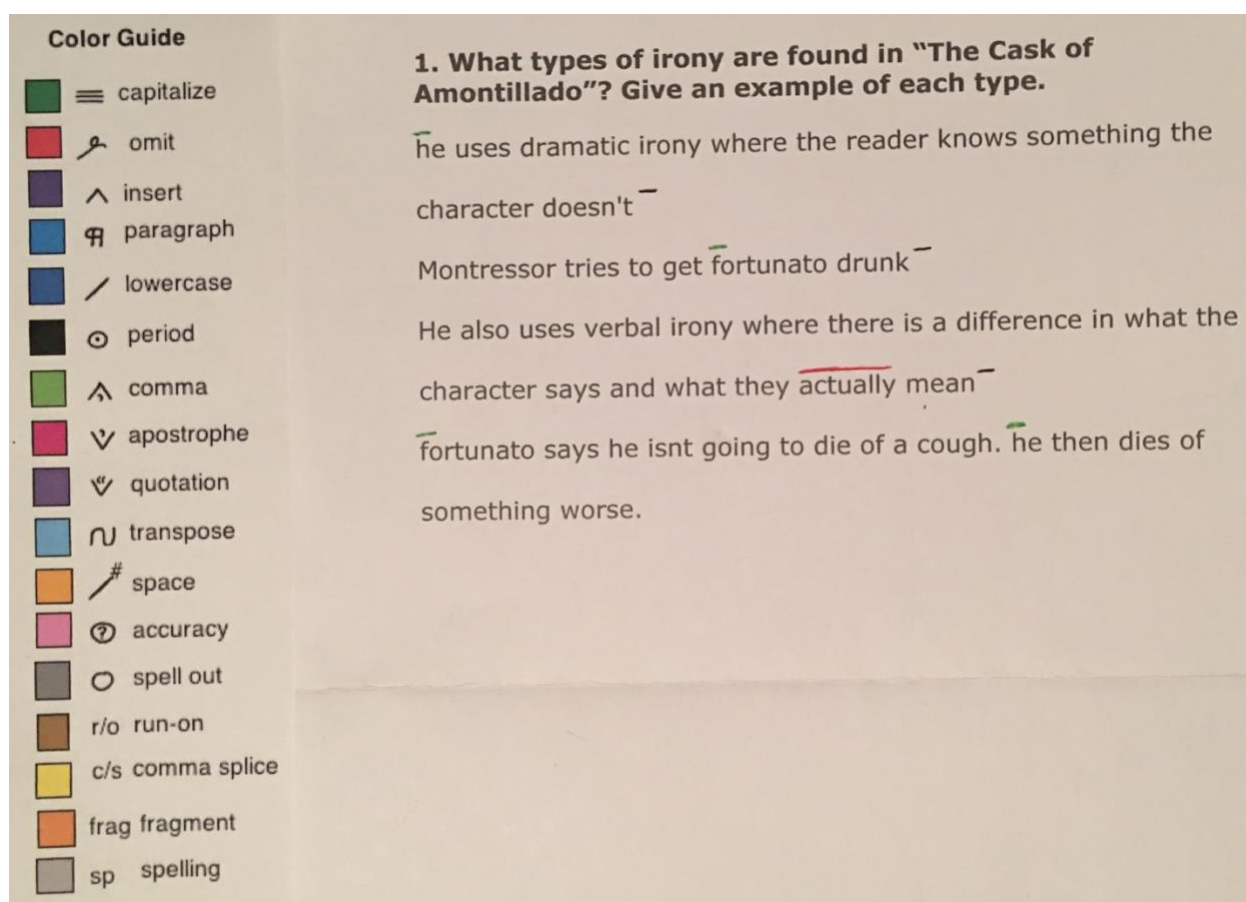


Figure 3.4. Color guide sidebar to link proofreading marks with colors. This figure represents the November 2014 appearance compromise by portraying an example of text with overline suggestions.

The revised design (i.e., using colors instead of proofreading mark images) was then mocked up and tested with a group of six secondary English teachers in Georgia. The mockup consisted of a series of still images developed in Paintbrush. We printed out an image of each of the major design features (e.g., toolbar, color key, sample text) and arranged the images on a table as if they were a functioning piece of technology. The teachers physically touched the images with a finger to model user behaviors and used a marker to draw a line over the text at the location of the identified error. For example, they would first touch the symbol of the feature they wanted to use, then locate a pen or marker that represented the color associated with the button, and finally draw a line over the appropriate letters or word before setting down the pen or marker and moving on to their next suggestion. After providing all of their surface-level feedback, the teachers wrote comments using sticky notes and placed them on the table near the location of the comment. When all comments were written, the teachers pushed the export comments button with a finger and relocated the sticky notes to a printed copy of the export comments table.

After reflecting on their process and considering how it might function in their classrooms, the teachers indicated that they liked how receiving feedback would require a student to make a decision about that feedback. However, they indicated a strong preference for displaying the proofreading marks as symbols on the page. Although they understood the programming constraints, their concern was over the use of colored lines to indicate student errors. The teachers suggested that if the images could not appear on the page, the colors needed to highlight the letters or words instead of overlining them; they believed that students would ignore the colored overline just as much as they ignore the red spelling underline. After seeing what the overline looked like on paper, we agreed with the teachers. The last thing we wanted

district's Google Apps for Education contact, who connected us with Promevo, a premier partner of Google that helped them create a variety of items. We verbally pitched the idea to Promevo on July 21, 2015, and the following day, we sent the company a newly updated version of the video depicting the design and functionality of the tool. The updated video combined features from Phase 1 and Phase 2; it emphasized the following features: (1) proofreading symbols as images rather than color coding, (2) an export comments table, and (3) a frequency tracker of toolbar buttons (see Figure 3.6). Based on teacher feedback and a review of the literature, we believed that these features were the most important to include in the design because of their potential to support the expansion of a revision task schema.

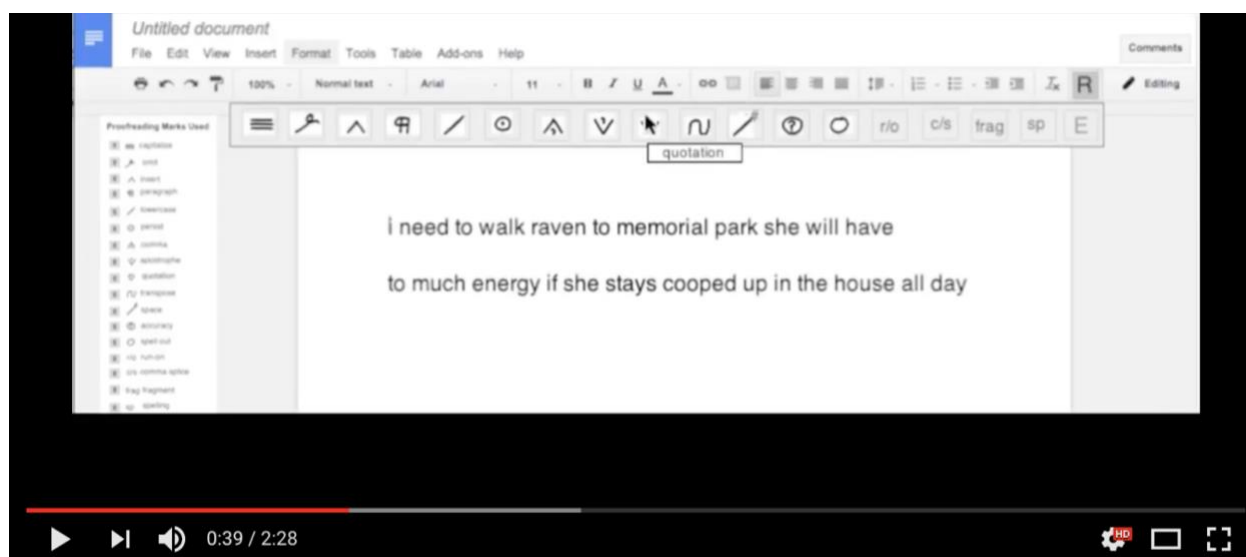


Figure 3.6. Video of the updated design sent to Promevo. This figure represents the video of the updated design that was sent to Promevo in July 2015.

By August 2015, Promevo created a working prototype of *Revision Assistant*. Several features did not appear in the add-on as we had hoped, so we met again with the developers to discuss the working prototype. One issue was that the proofreading marks did not appear as images in the document. The Promevo programmers confirmed that it was not feasible to

integrate the proofreading mark images on the page; however, they designed a solution to this issue that we had not previously conceptualized. After opening the add-on, a user would see a new toolbar along the right side of the Google Doc that contained a total of 23 buttons. The majority of buttons dealt with issues related to writing conventions, such as correcting case format (e.g., capitalization, lower case) or inserting punctuation marks (e.g., comma, colon, period). When used, these proofreading marks were set apart from normal text in two visually distinct ways. First, they were surrounded by parentheses at the location of the user-identified error. Second, they were set to a red text color. For example, an inserted comma appeared in red font as this: (,).

After the meeting, we spent some time exploring the features of the add-on and came up with four main design improvement suggestions for the programmers. The first was that the toolbar was cumbersome; having 23 different buttons made it difficult to easily find and make use of the various proofreading marks that were available. To address this, we suggested organizing the buttons into two categories to make scrolling through them more manageable and appealing for secondary students. We suggested the categories of Conventions (15 buttons) and Structure (7 buttons) and that they function as expandable dropdowns with all buttons in each category appearing in alphabetical order. This solution fit our initial design decisions well in that it separated surface-level errors from deeper text-based errors.

The second thing we noticed was the abrasive nature of the color red used to indicate all of the surface-level suggestions. To remedy this, we suggested that buttons included in the Conventions category be colored blue, with the exception of omit, and Structure buttons be colored green. Our third suggestion had the purpose of not only informing students about common errors they make while writing but also informing teachers of common errors students

make while writing; we again suggested adding an occurrence tracker on the toolbar to calculate the number of times each button was used on the document. Finally, our fourth suggestion was intended to allow both students and teachers to examine all documents on a page in an organized table; we again suggested adding an export comments button that exported all comments on a document into another Google Doc or Google Sheet.

Our suggested changes were quickly conceptualized. The Promevo programmers organized the toolbar into two categories – Conventions and Structure –, and all buttons within each category were alphabetized. Additionally, Conventions buttons output blue color, with the exception of red output for omit, and Structure buttons output green color. All buttons were tracked on the toolbar by the number of times they occurred on the page (Figure 3.7). Finally, the Promevo programmers added an Export Comments button that exported all comments on a document into a table at the end of the document. Comments were exported by timestamp and included the name of the person making the comment in the first column and the text of the comment in the second column. While we knew that we would eventually want to make additional updates, we submitted *Revision Assistant* to Google for final approval. On September 30, 2015, *Revision Assistant* was released as a free Google Docs add-on (Figure 3.8), and it has over 40,000 users in less than three years.

Phase 4: Users' Experience of the Design

Once a working version was available for use, it was time to test the functionality and usability of *Revision Assistant* with its intended audience: secondary teachers and students. We surveyed 11 secondary teachers who used the add-on and integrated it into their classrooms, and 56 secondary students (grades 6-9) who used the add-on to conduct peer review and revise their writing with feedback provided to them through *Revision Assistant*.



Figure 3.7. Image of the *Revision Assistant* toolbar. This image depicts the categories and expanded categories in the published version of *Revision Assistant* (.gif format).

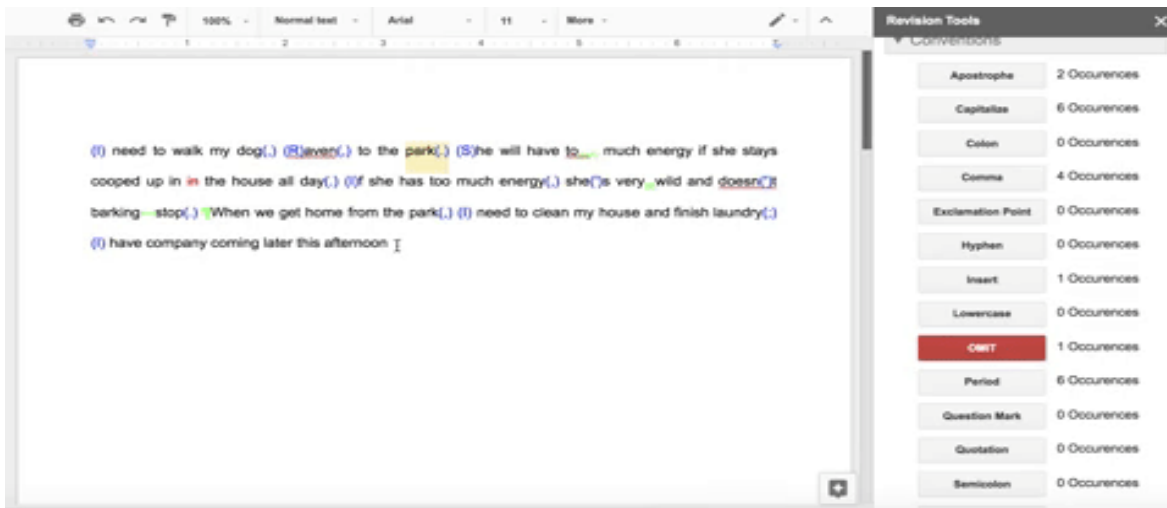


Figure 3.8. Demonstration of providing feedback. This image depicts a demonstration of how a user would give feedback to a paragraph with *Revision Assistant* and export comments into a table at the end of the document (.gif format).

Secondary teachers. All of the secondary teachers who completed the survey indicated that *Revision Assistant* was easy to use, it supported the revision process, and they would recommend it to other teachers; however, they also revealed that they did not always know where to find buttons, the colors did not always distinguish where changes needed to be made, and that making changes was sometimes difficult. After integrating the tool into their instruction for peer review, all of these teachers believed that their students understood what to do with the tool, used the tool effectively, provided useful feedback, and used the feedback they received to revise their own writing. Finally, the majority of teachers indicated that they used both the exported comments and occurrence tracker to inform their instruction.

Secondary students. Secondary students engaged in two primary activities when using *Revision Assistant*. The first was providing feedback to another student. Students were generally positive about providing feedback to another student because it was easy and saved time that would otherwise be lost writing comments. While students found this helpful for providing suggestions of errors to look for, they at the same time noted how they were sometimes confused about how the toolbar worked. Overall, when students were giving feedback to a peer, they found that the color distinctions between types of feedback were not helpful, were frustrated that the occurrence tracker only added occurrences, and lacked understanding of the meaning of many of the toolbar buttons.

The second action that students used *Revision Assistant* for was to receive feedback from a peer. Students were generally positive about receiving feedback because it was easy to make changes, feedback was visual in nature, and feedback – both surface-level and text-based – was organized. However, students also found some aspects of receiving feedback problematic. Several of these were a result of mechanical issues with the tool. To begin, the colored font

remained when making changes, forcing students to change it back after editing. Students also found it difficult to find suggested feedback on a document, and the occurrence tracker was not sophisticated enough to reduce an occurrence whenever a student made appropriate changes. Finally, students noted that there was not enough information in the comment table; they expected to see information about the context of the comment, such as the text associated with the comment or the page number. While their experiences using *Revision Assistant* varied, the majority of students indicated that they would use the tool again in the future.

Design Failures and Revisions

Despite the generally positive feedback we received from secondary teachers and students, both groups highlighted design failures and suggestions for improvement in the next version of *Revision Assistant*. Table 3.1 depicts the design decisions up to Phase 4, failures of those design decisions identified by users, and updated design decisions based on those failures. The only design decision that is not included in the table is the first one (building a tool that would be readily and widely available to teachers) because neither teachers nor students experienced failures with this aspect of the design. To begin, secondary teachers requested a variety of additional buttons. The requested buttons included: word choice, verb tense, subject-verb agreement, noun-verb agreement, pronoun agreement, vary sentences, simple sentence, compound sentence, complex sentence, and compound-complex sentence. While these buttons would enhance peer review activities, teachers saw that they also supported another use for *Revision Assistant* that was not part of the original design. Because *Revision Assistant* was a Google Docs add-on, teachers could easily check student understanding of grammar by distributing a model text using Google Classroom and having students label concepts of conventions in those texts. Secondary teachers also suggested the toolbar be reorganized into

Table 3.1

Failures of Design Decisions Indicated through User Experience and Updated Design Decision

Design Decisions up to Phase 4	Failure based on User Experience During Phase 4	Updated Decision / Revision
Visually separate error types (surface / text-based)	Two types of errors were not enough; teachers wanted more.	Group errors by common type that aligns with language used by teachers: Mechanics, Usage, and Sentence Formation (see Phase 3).
		Color code each error type: Mechanics-blue, Usage-red, and Sentence Formation-green.
	Teachers sought specific button types that were not initially included.	Addition of 10 new buttons: word choice, verb tense, subject-verb agreement, noun-verb agreement, pronoun agreement, vary sentences, simple sentence, compound sentence, complex sentence, and compound-complex sentence.
Engage in problem solving and decision making when revising	Students could not engage in problem solving and decision making because they were not fluent with the names of conventions or how to use them in writing.	Button includes an image of the mark output when a user pushes the button (e.g., Comma (,)).
		Button includes a hover-over definition and examples of how the mark is used.
Use colors to distinguish error types	Students indicated the green color was too bright.	Change the green color to darker shade - from #00ff00 to #4cbb17.
Capture revision data for both instructors and students	Teachers requested an additional column for the comments table.	Create an additional column in the table labeled "Addressed? How?"
	Teachers sought to create an exported occurrences table.	Create an export occurrences button that exports occurrence into a table at the end of the document.
	Teachers and students indicated that the comments table lacked critical information about the context of the comment.	Unable to resolve due to limitations of the programming language.
	Students were frustrated that the occurrence tracker did not remove an item when a button was mistakenly pushed and removed.	
	Teachers requested comments be exported in the order they appeared on the page instead of timestamp order.	

three main categories: Mechanics, Usage, and Sentence Formation. They felt these three categories would better align with how they discuss surface errors with students.

Both the teachers and students identified functional issues with the exported comments table and occurrence tracker that made them difficult to use effectively. The teachers noticed that comments were exported by timestamp, which became problematic when a student provided comments in a nonlinear fashion; because of this, they requested that comments be exported in the order in which they appear on the page. Teachers also requested the addition of a blank column that would allow them to request student explanations of the changes made based on the comment provided to them. Both secondary teachers and students explained that the comments table forced them to go back and forth between the text and comment because they did not know what part of the text a comment was associated with. As a result, we realized the necessity of additionally exporting the text associated with the comment into the table. The occurrence tracker frustrated secondary students because they were unable to take away an occurrence if they accidentally pushed a button, and while this did not bother teachers, the teachers wondered if the occurrences could also be exported into a table at the end of the document.

While the secondary teachers provided suggestions for making *Revision Assistant* a more effective instructional tool, secondary students highlighted features and provided suggestions for making *Revision Assistant* more useful for them. Several students noted that the green color output by the Structure buttons was too bright and difficult to see. Many of the younger students indicated that they were not fluent in the names of conventions or how to use them in writing; for them, using *Revision Assistant* was difficult because they were not confident in identifying errors or providing feedback on how to correct errors. These students requested additional information

about the buttons, such as a picture of the mark output by the button, definitions of each mark, and examples of how to use the mark correctly in writing.

Updating the Design

After identifying the design failures and potential solutions to those failures, we attempted to address the solutions through trial and error with a copy of the Google Script. We were successful in updating the script to reflect the majority of suggestions from secondary teachers and students. Specifically, we added teacher-requested buttons, reorganized the toolbar into three categories (Mechanics, Usage, Sentence Formation), created hover-over definitions and usage examples of each button, inserted an image of the mark output on each button, updated the green color output, and created a third column for the export comments table (Addressed? How?) (see video, Figure 3.9). After completing these updates, we sent the updated script and remainder of potential solutions to the identified design failures to Promevo. While they were not able to change the fact that comments appeared in timestamp order, the information included in the export comments table, or the ability to take away an occurrence, the Promevo programmers were able to create an export occurrences button that exports all occurrences of buttons used on a document into an organized table at the end of the document (Figure 3.9).

Bump in the Road

Once the script was ready to release as an update to the over 35,000 users we had at the time, we hit a major bump in the road that stalled the release of the updated version of the tool. An error message occurred when we attempted to deploy the add-on as a web add-on to the Google Chrome Web Store. Despite our attempts to contact Google and post on developer forums, we were unable to find a solution that would release the update to our current users. This

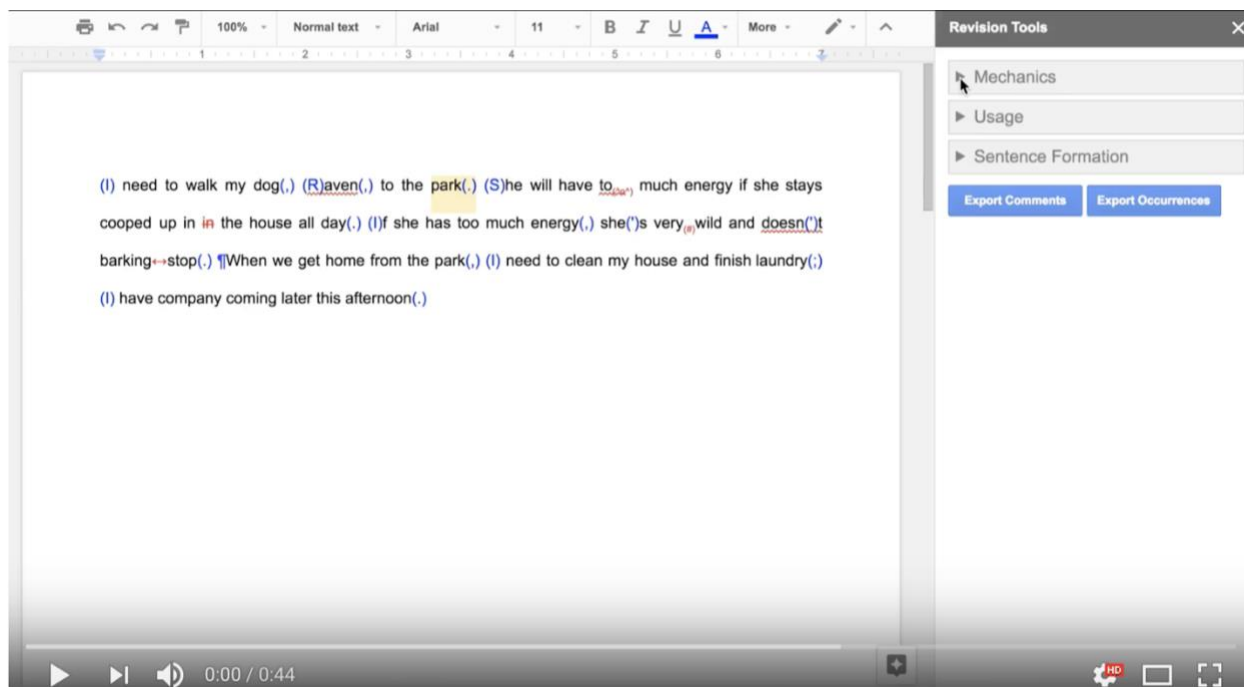






Figure 3.9. Video of the updated design. Reorganized toolbar, hover-over definitions and usage examples of each button, images of the mark output by each button, additional column in the exported comments table at the end of the document, and exported occurrences table at the end of the document.

major bump resulted in the publication of an entirely new add-on: *Revision Assistant, too*. The new add-on is searchable through the Google Chrome Web Store add-ons section, includes all of the previously mentioned updates, and updates the previous logo and promotional images with the squared symbol in the corner (see Table 3.2). The new add-on was a less-than-ideal scenario from a user perspective, as it forces users to install a new add-on rather than updating the existing add-on automatically. However, having two versions of the add-on is beneficial in some ways – creating two distinctly separate versions of the tool may be helpful for future research. Variations in toolbar design (i.e., two vs. three categories) and exported comment functionality can be compared to see which version better supports the formation of revision task schema.

Table 3.2

Promotional Materials for Revision Assistant and Revision Assistant, too

Image Type	<i>Revision Assistant</i>	<i>Revision Assistant, too</i>
Icon		
Logo		

Reflecting on Failure

Our initial decision to create a revision tool as an add-on for Google Docs led to a number of unanticipated constraints due to the limitations of Google’s programming interface. We ultimately had to move away from our original vision of using images to represent proofreading marks and instead used color-coding and parentheses to display those marks visually. This led to several compromises during the design and development of *Revision Assistant* and, at times, failures with our design evidenced during our user experience research. This begs the question – if we had it to do over again, would we make the same choice? That is, would we have chosen to create our tool using Google’s programming language if we knew the issues it would create?

After having some time to reflect on the user experience findings, we feel that the compromises made due to our choice of platform were not the primary cause of our major design

failures. For example, teachers wanted more buttons and wanted them organized differently than we originally anticipated. This issue is more a result of the ways theory and practice connect than the technological platform. The literature on revision discusses two types of errors – those that are surface and those that are text-based. We based our initial design on this dichotomy. Yet teachers have a more nuanced perspective of revision, which further separates surface errors into three categories so that students can more easily differentiate among them and master them over time. Similarly, students could not effectively make use of many of the buttons because they were not fluent with all the error types in the tool. While unanticipated, both issues were not a shortcoming of the platform but rather of our understanding of the theory and practice around revision.

In the end, only two issues remained unresolved due to the limitations of Google's programming interface – these deal with the occurrence tracker and the exported comments. At this time, the occurrence tracker does not remove an occurrence of an error when that error is resolved. Likewise, the exported comments appear without reference to the actual text, making it hard at times to understand the nature of some comments. Both were important analysis features of our initial design in that they provide critical information about the number and types of errors made and resolved during peer review. This was a disappointing trade-off for us as designers – to offer our tool on a popular, widely-used platform (i.e., Google) we had to settle for creating analysis features that were less-than-optimal.

At the same time, we are pleased that the analysis features still provide information that helps analyze student errors in a general sense. While they lack the specificity needed to engage in deeper analysis, students and teachers can use them to see patterns of error-making and address them accordingly. This outcome remains strongly aligned with the spirit of our initial

design in that we sought to provide teachers and students with a tool that helped support the cognitive process of reflection on writing. With this in mind, we feel that the benefits of working within the Google platform continue to outweigh the drawbacks created with our initial vision for the analysis features.

Conclusion

Now that the tool is updated to include all current, feasible solutions, we are studying secondary students' repeated use of *Revision Assistant, too* to investigate whether or not using it results in the intended effects. We imagine that after repeated use of the tool, students will expand their revision task schema and begin to internalize common surface-level errors they make, which will allow them to focus on amending more complex text-based errors during the revision phase of the writing process. The research study with *Revision Assistant, too* is being conducting with a group of eighth grade students at a school in the Pacific Northwest – the same school that inspired the design of the tool and provided secondary student perspectives of *Revision Assistant*.

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CHAPTER 4
FOSTERING THE DEVELOPMENT OF A REVISION TASK SCHEMA WITH AN ONLINE
REVISION TOOL ³

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Abstract

This convergent mixed methods study that uses a design-based research approach examines how repeated use of *Revision Assistant, too* impacts writing achievement and affects the development of revision task schema for 17 middle grades students. Analysis revealed that the students in this study not only reduced the amount of surface feedback and improved their rubric scores from first to third essay, but also they transitioned from only making surface changes to also making text-based changes during revision. The data suggest that the visual cues from *Revision Assistant, too* may have supported the reduction in surface feedback as well as the fundamental process of text processing by helping students distinguish between surface and text-based feedback.

Introduction

Since the advent of social media and other rapid forms of instant publication (i.e., text messages, email), students revise their formal writing less than before because the way people communicate through these avenues is less formal and often abbreviated (Verheijen, 2013). In the K-12 setting, the lack of formality becomes problematic. Students are assessed by teachers and through standardized tests, which demand more formal approaches to quality revision. Students who employ less formal approaches to revision in these formal assessment contexts risk poor performance (National Center for Education Statistics, 2012), which can prevent them from graduating in some states.

Over the past few decades, revision of student work has been studied in a variety of ways. Some have investigated what students do during the revision phase (Harper, 1997; Sommers, 1980), which led to a distinction of types of changes made by student writers (Faigley & Witte, 1981). Others compared handwritten revision to revision conducted with word processors (Grejda & Hannafin, 1992; Owston, Murphy, & Wideman, 1992). In the classroom setting, educators have started integrating technology to make the cognitive processes underlying writing and revision more effective for students. Few studies, however, have investigated how an online revision tool can encourage the development of the cognitive processes associated with revision.

To ensure that students stay on track and are well-versed in formal writing, it is important for students to learn and internalize revision strategies. Internalization is a process that allows social activities to evolve into internal mental activities (Vygotsky, 1978). In the context of revision, there are three fundamental processes that students engage in: text processing (i.e., critical reading), reflection (i.e., solving problems and making decisions about writing), and text production (i.e., creating new written work) (Hayes, 1996). Improving these three fundamental

processes directed by the revision task schema has the potential to improve the overall quality of students' writing (see Limpo, Alves, & Fidalgo, 2014; Roussey & Piolat, 2008).

Online collaborative tools, like Google Docs, have the potential to encourage and support the revision phase; however, the depth in which these tools support the development of a revision task schema and internalization of the revision phase has not been examined. There is a current need for research that links the repeated use of these tools to the development of a revision task schema and the internalization of the revision phase to student writing achievement. Such research would help inform educators of the value of these collaborative tools and provide instructional recommendations on how to further improve student achievement when using them.

The purpose of this mixed methods study was to examine how secondary students' use of *Revision Assistant, too (RAtoo)* feedback impacts writing achievement and affects the development of revision task schema. *RAtoo* is a Google Docs add-on that allows a user to provide visual proofreading marks on a document, tallies and exports occurrences into a table, and exports Google Docs comments into a table (Neumann, Kopcha, & Promevo, 2017). By researching the effects of repeated use of *RAtoo* on middle grades students' writing achievement and development of revision task schema, this study fills a significant gap in the existing literature. For the purposes of this study, repeated use is defined as using *RAtoo* as a tool to assist during the revision process of three or more writing assignments. Additionally, this study provides implications for teachers hoping to improve both the revision skills and the writing achievement of their students. The questions guiding this study were:

1. To what extent does repeated use of *Revision Assistant, too* impact the writing achievement of middle grades students? (*quantitative*)

2. How does using *Revision Assistant, too* affect the development of a revision task schema and internalization of the revision phase of the writing process for middle grades students? (*qualitative*)
3. To what extent do rubric scores and occurrence frequencies confirm how repeated use of *Revision Assistant, too* impacts the development of task schema and internalization of the revision phase of the writing process for middle grades students? (*mixed methods*)

Cognitive Development of Revision Skills

Revision is a problem-solving process that requires a writer to identify, evaluate, and resolve a problem in a written document (Allal & Chanquoy, 2004; McCutchen, 2006). Scholars have proposed models to explain the cognitive processes underlying the act of revision. For example, Scardamalia and Bereiter's (1983) Compare, Diagnose, and Operate (CDO) model indicated that writers compare their written text to their intended meaning, diagnose any problems with the written and intended text, and operate to choose a solution to the problem. The initial Hayes and Flower (1980) model emphasized reading and editing; reading involved the intentional act of evaluating text, and editing involved the automatic process of detecting problems. Continued research on the model led to greater specificity about the cognitive processes associated with revision; in their next version, revision included the processes of task definition, evaluation, and strategy selection (Hayes, Flower, Schriver, Stratman, & Carey, 1987). According to Hayes et al. (1987), the task definition involved the goals for revision, evaluation applied the goals set by the task definition, and strategy selection selected a strategy for revision.

In the 1990s, Hayes (1996) revised the previous cognitive model he developed with his colleagues to become what is the most widely accepted and recognized cognitive model of

revision to date. Hayes's (1996) revised model (see Figure 4.1) expanded on previous models; it includes the control structure, fundamental processes, and resources. The control structure, called the revision task schema, directs the fundamental or cognitive processes of revision (Hayes, 1996; McCutchen, 2006). According to Hayes (1996), a task schema is "a package of knowledge, acquired through practice, that is useful for performing the task and is retrieved as a unit when cues indicating the relevance of the schema are perceived" (p. 16). The revision task schema replaced 'task definition' from the previous model and is responsible for managing three fundamental processes: text processing, reflection, and text production. Text processing replaced 'evaluation' in the previous model and is the process of reading to evaluate and devise strategies for improving a text. Reflection replaced 'strategy selection' and encompasses the processes of problem solving and decision making. Text production was added to the model because of the importance of producing new text during revision. Finally, the working memory and long-term memory composed the resources component of the model. The working memory executes the fundamental processes by accessing the long-term memory, and the long-term memory stores schemata about tasks, topics, and audiences. The three fundamental processes directed by the revision task schema are described in more detail below.

Text Processing

The most critical process in Hayes's (1996) revision model is text processing because it emphasizes critical reading (Alamargot & Chanquoy, 2001). Critical reading during revision is reading a written text to evaluate and discover problems (Hayes, 1996, 2004). When reading to evaluate, a writer applies the subgoals and criteria directed by the revision task schema; subgoals

and criteria can direct a writer's focus on what to pay attention to and what errors to avoid during the revision process (Hayes, 1996; Hayes et al., 1987). Additionally, a writer will take contextual factors, such as topic, audience, and genre, into account when reading critically. Some believe that one must know how to correct an error to detect it; however, Hayes (2004) asserted that "the ability to detect problems is necessary for correcting them, but the ability to correct problems is not necessary for their detection" (p. 16).

The problems that a writer detects in a written text can vary in type. For instance, they can be well-defined problems (e.g., spelling errors, comma misuse) or ill-defined problems (e.g., sounds awkward) (Hayes et al., 1987). Well-defined problems seem to align most with surface errors, while ill-defined problems seem to align most with text-based errors. Inexperienced writers tend to focus on surface errors during revision (MacArthur, 2012, 2016; McCutchen, 2006; Zheng, Lawrence, Warschaur, & Lin, 2015); this is likely due to their lack of experience evaluating text-based errors in writing. Practice in setting goals and using criteria to evaluate text-based errors can lead writers to make text-based changes that improve their writing quality (De La Paz, Swanson, & Graham, 1998; Schriver, 1992; Wallace & Hayes, 1991). MacArthur (2016) concluded that teaching students how to set goals for evaluative reading could impact their revision task schema and overall approach to revision. Continued practice in evaluation during critical reading can assist writers in becoming better revisers (Hayes, 2004; MacArthur, 2016).

Reflection

After using critical reading to evaluate and detect a problem, a writer must engage in the fundamental process of reflection to problem solve and make decisions about correcting it. Reflection is also directed by the revision task schema. As illustrated in Hayes's (1996) revision

model, problem solving and decision making are two important components of reflection that are intricately linked. Problem solving occurs when a writer detects a problem based on his or her goals and devises solutions, and decision making occurs when a writer identifies viable solutions based on his or her evaluation and decides which solution to use to solve the problem (Hayes, 1996). Hayes asserted that these components are especially important for beginning writers because they do not have a fully-developed revision task schema and “must rely on their general problem-solving and decision-making skills to manage...the task” (p. 21).

During these reflection processes, writers compare their actual text to the intended form of the text (McCutchen, 2006); however, this can be problematic because inexperienced writers may not have an intended form of the text or know how to generate solutions to the problem (MacArthur, 2012; McCutchen, 2006). While the lack of being able to generate solutions to a specific problem can result in no changes or inadequate changes, a writer may decide to rewrite the sentence in a way that preserves the intended meaning and ultimately corrects the problem he or she was unable to find a solution for (Hayes, 2004). Much like practice in critical reading can assist writers in becoming better evaluators, practice and experience with these reflective processes can help writers develop their revision task schema to include problem-solving and decision-making skills specific to writing (Hayes, 1996; MacArthur, 2016).

Text Production

Text production, the third schema-directed fundamental process of revision, is the result of the processes of text processing and reflection; it typically occurs after writers have engaged in critical reading to evaluate feedback on their work, problem solving to consider solutions to that feedback, and decision making about which solution to choose. During text production, writers externalize the solutions they decide upon by making changes to their writing. It

therefore includes both surface changes and text-based changes that result in the production or modification of text (Van Gelderen & Oostdam, 2004).

A critical feature of successful text production is the development of specific revision subgoals. Without specific revision subgoals, an inexperienced writer will instinctively focus on surface errors because these are often easiest to detect and correct (Hayes, 1996; MacArthur, 2016; McCutchen, 2006). More substantial text-based changes result from subgoals that focus on improving the organization, structure, and sequencing of ideas (Hayes, 1996; MacArthur, 2012, 2016). As a writer's experience with language and evaluation increases, text production during revision can result in more complex subgoals and, in turn, revisions (Hayes, 1996).

Developing Revision Task Schema

Development of all three of the fundamental processes directed by the revision task schema can vary based on differences related to a writer's prior knowledge and experiences (MacArthur, 2012; McCutchen, 2006). These differences can be related to both contextual and individual factors. Contextual factors affecting these fundamental processes include a writer's conception of topic, audience, and genre (Hayes, 1996; MacArthur, 2012; McCutchen, 2006). Individual factors impacting the processes include knowledge of writing, understanding of revision, and overall writing development (MacArthur, 2012).

Knowing this about revision task schema development, effective revision instruction should focus on teaching students distinct strategies that have been shown to support the fundamental processes associated with the development of revision task schema. For example, instructional strategies should focus on the subgoals for revision, such as specific writing characteristics to look for or avoid (MacArthur, 2013, 2016). The subgoals used to guide revision often align with strategies that teach evaluative criteria to guide students through using that

criteria for providing feedback to writing, interpreting evaluative feedback, and applying evaluative feedback to writing (Lawrence & Sommers, 1996; Rijlaarsdam, Couzijn, & van den Bergh, 2004). Without specific subgoals directing the revision task schema, students tend to focus on surface errors only (MacArthur, 2012; Sommers, 1980).

Other strategies include guiding students through the steps of using a specific evaluation strategy (e.g., SCAN – Does it make sense?, Is it conected to my belief? Can you add more? Note errors?) or general strategies, such as using a rubric or checklist that is specific to the writing task (Ferretti & Lewis, 2013; MacArthur, 2013). Both approaches provide students with a specific goal or direction for revision. For example, when students use evaluative criteria during peer review, they engage with the writing as readers and are more likely to identify problems with the writing. Once they have identified problems, students can engage in the reflective practices of problem solving and decision making to identify a solution that allows them to produce evaluative feedback for writing. Likewise, a student must engage in critical reading, problem solving, and decision making to interpret evaluative feedback before producing text that applies that feedback.

Instructional approaches. After students are versed in evaluative criteria, they need to practice using that criteria to provide and apply evaluative feedback. There are several commonly used instructional approaches that effectively teach and reinforce the revision phase of the writing process, such as self-evaluation and peer review (MacArthur, 2013). Both of these instructional approaches encourage students to practice applying evaluative criteria to writing in a way that activates their revision task schema to direct the fundamental processes of text processing, reflection, and text production.

Self-evaluation. Being able to apply evaluative criteria to one's own writing through the process of self-evaluation is a crucial skill for students (MacArthur, 2013). Self-evaluation can help students practice how to read critically to identify discrepancies between what they have written and what they actually mean (McCutchen, 2006; Van Gelderen & Oostdam, 2004). Instruction should initially focus on applying criteria specific to the task, such as genre-related criteria (MacArthur, 2013); however, it should be noted that self-evaluation criteria at times may neglect or fail to result in the detection of other problematic aspects of the writing. That said, students can progress to applying more generic criteria related to a variety of types of writing (e.g., content, organization) after they develop mastery of applying specific criteria (e.g., genre-related, audience). Teachers should model how to apply both specific and generic criteria to writing and also model how to use that criteria to improve writing through the reflection and text production processes. Learning how to apply evaluative criteria to one's own writing is a key component of revision strategy instruction that can impact how students apply knowledge and skills in other instructional approaches to revision (MacArthur, 2013).

Peer review. Despite the promotion of self-evaluation strategies, students tend to do little revision without the help of their peers and teachers (Fitzgerald, 1987; Scardamalia & Bereiter, 1986). One instructional approach that helps students practice the fundamental processes of revision is peer review. Peer review activities are beneficial because students can provide more frequent feedback than the teacher can (MacArthur, 2012, 2013, 2016). Additionally, peer review becomes a reciprocal process; students might get just as much from giving feedback to another student as they do from receiving feedback (MacArthur, 2012, 2013; Trupiano, 2006). However, students may not have the schema to detect or solve errors in writing (Hayes, 1996; MacArthur, 2012) or may lack the experience needed to provide feedback that goes beyond the

surface-level (Faigley & Witte, 1981; Harper, 1997; McCutchen, 2006; Sommers, 1980; Zheng et al., 2015). More experience with language can help students develop schema to assist in error detection and ideas for solutions (Hayes, 1996), which can support students in providing quality feedback. Strategy instruction can help students focus on setting goals to evaluate more meaningful aspects about the content of writing. Training students on how to use problem-solving and decision-making strategies that help them provide and receive text-based feedback that can help them transcend surface errors (Fitzgerald & Markham, 1987; Harper, 1997; Rahimi, 2013). Participating in peer review activities can help students practice using evaluative criteria on the writing of peers (Hayes et al., 1987; MacArthur, 2016), encourage them make more revisions to their own writing (Scardamalia & Bereiter, 1986; Trupiano, 2006), and assist them in reflecting and learning about their own writing habits (MacArthur, 2012; McVey, 2008).

Design Framework

Revision Assistant, too is a Google Docs add-on that supports users in engaging in the fundamental processes directed by the revision task schema (Neumann et al., 2017). The add-on is a toolbar of surface error buttons, which are organized into the categories of Mechanics (e.g., capitalize, comma, period), Usage (e.g., agreement, insert, verb tense), and Sentence Formation (e.g., comma splice, fragment, run-on). When a toolbar button is pushed, a colored mark is outputted on the document at the location of the error as determined by the user. Mechanics buttons output blue color, Usage buttons output red color, and Sentence Formation buttons output green color. An occurrence tracker on the toolbar calculates the number of times each button has been used on a document, and the Export Occurrences button exports all counted occurrences into a table at the end of the document. Additionally, the toolbar includes an Export

Comments button that integrates with Google Docs comments to export all comments into an organized table at the end of the document.

The add-on was originally intended to be used during peer review activities and was designed to distinguish the two types of changes made during revision according to Faigley and Witte's (1981) taxonomy of surface changes and text-based (meaning) changes. When a peer identifies a surface error, they can visually portray their suggested solution using a button that outputs the suggestion encircled by parentheses. Parentheses are color coded in a blue, red, or green color on the page to indicate different types of feedback (e.g., blue for issues with mechanics). Google Docs comments can then be reserved for feedback or advice on the content of one's writing, which could lead to more text-based changes.

Supporting the Development of a Revision Task Schema

Hayes's (1996) cognitive model of revision was foundational to the design, development, and research of *RAtoo*. Specifically, *RAtoo* contains five features designed to support students with engaging in text processing, reflection, and text production. Those features include:

1. Visual cues that distinguish between surface and text-based feedback (e.g., colors, in-text indicators);
2. Toolbar buttons display an image of each error type, and definitions and usage examples for each error type are also provided through a hover-over feature;
3. Users are forced to manually accept or reject feedback rather than being able to 'accept all' changes at once;
4. Comments can be exported in table form for additional processing; and
5. The number of occurrences of each error type are tabulated and tracked and can be exported in table form for additional processing.

Figure 4.2 displays each of these features as they appear within *RAtoo*. For example, surface and text-based feedback are distinguished using both colors and in-text indicators in the form of parentheses (see Figure 4.2, #1). The color types – blue, red, or green – represent each of the toolbar categories within *RAtoo* (e.g., Mechanics, Usage, Sentence Formation), whereas the parentheses visually indicate where an error has been made and how it might be fixed. Comments can be exported to a separate table that includes a column for justifying any decisions made around each comment (see Figure 4.2, #4). The number of occurrences for each error type can also be exported into a table for analyzing occurrence frequencies (see Figure 4.2, #5).

The screenshot shows the RAtoo software interface. The main document area contains a paragraph of text with several errors highlighted in red and green. A red box labeled '1' points to the text: "(I) need to walk my dog (R)aven to the park(.) (S)he will have to... much energy if she stays cooped up in in the house all day(.) (I)f she has too much energy(.) she(')s very(,)) wild and doesn(') barking↔stop(.). When we get home from the park(.) (I) need to clean my house and finish laundry;(c/s)(c) (I) have company coming later this afternoon(.)". A red box labeled '2' points to the 'Revision Tools' sidebar, which is currently showing the 'Mechanics' category with options for 'Apostrophe (')', 'Capitalize (A)', and 'Colon (:)', each with its occurrence count. A red box labeled '4' points to a table of comments, and a red box labeled '5' points to a table of infractions.

Users	Comments	Addressed? How?
anonymous dog	If you want to be more specific, you could add which park you and Raven will visit.	

Infraction	Occurrences
Omit	2.0
Comma	2.0
Semicolon	1.0
Insert	1.0
Comma Splice	1.0
Period	4.0

Figure 4.2. Examples of the embodiments of *Revision Assistant, too*. (1) Visually distinguish surface and text-based feedback, (2) Image, definition, and usage examples of each error type, (4) Exported comments table, and (5) Occurrence tracker and table. Embodiment 3, the manually accept/reject rather than ‘accept all’ feature, is not shown because it is embodied by the action of a user.

The five features, or embodiments, of *RAtoo* were also designed to support the overall process of revision. Figure 4.3 depicts the overall revision process for a user of *RAtoo* and is based on Hayes's (1996) cognitive model of revision. The process begins after a user has received feedback and comments through *RAtoo*. Users first engage in text processing. Text processing most often leads into reflection; users will attempt to solve problems with the written text and make decisions about how to address given feedback. Users may attempt to solve an issue by creating entirely new text that avoids a given problem or simply accept feedback and make the

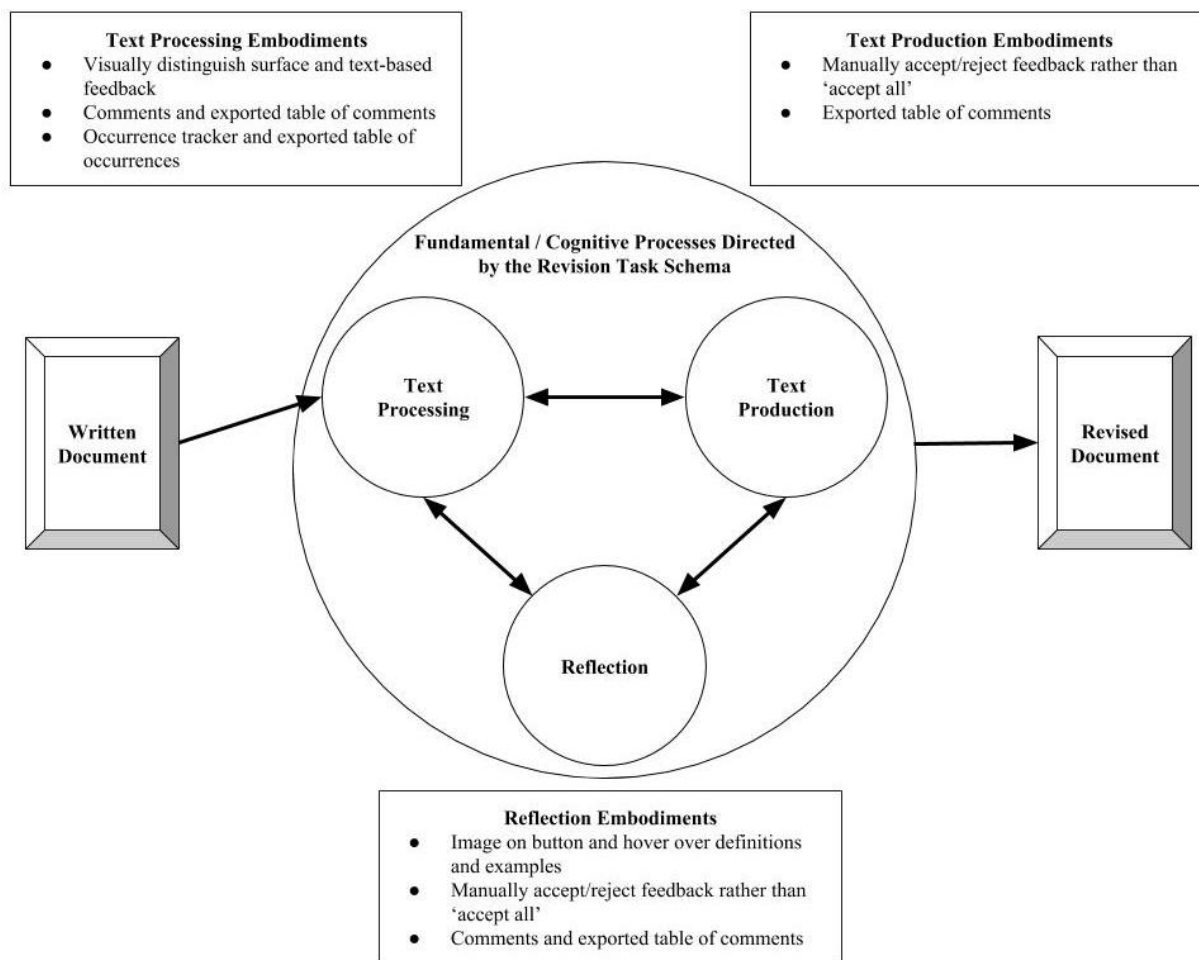


Figure 4.3. Engaging in the fundamental processes directed by the revision task schema with *Revision Assistant, too*. This figure depicts how embodiments of *Revision Assistant, too* engage students in the fundamental processes directed by the revision task schema.

change as indicated. This reflective activity then results in text production, where new text is formed.

It is important to note that the process from text processing to reflection to text production may not always be linear. Figure 4.3 depicts this non-linearity by using double-ended arrows to represent the potential non-linear interplay between each fundamental process. For example, a writer who reflects on feedback may need to reread the given text several times before deciding about how to improve that text. Likewise, a writer may make several attempts at revision before producing new text, rereading and reflecting repeatedly as new text is formed and improved. In other words, writers may engage in each of the fundamental processes several times before finalizing an externalized change or revision. Once a writer completes his or her revisions, he or she can create the final, revised written document. Figure 4.3 also displays the specific embodiments associated with each fundamental process directing the revision task schema. A description of the ways the embodiments support each fundamental process (i.e., text processing, reflection, text production) is summarized in Table 4.1 and provided below.

Table 4.1

Embodiments of Revision Assistant, too and Associated Fundamental Processes

Embodiment	Fundamental Processes		
	Text Processing	Reflection	Text Production
1. Visually distinguish surface and text-based feedback	Activates editing schema (Hayes, 1996).	N/A	N/A
	General strategies such as using a rubric or checklist that is specific to the writing task (Ferretti & Lewis, 2013; MacArthur, 2013).		
2. Image on button and hover over definitions and	N/A	Practice detecting problems, generating solutions, and deciding on revisions help students build these skills as they	N/A

usage examples		relate to writing (Beal, 1990; Hayes, 1996; MacArthur, 2016; Raymond, 1989)	
3. Manually accept/reject feedback rather than 'accept all'	N/A		Surface errors instinctively focus an inexperienced writer's revision task schema, which will result in the production of surface changes (Hayes, 1996; MacArthur, 2012, 2016; McCutchen, 2006).
4. Exported table of comments	Practice in setting goals and using criteria to evaluate text-based errors can lead writers to make text-based changes that improve their writing quality (De la Paz et al., 1998; Schriver, 1992; Wallace & Hayes, 1991).	Experiences in making decisions about feedback and engaging in both problem solving and decision making to improve the content of their writing can expand a student's schema for text-based errors and offer solutions as they encounter these errors in their own writing (Rijlaarsdam et al., 2004).	Practice in interpreting and applying feedback to improve writing (Lawrence & Sommers, 1996; Rijlaarsdam et al., 2004). Explain or justify choices made prior to or during revision (Berzsenyi, 2001). More substantial text-based changes will result from subgoals focused on text-based errors and more experience with writing and language (Hayes, 1996; MacArthur, 2012, 2016).
5. Occurrence tracker and exported table of occurrences	General strategies such as using a rubric or checklist that is specific to the writing task (Ferretti & Lewis, 2013; MacArthur, 2013). Activates editing schema (Hayes, 1996).	N/A	N/A

Text processing (critical reading). *RAtoo* embodies the theory associated with text processing through three features – the visual distinguishing between surface and text-based feedback, the exported table of comments, and the occurrence tracker. When a writer receives feedback from a peer using *RAtoo*, he or she can immediately distinguish between the two types

of feedback provided. Surface feedback is visually distinguished from text-based feedback in two ways – it is both color-coded and appears directly within the text of the document, whereas text-based feedback is provided as comments that are separated from the body of the text.

Additionally, the number of surface error occurrences counted within the document is numerically displayed adjacent to each button on the toolbar and can be exported into a table at the end of the document.

The visual features support students' text processing in several ways. First, they can support critical reading. As writers critically read their written document, the visual separation of surface and text-based feedback can activate editing schema as students process the feedback (Hayes, 1996). Activating editing schema in this way is important. Editing schema for surface errors is typically less complex than the schema associated with text-based errors. For example, correcting punctuation errors is less demanding than reorganizing an entire section of a paper or rewriting a run-on sentence. In addition, students typically have more effective revision task schema for surface errors; text-based errors are often more difficult for them to detect (Hayes, 1996; MacArthur, 2012, 2016; McCutchen, 2006). Visually distinguishing the two error types can therefore help students separate less complex errors from more complex ones, making the overall task of revision more manageable.

Combining the visual separation of error types with the occurrence tracker can also trigger users to engage in evaluation of the feedback. Both the visual surface feedback and the number of occurrences can function like a rubric or checklist that assists users in evaluating their feedback as they revise (Ferretti & Lewis, 2013; MacArthur, 2013). The evaluation of suggested surface changes may be simple for students because they already have a revision task schema that is focused on surface errors (MacArthur, 2012; Sommers, 1980). Providing students with a

frequency count of their surface errors can help them focus on making surface changes all at once, leaving more time and focus to be spent on evaluating text-based errors.

Comments, exported or in-text, appear to the side or at the bottom of the document rather than within the text and indicate the presence of text-based feedback. Because comments are separated from the body of the text, writers can more fully engage in critical reading of the text-based feedback provided to them. This can also lead them into evaluation. The evaluation of text-based feedback, however, may be more complex; it requires a writer to acknowledge the different types of text-based errors that have been made and consider the text as a whole while also evaluating the effectiveness of a peer's suggestion for writing. Practice in setting goals and using criteria to evaluate text-based errors can lead writers to make text-based changes that improve their writing quality (De La Paz et al., 1998; Schriver, 1992; Wallace & Hayes, 1991).

Reflection (problem solving and decision making). Reflection is an important step in the revision process because it involves solving problems and making decisions about the feedback provided by a peer. *RAtoo* embodies the theory associated with reflection through three features: forcing students to manually make changes to the document rather than doing so automatically with an 'accept all' feature, toolbar buttons that display an image and definition of each error type, and the ability to export comments into a separate table.

Forcing users to manually make suggested changes was an intentional feature of *RAtoo*. Surface feedback and some forms of text-based feedback can be directive and offer specific solutions (Beach & Friedrich, 2006; Nelson & Schunn, 2009). With directive feedback, there is a risk that students will simply accept a suggested change without deeper thought. Inexperienced writers in particular are more likely to simply make changes as directed (e.g., add a comma; capitalize a letter), even when the feedback may not be accurate (Dinkins, 2014). By manually

forcing users to make changes to the text itself, they are forced consider whether to use the feedback as directed or reject it and consider alternatives. This feature is likely to improve students' revision task schema because practice with detecting problems, generating solutions, and deciding on revisions helps students build these skills as they relate to writing (Beal, 1990; Hayes, 1996; MacArthur, 2016; Raymond, 1989).

When combined with the feature of toolbar buttons displaying an image and definition of each error type, the requirement to manually accept or reject also supports deeper reflection on surface and text-based errors. Inexperienced writers may be unfamiliar with each of the different surface and text-based errors that can occur. This risk is particularly salient when feedback is nondirective or simply identifies a problem without offering a solution (Cho & MacArthur, 2010; Hayes, 2004). A writer cannot successfully reflect on and solve a problem with writing if he or she lacks an understanding of what the different errors look like and how to make changes that correct those errors. To address this, the toolbar buttons in *RAtoo* provide both definitions and usage examples of each error type. The definitions and usage examples help inform users about the nature of each error type and make more effective decisions about how to address those errors, which can strengthen a writer's ability to detect and address problems with writing in the future (Hayes, 1996; MacArthur, 2016).

Finally, *RAtoo* contains a feature that allows users to export all comments into a table on a separate page. This feature supports reflection in that it places focus solely on text-based feedback. Since comments primarily deal with text-based errors, putting comments in a table on a separate page not only helps users address that feedback systematically but also provides an opportunity for them to explain or justify their decision making. This is important – students need experiences with making decisions about feedback and engaging in both problem solving

and decision making to improve the content of their writing and expand their schema for addressing text-based errors (Rijlaarsdam et al., 2004).

Text production. The act of text production is critical to the revision process; it represents a culmination of both text processing (i.e., critical reading) and reflection (i.e., problem solving, decision making) in an effort to improve the overall quality of a written document. *RAtoo* contains two features that support text production of surface and text-based changes: forcing students to manually make changes to the document rather than do so automatically with an ‘accept all’ feature and the ability to export comments into a table.

Because surface errors instinctively focus the revision task schema of inexperienced writers, they will most likely produce surface changes (MacArthur, 2012; Sommers, 1980). Forcing students to manually make changes requires users to produce or modify their writing based on the surface feedback provided to them. As previously mentioned, this feature forces users to consider whether or not to use the provided feedback and can assist users in producing text that avoids those errors in the future. The ability to export comments into a table provides users with an opportunity to explain the ‘why’ and ‘how’ behind their decisions when making specific changes to their written work. These explanations can reinforce writers’ decisions about their text-based changes and form schema for when they encounter them in the future (Berzsenyi, 2001). Practice with interpreting and applying feedback to improve writing can lead to more complex text production in the future (Lawrence & Sommers, 1996; Rijlaarsdam et al., 2004).

Using a Design-Based Research Approach

The current study uses a DBR approach to investigate the outcomes of repeated use of *RAtoo* and the design features that support those outcomes. DBR studies use real-world contexts

to develop theory and educational interventions that can transfer into classrooms (Anderson & Shattuck, 2012; Reinking & Bradley, 2008). They are characterized as being focused on interventions, transformative, methodologically flexible, goal oriented, theoretical, iterative, and pragmatic (Reinking & Bradley, 2008).

This study represents the second iteration of DBR on *RAtoo*. The DBR project began with an initial case study of 21 middle school students' who used comments in Google Docs to engage in peer and teacher review of argumentative writing (see Chapter 2). The results of that study revealed that peer feedback led to improvements in surface errors (e.g., comma use, capitalization), whereas teacher feedback led to improvements in both surface and text-based errors (e.g., organization, use of professional language). Students also experienced issues with receiving feedback within Google Docs. The most notable issue was that students used an inordinate number of comments to address surface errors. As a result, feedback provided on text-based issues became obscured and was often overlooked as students revised their work.

The results of the initial study led to the design and development of the first version of *RAtoo* (see Chapter 3). The first version, called *Revision Assistant*, contained three primary design features that addressed the issues with peer review found in the initial study. The first feature was a visual separation of surface and text-based error types. *Revision Assistant* included 23 toolbar buttons of common surface errors (e.g., capitalization, comma splice); these separated surface-level feedback from text-based feedback so users could more easily focus on text-based feedback (Neumann, Kopcha, & Promevo, 2015). The tool also contained an occurrence tracker for toolbar buttons and an exported comments button that exported all Google Doc comments into a table at the end of the document. These features were included to support users in solving problems and making decisions about the feedback they received during peer review.

After being developed and published, *Revision Assistant* was tested with 11 secondary teachers who used it for instruction and 56 secondary students (grades 6-9) who used it to conduct peer review. Open-ended survey responses led to several revisions that were incorporated into the tool, including a description and example for each error type, an improved table of comments feature, and an exported table of occurrences feature. The revised version of *Revision Assistant* was then published under the new name of *Revision Assistant, too*. The current study represents the next iteration in the DBR project; it examines how secondary students' use of *RAtoo* feedback impacts writing achievement and affects the development of a revision task schema.

Methods

This study used a collective case study design, incorporating a convergent mixed methods approach (see Figure 4.4) to deeply investigate the writing achievement, development of a revision task schema, and internalization of the revision phase of the writing process. A case study design allowed for in-depth and detailed research while investigating specific cases in the setting in which they naturally occur to better understand the 'how' and 'why' behind the research questions (Patton, 2015; Rowley, 2002; Stake, 2006).

This case study is considered collective in that individual cases were examined in conjunction with quantitative and qualitative data collected from a larger group of participants who engaged in peer review using *RAtoo* (Stake, 2006). Specifically, five participants were selected to provide rich, detailed data about their use of *RAtoo*. These five participants strengthened the collective case by providing unique perspectives about the ways that repeated use of *RAtoo* affected the development of revision task schema. Particular emphasis was placed on examining whether cognition occurred and what the learner was experiencing when it

occurred. In this way, the individual cases helped identify similarities and differences across participants and characterize changes in students' revision task schema after repeated use of *RAtoo* (Baxter & Jack, 2008; Stake, 1995). Details about the selection of participants appear in the Participants section.

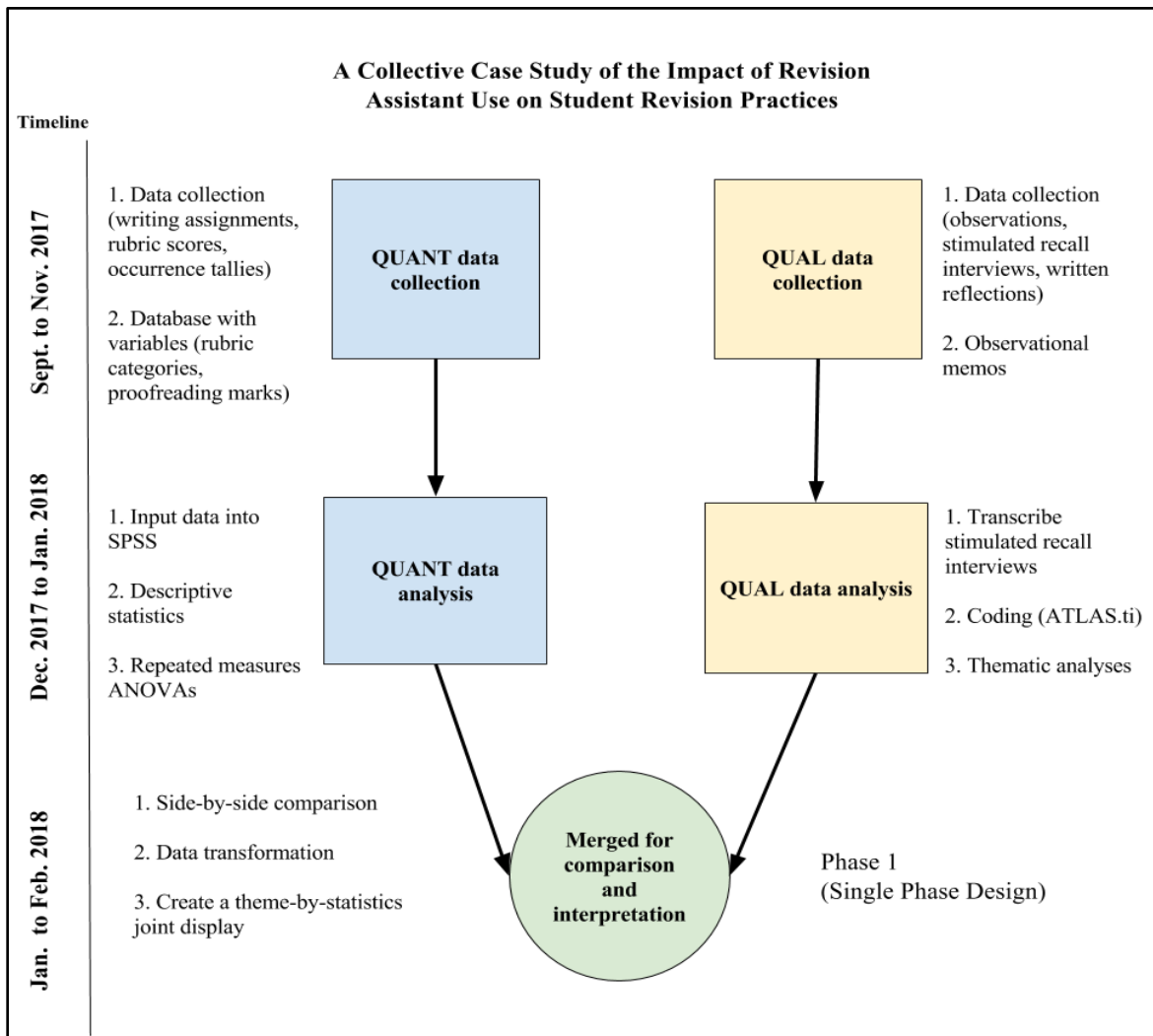


Figure 4.4. Graphical representation of research design. This figure illustrates the collective case study design that employs a convergent mixed methods approach.

Mixed methods research involves several methods and data collection techniques (Greene, 2007; Hesse-Biber, 2010; Johnson, Onwuegbuzie, & Turner, 2007). Mixed methods

researchers approach their use of mixed methods differently; some view it as a philosophical stance and others as a methodology (Creswell, 2015). For the current study, mixed methods was defined as a research method that used “both quantitative and qualitative data to answer a particular set of questions” (Hesse-Biber, 2010, p. 26). The methods used were convergent in that they brought together both quantitative and qualitative data for the purpose of triangulation during analysis (Creswell, 2015). According to Greene (2007), “Triangulation seeks convergence, corroboration, or correspondence of results from multiple methods” (p. 100). The results of the statistical analyses of toolbar frequencies and rubric scores were triangulated with the findings from the thematic analyses of observations, stimulated recall interviews, and written reflections (see the Data Collection and Data Analysis sections for more information) to develop a narrative of the patterns that emerged among students. This use of triangulation helped increase the validity and trustworthiness of the results (Creswell, 2015; Greene, 2007).

Mixed methods was an appropriate methodology for the research questions presented in this study because answering the questions with a single methodology would not allow for sufficient understanding of the problem (Creswell, 2015). For example, the research questions in this study sought to understand learner experiences across a large group as well as within specific individuals. Quantitative data reflected the larger group’s experience, whereas the qualitative data reflected the experiences of specific individuals. Using a concurrent design allowed the quantitative and qualitative datasets to remain separate so that one dataset did not drive or inform the other (Onwuegbuzie & Leech, 2006).

Merging during data analysis then yielded “interpretations based on the combined strengths of both sets of data to understand research problems” (Creswell, 2015, p. 2). The quantitative data allowed for statistical analyses of student work to investigate the effect of

specific variables (Field, 2013). The qualitative data allowed for the collection of detailed descriptions of how middle grades students undergo the revision process to understand the ‘how’ and ‘why’ behind changes in writing achievement of specific students. It also brought insight into the context in which the process occurs (Patton, 2015). Using mixed methods allowed for balance and the achievement of a level of nuance that helped provide answers to the research questions about the revision phase of the writing process.

Research Site

The research site for this study was an International Baccalaureate and district charter school the Pacific Northwest. Data were collected over a period of three months – long enough for the participants to write and revise three major informative/explanatory writing assignments. The data were not collected continuously over those three months; they were collected as students were revising their writing assignments and reflecting upon their revision process.

Participants

The participants were 18 eighth grade students in a Humanities class; one student was omitted during the data analysis because his absences resulted in a lack of submitted work. Rubric scores and written reflections were collected from the remaining 17 students; this sample was considered convenient because the researcher had previously gained access to conduct research at the school. Observations and stimulated recall interviews were collected from five of those students to serve as individual cases. This number of cases was considered adequate; Stake (2006) asserted that having between four and 10 cases brings the most benefit to multi-case research.

Cases were selected using two purposeful sampling strategies: snowball and criterion; the combination of these strategies allowed critical cases to be portrayed during analysis. Snowball

sampling involved drawing on existing participants to identify additional cases as the research unfolded. Prior to the study, the teacher identified three students whose prior interactions with the teacher indicated that they would likely benefit most from repeated use of *RAtoo*: Student C, Student F, and Student R. These teacher-identified critical cases were studied using observations and stimulated recall interviews (described in the Methods section) when revising their three papers with *RAtoo*. After the students revised their first paper, the researcher convened with the teacher to identify an additional two cases that demonstrated the potential for developing or improving revision task schema while using *RAtoo*.

The two additional cases, Student I and Student L, were therefore selected using criterion sampling; these students scored better than peers after using *RAtoo* to revise their first paper and were not initially identified by the teacher as a potential case. Using criterion sampling as part of snowball sampling allowed for the selection of participants that met specific criteria most closely associated with the research questions guiding the study while also helping to identify and accumulate critical cases (Onwuegbuzie & Collins, 2007; Patton, 2015).

Instructional Environment and Procedures

The eighth grade students that participated in this study used *RAtoo* as a tool to support peer review and revision for three essays. Each essay addressed the same genre of writing – informative/explanatory writing. In Essay 1, students compared and contrasted two Native American tribes. In Essay 2, students explained the social factors influencing people to become colonists. In Essay 3, students explained the economic, social, and political causes that led to the Boston Tea Party. After completing each essay, students completed a written reflection (Appendix 4.B) before conducting peer review and then again after revising each essay. The students accessed and submitted their reflections electronically (i.e., in Google Classroom).

All students in the class used the previous version of *RAtoo* as a tool for the peer review process; however, the first time they used *RAtoo* was during peer review of Essay 1. Because it was their first time using *RAtoo*, the teacher provided a 30-minute lesson on the act of providing feedback using *RAtoo* prior to reviewing Essay 1. The lesson reviewed key aspects of informative/explanatory texts, including purpose, organization, elaboration, evidence, conventions, and formatting. As part of the lesson, the teacher also trained students to use a checklist to support the peer review process (Appendix 4.C). When students were finished reviewing a peer's paper, they were expected to push the Export Comments button and Export Occurrences button. The instruction, peer review, and revision on Essay 1 occurred over two 90-minute class periods.

While the instruction on peer review and using *RAtoo* lasted 30 minutes for Essay 1, the instruction before Essay 2 lasted 5 minutes. This consisted of passing out the peer review checklist, reminding students to use the Export Comments and Export Occurrences button, and reminding students to submit their assignments in Google Classroom. Peer review and revision on Essay 2 occurred over one 90-minute class period.

The instruction before Essay 3 occurred on an Early Release Day and lasted the full 30-minute period. During this session, the teacher provided targeted support for engaging in peer review. He electronically distributed a sample essay and asked students to work in groups to provide feedback to specific paragraphs using *RAtoo*. Students provided feedback to their assigned paragraph and, once finished, explained their feedback to the other groups while the teacher supported students' explanations. Peer review and revision on Essay 3 occurred over the following 90-minute class period.

Students submitted the three writing assignments in Google Classroom at two different points in time: after a peer provided feedback but before revision began and after completing revision based on their peer's feedback. The essays were collected after peer review but prior to revision to preserve the peer's surface and text-based feedback, and the teacher downloaded the folder of assignments with peer feedback prior to releasing them to students for revision. The revised essays were collected to assess student writing achievement.

Data Collection

Because this is a mixed methods study, both quantitative and qualitative data were collected. The analyses of these data are described below.

Quantitative data. Quantitative data consisted of frequencies of toolbar button occurrences and rubric scores for each of the three essays. The three writing assignments were downloaded from the Google Classroom folder in Google Drive at two different points in time. First, students submitted their assignments after a peer provided feedback and before revision began; the teacher downloaded the folder prior to releasing them back to students and de-identified the assignments by replacing each name with a code prior to giving them to the researcher. Next the teacher released the assignments back to students for revision. After completing revision based on their peer's feedback, students submitted the final drafts of their assignments in Google Classroom. The data were handled by the teacher before releasing to the researcher. The teacher downloaded the Google Drive folder that contained the revised writing assignments and de-identified them using the same codes prior to giving them to the researcher.

Frequencies of toolbar button occurrences were calculated for each writing assignment by counting the occurrences that appeared on the documents submitted after a peer provided feedback and before the beginning of revision. These frequencies were organized in a multiway

frequency table (French, Immekus, & Yen, 2013); the table detailed frequencies of each toolbar button for each of the three writing assignments.

Each essay was scored using the 4-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11) (Appendix 4.D). The 4-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11) assesses student work based on three criteria: Purpose/Organization, Evidence & Elaboration, and Conventions; it is adapted from the 4-Point Smarter Balanced Explanatory Performance Task Writing Rubric (Grades 6-11) (Smarter Balanced Assessment Consortium, 2014). The criteria of Purpose/Organization and Evidence & Elaboration both assess text-based aspects of writing informative/explanatory texts. For example, Purpose/Organization assesses clearly communicating and focusing the main idea, effectively introducing and concluding the response, logically progressing between ideas, and consistently transitioning between ideas. Elaboration & Evidence assesses using specific, relevant evidence, effective elaborative techniques, appropriate vocabulary, and effective style. Conventions assesses surface issues with writing, such as correct capitalization, grammar, punctuation, sentence formation, and spelling.

Analytical scoring (Jonsson & Svingby, 2007) was used to generate a score for each criterion on the on the 4-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11). Scores were generated by both the teacher and a trained researcher. The teacher used the 4-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11) to generate rubric scores for each writing assignment after the final drafts of each writing assignment were submitted. A trained researcher then independently evaluated the writing assignments using the same rubric as the teacher. When there was a disagreement between the researcher and the teacher, the scores were averaged to establish a rubric score. Scores from both

the teacher and researcher helped establish inter-rater reliability, which was calculated at .90 using Cohen's kappa coefficient. This level of agreement suggests that both the teacher and researcher scored the essays nearly the same; Viera and Garrett (2005) suggested that any score greater than .60 indicates strong agreement between reviewers.

Qualitative data. Qualitative data consisted of recorded observations and stimulated recall interviews from five students and written reflections from 17 students.

Recorded observations. Observations were conducted for all identified cases as they revised their writing and were recorded using Screencastify, which recorded both the screen and the participants' face as they revised their writing. Students at the school regularly used Chromebooks that contained Screencastify as an installed software. Before a student began making changes, he or she started the recording on Screencastify. After the student finished revising, he or she pushed stop and the video automatically saved to a Google Drive folder that was shared with the researcher. Observations were conducted using the recordings after students were finished revising and were guided using an observation checklist (see Appendix 4.E) to focus the observation (Suzuki, Ahluwalia, Arora, & Mattis, 2007). Observational memos were also recorded to help provide detailed descriptions of the setting observed (Patton, 2015). Both the observation checklist and additional memos captured student behavior as they revised as well as the actual changes they made to their writing during revision.

Stimulated recall interviews. After completing their revisions and saving the recorded observation, students participated in a stimulated recall interview. Stimulated recall interviews are a methodology that aims to “prompt participants to recall thoughts they had while performing a task...Some tangible (perhaps visual or aural) reminder of an event will stimulate recall of the mental processes in operation during the event itself” (Gass & Mackey, 2000, p.13). Gass and

Mackey asserted that stimulated recall interviews help isolate thoughts and the type of knowledge someone is using to communicate, can help determine how knowledge is organized, and if and when cognitive processes are being used when someone is performing a task. The benefit of using stimulated recalls is that they assist researchers in investigating the cognitive processes of participants without interrupting them in action (Bloom, 1954; Rose, 1984; Smagorinsky & Coppock, 1994).

The stimulated recall interviews used in the study were “conducted as soon after the recording as practicable, to ensure the greatest memory of the activities by informants as possible” (Dempsey, 2010, p. 355). The length of time between the recording and the interview ranged from almost immediately after the recording (15-20 minutes) to the following school day (within 24 hours). During the interviews, participants viewed the recorded observation (i.e., Screencastify video recording) of themselves as they revised their writing based on peer feedback and described what they were doing in the video and why. At times, participants responded to questions from the researcher (see Appendix 4.F) about the recorded observation to encourage more detailed accounts of student thinking as they engaged in the revision process (Rose, 1984; Smagorinsky & Coppock, 1994). The stimulated recall interviews were recorded using Quicktime screen recording for Mac.

Prior to participating in the first official stimulated recall interview, each student completed a practice stimulated recall interview. First students practiced recording their screen and face with Screencastify as they wrote a short answer response assignment assigned as a normal part of their coursework. Next students participated in a practice interview, which began with students explaining the composition of their short answer response. When a student paused or stopped talking, the researcher probed with questions to elicit details about the nature of the

recorded response. At the completion of the practice interview, students were informed that they would participate in another stimulated recall interview about their revision of a writing assignment in the near future.

Written reflections. Written reflections took the form of electronic data to accurately and quickly capture the data (Suzuki et al., 2007). All participants typed written reflections in Google Docs before and after revising written assignments. Reflection prompts (see Appendix 4.B) asked students to consider how they revise, what changes they made, how using *RAtoo* impacted the quality of their writing, and the three biggest changes they made to their writing. Students submitted their reflections in Google Classroom at the completion of each reflection. The teacher downloaded the folder from Google Drive and de-identified the reflections using the same codes that were used for the writing assignments. In all, there were six reflection documents for each student. The reflections provided insight into how repeated use of *RAtoo* affected the development of a revision task schema and student internalization of revision techniques. Additionally, they provided insight into the specific features of *RAtoo* that affected the development of revision task schema and internalization.

Data Analysis

The data analysis is presented, below, by research question. The data collection and analysis are also presented by research question in Table 4.2.

RQ1: To what extent does repeated use of *Revision Assistant, too* impact the writing achievement of middle grades students? To examine research question 1, frequencies of toolbar button occurrences and mean rubric scores on three writing assignments for all (17) participants in the study were calculated (see Table 4.2). Repeated-measures ANOVAs were conducted on the occurrence frequencies at three points in time: after peer review was conducted

Table 4.2

Data Collection and Analysis by Research Question

Research Question	Data Collection	Data Analysis
1 QUANTITATIVE	To what extent does repeated use of <i>Revision Assistant, too</i> impact the writing achievement of middle grades students?	Frequency of toolbar button occurrences
		Repeated-measures ANOVAs overall occurrences
		Repeated-measures ANOVAs for each toolbar button
	Rubric Scores	Repeated-measures ANOVAs for overall rubric scores
		Repeated-measures ANOVAs for each rubric criterion
2 QUALITATIVE	How does using <i>Revision Assistant, too</i> affect the development of a revision task schema and internalization of the revision phase of the writing process for middle grades students?	Recorded observations
		Thematic analysis
		Stimulated recall interviews
	Written reflections	Thematic analysis
3 MIXED METHODS	To what extent do rubric scores and occurrence frequencies confirm how repeated use of <i>Revision Assistant, too</i> impacts the development of task schema and internalization of the revision phase of the writing process for middle grades students?	Quantitative data
		<ul style="list-style-type: none"> • Frequency of toolbar button occurrences • Rubric scores
		Qualitative data
		<ul style="list-style-type: none"> • Observations • Stimulated recall interviews • Written reflections
		Merge by using a theme-by-statistics joint display

on Essay 1, Essay 2, and Essay 3. Repeated-measures designs require fewer subjects because the same subjects are used over multiple treatment periods (Minke, 1997). Separate repeated-measures ANOVAs were conducted for total occurrences and each individual toolbar button to investigate the difference in the frequency of occurrences after each writing assignment. The frequencies table created during data collection was converted into a chart that portrays the

distribution of button occurrences after each writing assignment (Field, 2013). Additionally, separate repeated-measures ANOVAs were conducted on overall rubric scores and the rubric scores for each criterion (Purpose/Organization, Elaboration & Evidence, and Conventions) to examine the difference in scores at three points in time: Essay 1, Essay 2, and Essay 3. When there were statistically significant effects for both occurrences and rubric scores, a Bonferroni correction was used to control for Type 1 error and follow-up pairwise comparisons were conducted to determine the exact nature of the differences.

RQ2: How does using *Revision Assistant, too* affect the development of a revision task schema and internalization of the revision phase of the writing process for middle grades students? To examine research question 2, qualitative thematic analyses were conducted on the recorded observations, stimulated recall interviews, and written reflections (see Table 4.2). Prior to beginning the analyses, observational memos were written while completing the observation checklist, and stimulated recall interviews were transcribed using Express Scribe transcription software. The three separate thematic analyses (recorded observations, stimulated recall interviews, and written reflections) were conducted using coding features in the qualitative data analysis software ATLAS.ti Mac v.1.0.50; the analyses were conducted in the following order: recorded observations, stimulated recall interviews, and written reflections.

Braun and Clarke's (2006) six phase step-by-step guide to inductive analysis was used to scan the data for categories and develop themes (LeCompte & Preissle, 1993; Patton, 2015). Phase 1 included reading the data and taking notes. Phase 2 consisted of coding. In Phases 3 and 4, the data were examined at to see if repeating patterns emerged from the data for the purpose of categorizing codes (Auerbach & Silverstein, 2003); after sorting codes into categories, codes were organized into code groups in ATLAS.ti. Additionally, memos were written to explain and

define “properties and characteristics” of the code groups (Lempert, 2007, p. 249). During Phase 5, themes were defined and named. Finally in Phase 6, themes were linked to examples that helped illustrate and report the themes. The six-phase process is broken down for each dataset and is presented below. Additionally, Table 4.3 displays the number of initial codes, categories, code groups, and themes for each dataset.

Recorded observations. The thematic analysis of the recorded observation data was conducted on the 13 observational checklists and the additional memos that were taken on the checklists. After reading through the data and taking notes, the data was coded. The initial coding resulted in 54 codes (see Table 4.3). The 54 initial codes were sorted into 15 categories. For instance, ‘AcceptSurface Insert,’ ‘AcceptSurface Omit,’ ‘AcceptSurface Space,’ and ‘AcceptSurface Word Choice’ were combined to create the category ‘AcceptSurface Usage.’

Table 4.3

Refining Codes to Themes During Thematic Analysis of Qualitative Data

Qualitative Data		Initial Codes	Categories	Code Groups	Themes
Observations		54	15	12	6
Stimulated Recall Interviews		17	8	8	5
Written Reflections	Before E1	41	12	4	1
	Before E2 & E3	28	6	4	1
	After E1, E2, & E3	107	38	8	3

After defining the properties and characteristics of the codes and looking across them for each student as well as each essay, six of the categories were further refined into three code groups, which resulted in 12 code groups. One code group, for example, included the categories ‘AcceptSurface Mechanics,’ ‘AcceptSurface Usage,’ and ‘AcceptSurface Sentence Formation’ to create the code group ‘AcceptSurface.’ When looking at this code group across each student and each essay, ‘AcceptSurface’ was later refined to combine with ‘RejectSurface’ to create

‘Transitioning from Accepting to Rejecting Surface.’ Review of the 12 code groups resulted in the elimination of six code groups because they lacked frequency, which resulted in six themes. The themes were named, defined, and linked to examples; the final six themes and illustrations are presented in the Results section of this paper.

Stimulated recall interviews. Thematic analysis was conducted on the 13 transcripts created for each of the stimulated recall interviews. First, all 13 transcripts were read with the interview video playing simultaneously to provide context to what was being described. During this reading and viewing, notes were taken to record ideas for possible codes in later phases of the analysis. Next the transcripts were coded, which resulted in 17 initial codes (see Table 4.3). Some examples of initial codes include ‘Multiple Solutions to Comment Revision,’ ‘Single Solution to Comment Revision,’ ‘Single Solution from Comment,’ and ‘Text Processing after Text-Based Change Leads to New Solution.’ Initial codes were refined into eight categories and later code groups by looking across the codes for each student as well as each essay. For example, the initial codes listed above – ‘Multiple Solutions to Comment Revision,’ ‘Single Solution to Comment Revision,’ ‘Single Solution from Comment,’ and ‘Text Processing after Text-Based Change Leads to New Solution’ – were combined after looking across each student and each essay to create the category, which also became a code group, ‘Transitioning to Additional Rounds of Text Processing and Text Production with Text-Based Changes.’ Three of the code groups were eliminated due to lack of frequency, which resulted in five themes. While naming and defining the themes, it became evident that the five stimulated recall themes were the same as five of the six recorded observation themes. In fact, the quotations from the stimulated recall interviews brought insight into the themes that emerged from the recorded

observations. Because of this, the themes from the recorded observations and stimulated recall interviews are presented concurrently in the Results section.

Written reflections. Thematic analysis of the written reflections was conducted on the reflections submitted by all 17 students before and after each essay (102 documents). The initial read through of the data revealed the need to separate the thematic analysis into three phases: one for reflections before review of Essay 1, one for reflections before review of Essay 2 and Essay 3, and one for reflections after review of Essay 1, Essay 2, and Essay 3. The purpose of splitting this thematic analysis into three parts was to better organize the analysis within the context of the reflection questions asked of students. Students were asked about their typical process of revision before review of Essay 1, whereas they were asked to explain whether they made any changes in preparation for the review of both Essay 2 and Essay 3. After revising each essay based on peer review feedback, students were asked to reflect on how they used *RAtoo*, what kind of changes they made, and how they thought *RAtoo* helped them during revision. Therefore, organizing the analyses into three parts helped provide context to the themes that emerged from the written reflections.

The analysis of written reflections before Essay 1 (17 documents) resulted in 41 initial codes, such as 'Begin Identify Mechanics Errors,' 'Changes Fix Surface Errors,' 'Done Surface Complete,' and 'Important Mechanics.' The 41 initial codes were combined into 12 categories (i.e., 'Typical Make Surface Changes,' 'Typical Share with Someone,' 'Typical Read Through for Clarity'). The 12 categories were combined to create four code groups (i.e., 'Typical Look for Surface,' 'Typical Read Through,' 'Typical Seek Assistance,' 'Typical Lengthy'); two code groups were removed due to lack of frequency. The two remaining code groups were later combined into a single theme with two subthemes (see Table 4.3). There were 28 initial codes on

the written reflections before review of Essay 2 and Essay 3 (34 documents). Examples of initial codes include ‘Change Not Needed,’ ‘Continued Looking for Surface,’ ‘Continued Addressing Mistakes,’ and ‘Continued Fluency Check.’ The 28 initial codes were combined into six categories (i.e., ‘No Need to Change,’ ‘Continued Typical Process,’) before being refined into four code groups (i.e., ‘Changed Focus on Requirements,’ ‘Change Not Needed,’ ‘Changed Conscious of Peer,’ ‘Unsure of How Change is Possible’). Two code groups were eliminated due to lack of frequency, which resulted in two code groups that were combined to create a theme with two subthemes (see Table 4.3). Finally, the written reflections after revision based on peer review feedback of all three essays (51 documents) yielded 107 codes. Example codes include ‘Changes Usage,’ ‘Biggest Changes Organization,’ ‘Changes Address Requirements,’ ‘Begin Look for Surface,’ and ‘Impact Changes Easy to Identify.’ These codes were combined into 38 categories, such as ‘Use RA2 to Identify Surface,’ ‘Changes Surface,’ ‘Changes Text-Based,’ and ‘Impact Efficiency.’ After looking across each essay, the categories were refined into eight code groups (i.e., ‘Use Visual Features of RA2,’ ‘Change from Focus on Surface to Text-Based,’ ‘Focus Revisions on Essay Requirements’). Five of the code groups were removed due to lack of frequency, which resulted in three themes (see Table 4.3).

RQ3: To what extent do rubric scores and occurrence frequencies confirm how repeated use of *Revision Assistant, too* impacts the development of task schema and internalization of the revision phase of the writing process for middle grades students?

Once the quantitative and qualitative data were analyzed, they were merged together for comparison purposes to answer research question 3 (see Table 4.2). First, recorded observation and stimulated recall interview themes were aggregated for each of the five students that participated in this portion of the study. Next, themes from written reflections for each student in

the class were aggregated. After organizing all of the themes that were present for each student, trends in each student's occurrence frequencies and rubric scores for all three essays were summarized. The overall occurrence frequencies and overall rubric scores allowed for the grouping of students that had the same patterns in quantitative data. Then the themes of students that had the same quantitative patterns were compared. To organize the comparisons, a theme-by-statistics joint display was created to present the quantitative data on a vertical axis and qualitative themes on a horizontal axis (Creswell, 2015); cells include quantitative patterns and qualitative themes. This table, presented in the Results, is a visual representation that portrays how the statistical results and thematic findings compare.

Validity and Reliability

To assess quantitative data (occurrence frequencies and rubric scores) quality, sphericity was assessed using Mauchly's test and, when necessary, a Bonferroni correction was applied to pairwise comparisons to control Type 1 error (Field, 2013). Validity of rubric scores was established using Cohen's kappa coefficient (see Data Collection, above). To assess qualitative data quality, Lincoln and Guba's (1986) criteria for establishing quality in qualitative research were used by addressing credibility and transferability. Credibility was addressed with the use of triangulation. Triangulation of the qualitative data included comparing and cross-checking the recorded observations, stimulated recall interviews, and written reflections (Lincoln & Guba, 1986; Patton, 2015). Transferability was addressed using thick, rich description of the context for others to fully understand the context and what can be transferred to their specific settings (Lincoln & Guba, 1986). Finally, the combined quantitative and qualitative data were integrated using a comparative side-by-side analysis to triangulate the quantitative and qualitative data together (Creswell, 2015; Patton, 2015).

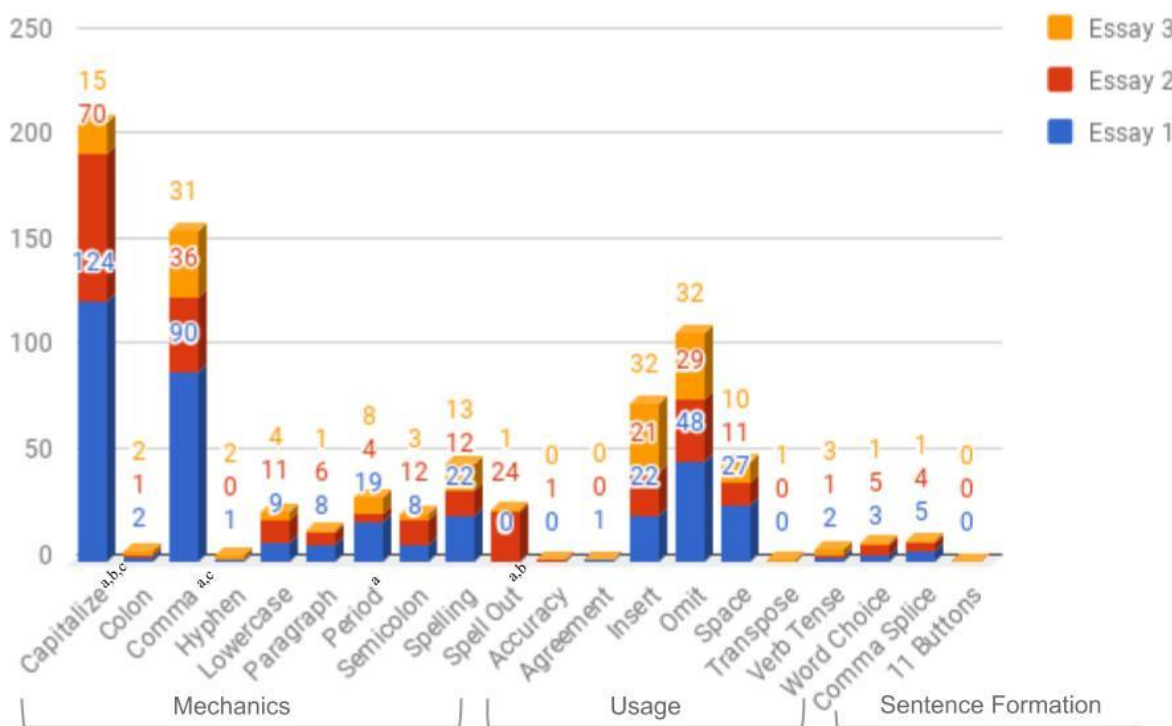
Results

This section is organized in the following manner: research question 1 results (quantitative), research question 2 results (qualitative), and research question 3 results (mixed methods).

Extent of Impact on Writing Achievement (Research Question 1)

Occurrences. Overall, the frequency of occurrences decreased from Essay 1 (391) to Essay 2 (248) to Essay 3 (160). Repeated-measures ANOVA revealed a statistically significant difference in mean occurrences over time, $F(2, 32) = 28.13, p = .000$. Follow-up pairwise comparisons with a Bonferroni correction to control for Type 1 error revealed statistically significant differences in mean occurrences from Essay 1 ($M = 23.00$) to Essay 2 ($M = 14.59$), $p = .002$; Essay 2 ($M = 14.59$) to Essay 3 ($M = 9.41$), $p = .014$; and Essay 1 ($M = 23.00$) to Essay 3 ($M = 9.41$), $p = .000$.

The frequency of occurrences of specific toolbar buttons (e.g., Capitalize, Comma, Paragraph, Space, and Comma Splice) decreased with each essay (see Figure 4.5). The results of separate repeated-measures ANOVAs showed statistically significant differences in mean occurrences over time for four buttons: Capitalize, $F(1.19, 19.10) = 17.97, p = .000$; Comma, $F(1.19, 19.01) = 12.75, p = .001$; Period, $F(2, 32) = 4.33, p = .022$; and Spell Out, $F(1.03, 16.54) = 12.26, p = .003$. Three tests violated the assumption of sphericity: Capitalize, $\chi^2(2) = 16.89, p = .000$; Comma, $\chi^2(2) = 17.25, p = .000$; and Spell Out, $\chi^2(2) = 40.92, p = .000$; the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (Capitalize: $\varepsilon = .60$; Comma: $\varepsilon = .59$; Spell Out: $\varepsilon = .52$). Follow-up pairwise comparisons for the Capitalize button, adjusted with Bonferroni, revealed statistically significant differences in mean occurrences from



^a Statistically significant from first to second essay, $p < .05$.

^b Statistically significant from second to third essay, $p < .05$.

^c Statistically significant from first to third essay, $p < .05$.

Figure 4.5. Occurrences by toolbar button. This figure illustrates the total number of occurrences by toolbar button. Eleven buttons had zero occurrences for Essay 1, Essay 2, and Essay 3. These buttons are represented by ‘11 Buttons’ and include Apostrophe, Exclamation Point, Question Mark, Quotation, Complex, Compound, Compound-Complex, Fragment, Run-on, Simple, and Vary Sentences.

Essay 1 ($M = 7.29$) to Essay 2 ($M = 4.12$), $p = .027$; Essay 2 ($M = 4.12$) to Essay 3 ($M = .88$), $p = .000$; and Essay 1 ($M = 7.29$) to Essay 3 ($M = .88$), $p = .001$. Pairwise comparisons for the frequency of Comma buttons were adjusted with Bonferroni and indicated statistically significant differences in mean occurrences from Essay 1 ($M = 5.29$) to Essay 2 ($M = 2.12$), $p = .003$, and Essay 1 ($M = 5.29$) to Essay 3 ($M = 1.82$), $p = .002$. The mean occurrences for the

Period button was statistically significant from Essay 1 ($M = 1.12$) to Essay 2 ($M = .23$), $p = .011$. Finally, the frequency of Spell Out occurrences showed statistically significant differences in mean occurrences from Essay 1 ($M = .000$) to Essay 2 ($M = 1.41$), $p = .002$, and Essay 2 ($M = 1.41$) to Essay 3 ($M = .06$), $p = .003$.

Rubric scores. The overall rubric score means increased with each essay (see Table 4.4). Repeated-measures ANOVA revealed that the difference in rubric score means across the three essays was statistically significant, $F(2, 32) = 29.64$, $p = .000$. Follow-up pairwise comparisons were adjusted using a Bonferroni correction to control for Type 1 error and revealed statistically significant differences from Essay 2 ($M = 5.86$) to Essay 3 ($M = 7.73$), $p = .000$, and Essay 1 ($M = 5.58$) to Essay 3 ($M = 7.73$), $p = .000$.

Table 4.4

Mean Rubric Scores for Each Essay by Criteria

Rubric Criterion	Essay 1	Essay 2	Essay 3
Purpose/Organization ^{b,c}	2.44	2.65	3.18
Evidence & Elaboration ^{a,b}	2.35	2.00	2.61
Conventions ^{b,c}	0.79	1.21	1.94
Total ^{b,c}	5.58	5.86	7.73

^a Statistically significant from first to second essay, $p < .05$.

^b Statistically significant from second to third essay, $p < .05$.

^c Statistically significant from first to third essay, $p < .05$.

Individual repeated-measures ANOVAs for each rubric criterion revealed statistically significant differences in all three criteria: Purpose/Organization, $F(2, 32) = 10.29$, $p = .000$; Evidence & Elaboration, $F(2, 32) = 11.43$, $p = .000$; and Conventions, $F(2, 32) = 40.64$, $p = .000$. Follow-up pairwise comparisons were adjusted using Bonferroni and revealed a statistically significant difference in the criteria of Purpose/Organization from Essay 2 ($M = 2.65$) to Essay 3 ($M = 3.18$), $p = .009$, and Essay 1 ($M = 2.44$) to Essay 3 ($M = 3.18$), $p = .002$; Elaboration &

Evidence from Essay 1 ($M = 2.35$) to Essay 2 ($M = 2.00$), $p = .028$, and Essay 2 ($M = 2.00$) to Essay 3 ($M = 2.61$), $p = .001$; and Conventions from Essay 2 ($M = 1.21$) to Essay 3 ($M = 1.94$), $p = .000$, and Essay 1 ($M = 0.79$) to Essay 3 ($M = 1.94$), $p = .000$.

Development of a Revision Task Schema and Internalization (Research Question 2)

Three separate thematic analyses were conducted on the qualitative data in the following order: recorded observations, stimulated recall interviews, and written reflections. The presentation of the themes from the recorded observations and stimulated recall interviews are presented concurrently because five of six recorded observation themes also emerged from the stimulated recall interview data.

Recorded observations and stimulated recall interviews. Three students (C, F, R) participated in the recorded observations and stimulated recall interviews for Essay 1. After identifying two additional students before Essay 2, a total of five students (C, F, I, R, L) participated in recorded observations and stimulated recall interviews for the second and third essays. Six themes emerged from the five students who participated in the recorded observations, and five of those six themes emerged from the stimulated recall interviews (see Table 4.5). These themes are described below; the evidence/quotations include descriptions of what was observed and quotations from the stimulated recall interviews to illustrate the themes that emerged. The first theme presented, “Increasing length of revision,” is the only theme that uses data exclusively from the recorded observations; the remaining five themes are associated with both the recorded and stimulated recall interviews.

Table 4.5

Themes from the Recorded Observations and Stimulated Recall Interviews

Theme (#) ^a	Definition	Evidence/Quotations
Increasing length of revision (5)	The average length of revision time increased from Essay 1 to Essay 3.	Essay 1: $M = 4.15$ Essay 2: $M = 5.92$ Essay 3: $M = 10.9$
Beginning with critical reading and evaluation (4)	Students begin their revision process with some text processing (critical reading and evaluation) before being interrupted by accepting a surface change.	Essay 1 (Student C): “I started out by reading through [my introduction] and saw the blue [feedback] and realized I forgot the comma. <i>Observation showed the student reading through the first two sentences of her introduction paragraph before coming upon a Mechanics suggestion that she implemented.</i> Essay 2 (Student L): “I was just reading and now I’m looking at the red editing [feedback]. I made the change but then I couldn’t get rid of the red.” <i>Observation showed the student reading through her writing until she encountered a Usage suggestion that she implemented.</i>
Becoming more critical of surface feedback (3)	Students transition from accepting all surface feedback in Essay 1 and/or 2 to rejecting some surface feedback by Essay 3.	Observation of Student F during Essay 1 revealed that she made surface-level revisions as directed by her peer, even if it was incorrect. This happened on at least two separate incidents. By Essay 3, Student F became more critical of her peer’s surface feedback. Essay 3 (Student F): “Here I didn’t like how [my partner] chopped up the sentence with a comma, so I kept it how it was because I thought it would make a comma splice.”
Becoming more critical of text-based feedback (4)	Students transition from accepting or attempting to implement all text-based feedback in Essay 1 and/or 2 to rejecting some text-based feedback by Essay 3.	Essay 2 (Student L): I was just trying to do what [my partner’s comments] told me to do. <i>Observation of Essay 2 revealed that Student L attempted to implement the nondirective feedback described in the text-based suggestion. By Essay 3, Student L began to consider text-based suggestions rather than accept them outright.</i> Essay 3 (Student L): I didn’t agree with what [my partner’s] comment suggested I do. I thought that would make my paper disorganized, so I didn’t do it. <i>Observation of this Essay 3 rejection revealed that the student maintained the order of her paragraphs instead of changing them as described in the text-based suggestion.</i>

Using more sophisticated text processing and reflection as evidenced by externalization during text production (4)	Students used more sophisticated text processing and reflection by Essay 3 by transitioning from externalizing a single solution when making a comment-inspired revision to externalizing multiple solutions.	<p>Essay 2 (Student I): [My partner] told me to change the way I worded this part of the sentence, so I was just changing it to how she told me to do it in the comment.</p> <p><i>Observation of Essay 2 revealed that Student I inserted the directive feedback prescribed in the text-based suggestion. By Essay 3, she inserted the directive feedback prescribed in the text-based suggestion; however, after externalizing this solution, the student engaged in additional rounds of text processing, reflection, and text production before finalizing an externalized solution.</i></p> <p>Essay 3 (Student I): I agreed with [my partner's] comment and that my sentence could be worded better and shorter. I tried the way [my partner] phrased it, but then I didn't like that and deleted it to try something else. But I didn't like that either.</p>
Becoming more self-aware of one's writing (4)	Students transition from only using feedback to prompt revisions to becoming more self-aware of their own writing by making both surface and text-based revisions not in response to any feedback by Essay 3.	<p>Essay 2 (Student F): I thought the period I originally had here separated my ideas too much. I remembered telling [my partner] to fix this problem with a semicolon, so that's what I did to show that my two ideas were connected.</p> <p><i>Observation of Essay 2 revealed that the student replaced a period with a semicolon and changed a capital letter to a lowercase one.</i></p> <p>Essay 3 (Student R): The first thing I did was fix the Works Cited. I forgot to add it, and I guess [my partner] did too because he didn't tell me about it, but when I was looking at his paper, I realized I forgot mine.</p> <p><i>Observation of this Essay 3 change revealed that the student began his revisions by adding a Works Cited page and in-text citations, neither of which were suggested by his peer.</i></p>

Note. The mean length of revision is calculated in minutes.

^a The number of students representing the theme are in parentheses after the theme name.

Increasing length of revision. Overall, the average length of time (in minutes) students spent revising increased from Essay 1 ($M = 4.15$) to Essay 2 ($M = 5.92$) to Essay 3 ($M = 10.9$). All five students increased the length of time spent revising from Essay 1 to Essay 3, while four (C, I, L, R) students increased the length of time spent revising for each observed essay. Student

F's revision length decreased from Essay 1 (4.86) to Essay 2 (3.98); however, her length of time spent revising Essay 3 (5.77) was longer than both the first and second essays.

Beginning with critical reading and evaluation. Four of the five students – C, F, I, L – began their revision process for each essay critically reading and evaluating their written work in conjunction with the feedback that was left by a peer. The text processing of these students was interrupted by producing a surface change identified by their peer in all cases except for Student I's third essay; Student I did not receive surface feedback on this essay. Observation of Student C's revision of Essay 1 showed her reading through the first two sentences of her introduction paragraph before coming upon a Mechanics suggestion that she implemented. When watching the recording, she explained, "I started out by reading through [my introduction] and saw the blue [feedback] and realized I forgot to capitalize that word. So I changed it." Similarly, Student L's Essay 2 observation showed her reading through her writing until she encountered a Usage suggestion, which she implemented. Student L recalled, "I was just reading and now I'm looking at the red editing [feedback]. I made the change but then I couldn't get rid of the red."

While the strategy of critical reading prior to accepting a surface change was embodied and articulated by most students, Student R immediately externalized text production when he started revising all three of his essays. The first thing Student R did while revising Essay 1 was text process (look) for surface suggestions before accepting one, whereas the other students read through their work and some of the comments before accepting a surface change. On Essay 2 and Essay 3, Student R immediately made changes not suggested by his peer.

Becoming more critical of surface feedback. All five students employed a singular strategy for dealing with surface feedback during their first recorded observation – they accepted all of their peer's surface feedback outright, even if it was not grammatically correct. By Essay 3,

three students (C, F, I) became more critical of the surface feedback suggested to them. While viewing the recording of Essay 1, Student F indicated, “[My partner] said I needed a comma, so I added it”; however, observation of this change revealed that the inserted comma created a comma splice in the student’s sentence. By Essay 3, Student F was observed rejecting her peer’s comma suggestion, which would have resulted in a comma splice had she accepted it. She explained her thought process of evaluating, problem solving, and decision making that eventually led to rejecting her peer’s feedback: “I didn’t like how [my partner] chopped up the sentence with a comma, so I kept it how it was because I thought it would make a comma splice.” Two students, Student R and Student L, continued to accept all surface feedback provided to them on Essay 2 and Essay 3 and did not articulate any additional evaluation or problem solving of the provided surface suggestions.

Becoming more critical of text-based feedback. Four students (C, F, L, R) also transitioned from accepting or attempting to implement all text-based feedback provided to rejecting some text-based feedback by Essay 3. For example, observation of Student L’s Essay 2 revisions revealed that Student L attempted to implement the nondirective feedback described in her peer’s text-based suggestion. During her Essay 2 interview, Student L explained, “I was just trying to do what [my partner’s comment] told me to do.” Student L’s complete acceptance of the text-based feedback provided to her changed by Essay 3: “I didn’t agree with what [my partner’s] comment suggested I do. I thought that would make my paper disorganized, so I didn’t do it.” Observation of this Essay 3 rejection revealed that Student L maintained the order of her paragraphs instead of changing them as described in the text-based suggestion. Student I was the only student that did not reject the text-based feedback provided to her or express hesitation when trying to enact text-based suggestions.

Using more sophisticated text processing and reflection as evidenced by externalization during text production. Four students (F, I, L, R) externalized single solutions to text-based feedback. The observation of Student I's Essay 2 revision showed her adding the exact wording of text suggested by her peer's comment. In her Essay 2 interview, Student I detailed that her partner suggested she change the wording of her sentence, which is why she reworded her sentence to reflect the exact wording suggested by her peer (see Table 4.5). Three of these students – I, L, R – used more sophisticated text processing and reflection by Essay 3 by transitioning from externalizing a single solution when making a comment-inspired revision to externalizing multiple solutions. Observation of Student I's revision showed her attempting to employ the same strategy of changing her sentence to reflect the exact wording suggested by her peer; however, after producing this text, she deleted and rewrote it three times before finalizing a solution. She explained, "I agreed with [my partner's] comment and that my sentence could be worded better and shorter. I tried the way [my partner] phrased it, but then I didn't like that and deleted it to try something else. But I didn't like that either." Of the five students, Student C externalized both single and multiple solutions to text-based feedback on all three essays, and Student F was the only student who only externalized single solutions to text-based feedback.

Becoming more self-aware of one's writing. When revising Essay 1, all three of the recorded observation and stimulated recall interview participants only made changes, both surface and text-based, suggested by their peers. By Essay 3, three of the five students – F, I, R – became more self-aware of their own writing by making surface revisions not in response to any feedback. Observation of Student F's Essay 2 revisions showed her replacing a period with a semicolon and changing a capital letter to a lowercase one. In her interview, she explained, "I thought the period I originally had here separated my ideas too much. I remembered telling [my

partner] to fix a similar problem with a semicolon, so that's what I did to show that my two ideas were connected." In addition to making additional surface changes, four students (C, F, I, R) became more self-aware by making text-based changes not in response to any feedback. Student R started his revision of Essay 3 began by adding a Works Cited page and in-text citations, neither of which were suggested by peer feedback. Student R described why he made additional text-based changes in Essay 3 that went beyond the feedback of his peer; he recounted, "The first thing I did was fix the Works Cited. I forgot to add it, and I guess [my partner] did too because he didn't tell me about it, but when I was looking at his paper, I realized I forgot mine." Of the students who made additional revisions, Student C was the only student who only made additional text-based revisions (no additional surface revisions). Finally, Student L was the only student who made did not make her own additional surface or text-based revisions

Written reflections. Five major themes emerged after a thematic analysis of the written reflections; two of the major themes include two subthemes (see Table 4.6). The major themes or associated subthemes are defined, indicate the number of students represented by the theme, and provide examples that reflect the major theme or subtheme.

Typical approach to the revision process. Before students conducted peer review and engaged in revision of Essay 1, they described their typical revision process (see Appendix 4.B). Students described their typical process of revision in two ways (see Table 4.6 for examples). Almost all (15) students indicated that their typical strategy was to text process, or look, for surface errors so they could make surface changes to their writing, such as capitalization, punctuation, and spelling. Student I described this strategy: "I check for spelling, punctuation, and if I accidentally typed the wrong word." Additionally, 13 students believed their typical strategy was to engage in text processing, or critical reading, all the way through their writing.

Table 4.6

Themes from Written Reflections

	Theme: Definition	#^a	Examples
Typical approach to revision	Typically processed text for surface errors: Before peer review and revision of Essay 1, the students believed their typical revision strategy was to look for surface errors and make surface changes to their writing.	16	<ul style="list-style-type: none"> - I look for capitalization and commas/periods and that all my information is spelled right and is correct. - I check for spelling, punctuation, and if I accidentally typed the wrong word. - My revision process is looking through and finding the mistakes. If I can't find any mistakes then I will make sure to keep going through it till I find one simple mistake that I made.
	Typically processed text all the way through: Before peer review and revision of Essay 1, the students believed their typical revision strategy was to read all the way through their writing.	13	<ul style="list-style-type: none"> - I normally read over the paper once or twice then make the changes needed. - Normally, I read back through to the end and if anything sounds weird change it. - I usually look over my paper a couple of times to find mistakes. - Usually I re-read my whole paper once. Then I make changes if I need to and read the whole paper again just in case I missed something before I turn it in.
Approach in preparation for review	Became more aware of peer's perspective: The student changed their approach in preparation for peer review and the revision phase because they became more aware of their peer's perspective.	9	<ul style="list-style-type: none"> - I know it sounds crazy, but when you have to pressure of someone else looking at your paper you seem to try harder, I try always try my best on everything I write, but when preparing for revision I really did try to make my writing better. - I [changed my approach] because I wanted it to look as good as possible before I let my peers read it. - When knowing that my paper was going to get reviewed, I get this feeling that I have to make it right the first time. Which is exactly what I did. I made sure that when I was ready to give it to my peer it was in tip top shape so I wouldn't see too many mistakes when I got it back.
	Believed they did not need to change their approach: The student was satisfied with their typical approach to peer review and revision and believed they did not need to change their approach in preparation for review.	12	<ul style="list-style-type: none"> - No, I didn't do anything before in preparation for the revision phase. Because I didn't feel the need to. - I did not do anything different, because I didn't have a need to do anything different. - I didn't do anything differently because I didn't need to fix anything. - I didn't do anything before in preparation for the revision phase. Because I didn't feel the need to - I did nothing different to get ready for the revision stage. The reason why is because I did not see a purpose in doing anything different.
	Became more aware of common surface errors: After receiving feedback from a peer who used <i>Revision Assistant</i> , too,	10	<ul style="list-style-type: none"> - Revision Assistant helped because it told me I needed to double check my writing for capitalization errors because they were what I had the most of in my last paper. - Using Revision Assistant too has actually really impacted my quality of writing because when I would be writing my first

students became more aware of the common surface errors they make while writing.	<p>draft I would check to find the mistakes I had in my other papers.</p> <ul style="list-style-type: none"> - The revision assistant impacted my essay a lot because it showed me mistakes that I always make on very important essays. - When writing my paper I made sure my wording and spelling/commas were okay because I had a lot of those last time. - I noticed I had pretty much the same errors as my last paper.
<p>Visual features helped identify surface errors: The visual features of <i>Revision Assistant, too</i> helped identify surface errors, and as a result, helped students improve the errors in their writing.</p>	<p>16</p> <ul style="list-style-type: none"> - It honestly really helped and I like how it used the colors. It's so helpful instead of just highlighting and typing a comment that says "correction" your partner can show you where and what more clearly. - It helped improve my paper by showing the errors, without just changing them. - It makes it easy for spelling mistakes or punctuation mistakes to be easily fixed because it helps you see where they are. - I think the Revision Assistant helps a lot. If people just tell you the suggestion then you could forget to add it later, and the colors stand out so you can easily see what needs to be changed. - The table was useful for knowing which errors to look for and the colors helped the errors pop out more so they were easy to find. - Revision assistant helped me because it makes my errors really bold so I can see them clearly. - Revision Assistant helped me omit words easily by crossing out the word, and I like it better than commenting because the person doesn't have to read the comment. They can just see right away that it should be taken out. Adding words with Revision Assistant is also easier than commenting, because they can see right where the word should be, and same with adding commas. - The bright colors help me see everything clearly and made it easier to look at the comments.
<p>Increased attention to text-based changes: After revising Essay 2 and/or Essay 3, students increased their attention to revising text-based errors.</p>	<p>16</p> <ul style="list-style-type: none"> - I had to completely rewrite a paragraph because it didn't sound good and I had to change the order of the whole thing because it didn't flow perfectly. - The biggest revision was when I added evidence. The evidence was incredibly impactful because it made my paper more effective. - I fixed my Works Cited page and I put citations in sentences. - I changed my sentences so that they referred back to my thesis. - I changed the way my paragraph was organized and setup.

^a Number of students representing the theme.

For example, Student E explained, “I normally read over the paper once or twice then make the changes needed.” Of the 15 students who described their typical process as one focusing on making surface changes, 12 also described their typical strategy of engaging in text processing all the way through their writing.

Approach in preparation for review. Prior to revising both Essay 2 and Essay 3, students explained whether they did anything differently in preparation for peer review and revision (see Appendix 4.B). Nine students said that they changed their approach by becoming more aware of their peer’s perspective of their writing (see Table 4.6 for examples). For instance, Student H described, “I know it sounds crazy, but when you have the pressure of someone else looking at your paper you seem to try harder, I try always try my best on everything I write, but when preparing for revision I really did try to make my writing better.” Similarly, Student J explained, “When knowing that my paper was going to get reviewed, I get this feeling that I have to make it right the first time. Which is exactly what I did. I made sure that when I was ready to give it to my peer it was in tip top shape so I wouldn’t see too many mistakes when I got it back.” Five students (J, M, O, Q, R) changed their approach in response to their awareness before review of Essay 2, while eight students (A, D, H, J, K, M, O, R) changed their approach before review of Essay 3; four students (J, M, O, R) said they changed in preparation for the review of both essays.

Twelve students believed they did not need to change their approach in preparation for review (see Table 4.6 for examples). Student C explained her reasoning: “I did nothing different to get ready for the revision stage. The reason why is because I did not see a purpose in doing anything different.” Six students (C, E, F, I, N, L) believed they did not change for either essay, and the other six (B, D, H, K, P, Q) believed they changed their approach for at least one of the

essays. Overall, these students believed they did not need to do anything differently in preparation for review.

Became more aware of common surface errors. After receiving feedback from a peer who used *RAtoo*, a total of 10 students believed they became more aware of the common surface errors they made while writing (see Table 4.6 for examples). For instance, Student O described the knowledge of her common errors to evaluate her writing: “Using *Revision Assistant, too* has actually really impacted my quality of writing because when I would be writing my first draft I would check to find the mistakes I had in my other papers.” Another student, Student Q, explained how this awareness helped [her] while she was writing: “When writing my paper I made sure my wording and spelling/commas were okay because I had a lot of those last time.” Finally, Student J recognized a similarity between the errors he had on Essay 1 and Essay 2: “I noticed I had pretty much the same errors as my last paper.” One student (R) indicated an awareness of their common errors after Essay 1; however, six students (D, J, H, M, O, R) described an awareness after Essay 2 and five students (B, D, E, K, Q) described it after Essay 3.

Visual features helped identify surface errors. All but one student (C) indicated that the visual features of *RAtoo* helped them identify surface errors, and as a result, helped them improve their writing. Nine students specifically contributed the identification of these errors to the use of color. For example, Student F explained, “I think the *Revision Assistant* helps a lot. If people just tell you the suggestion then you could forget to add it later, and the colors stand out so you can easily see what needs to be changed.” Some students (8) specifically noted the visual outputs to accurately portray the location and nature of a surface error, such as Student K:

Revision Assistant helped me omit words easily by crossing out the word, and I like it better than commenting because the person doesn't have to read the comment. They can

just see right away that it should be taken out. Adding words with *Revision Assistant* is also easier than commenting, because they can see right where the word should be, and same with adding commas.

Additionally, seven students noted *RAtoo*'s ability to distinguish surface from text based feedback; Student Q reflected, "The bright colors help me see everything clearly and made it easier to look at the comments." Fourteen students noted the visual features after the first essay, 12 students after the second essay, and 14 after the third essay. Nine students (A, F, H, M, N, O, P, Q, R) mentioned the impact of visual features after all three essays.

Increased attention to text-based changes. All but one student (O) began talking about making text-based changes in addition to surface changes by Essay 3. Student M described only surface changes after revising Essay 1: "The biggest changes I made were spelling corrections. I had a lot of spelling issues, because I type fast." By Essay 3, Student M discussed making both surface and text-based changes: "I had one or two spelling errors and I changed the way my paragraph was organized and setup." The types of changes students described were primarily about organization and evidence. When describing organization, Student E noted, "I had to completely rewrite a paragraph because it didn't sound good and I had to change the order of the whole thing because it didn't flow perfectly." Student P described his increased attention to evidence: "The biggest revision was when I added evidence. The evidence was incredibly impactful because it made my paper more effective." Five students (E, H, I, N, Q) described making text-based changes after revising all three essays. Thirteen students described making text-based changes after revising Essay 2, and 16 students described making text-based changes after revising Essay 3.

Extent that Quantitative Data Confirms Qualitative Data (Research Question 3)

The quantitative and qualitative data were merged using a theme-by-statistics joint display for triangulation purposes (see Table 4.7). During this process, four quantitative patterns

Table 4.7

Integration of Qualitative and Quantitative Data in a Theme-by-Statistics Joint Display

Quantitative Pattern	Qualitative Themes		
	Essay 1	Essay 2	Essay 3
Consistent Shifters (7 students: H, J, M, O, P, Q, R; Occurrences decreased and rubric scores increased each essay)	O & SRI (R) - No observation and stimulated recall themes present for this essay	O & SRI (R) - Increased length of revision - Began with making a surface change - Began to make additional revisions	O & SRI (R) - Increased length of revision - Became more critical of text-based feedback - Used more sophisticated text processing and reflection as evidenced by externalization during text production - Became more self-aware of one's writing
	Written Reflections - Typically processed text for surface errors (7) - Visual features helped identify surface errors (6)	Written Reflections - Became more aware of peer's perspective (5) - Became more aware of common surface errors (5) - Visual features helped identify surface errors (6) - Increased attention to making text-based changes (5)	Written Reflections - Became more aware of peer's perspective (5) - Visual features helped identify surface errors (7) - Increased attention to making text-based changes (6)
Delayed Shifters (3 students: A, B, D; Occurrences decreased and rubric scores increased but not until Essay 3)	Written Reflections - Typically text processes for surface errors (2) - Visual features helped identify surface errors (3)	Written Reflections - Believed they did not need to change their approach (2) - Visual features helped identify surface errors (2)	Written Reflections - Became more aware of peer's perspective (2) - Became more aware of common surface errors (2) - Increased attention to making text-based changes (3)

Almost Consistent (5 students: E, F, I, K, N; Rubric scores decreased for Essay 2)	O & SRI (F, I) - Began with critical reading and evaluation	O & SRI (F, I) - Began with critical reading and evaluation	O & SRI (F, I) - Increased length of revision - Began with critical reading and evaluation - Became more self-aware of one's writing
	Written Reflections - Typically processed text for surface errors (5) - Typically processed text all the way through (5) - Visual features helped identify surface errors (4) - Increased attention to making text-based changes (2)	Written Reflections - Believed they did not need to change their approach (5) - Visual features helped identify surface errors (4) - Increased attention to making text-based changes (5)	Written Reflections - Believed they did not need to change their approach (4) - Visual features helped identify surface errors (5) - Increased attention to making text-based changes (4)
Atypical (2 students: C, L; No consistent patterns found)	O & SRI (C, L) - Beginning with critical reading and evaluation	O & SRI (C, L) - Increased length of revision - Began with critical reading and evaluation	O & SRI (C, L) - Increasing length of revision - Beginning with critical reading and evaluation - Using more sophisticated text processing and reflection as evidenced by externalization during text production
	Written Reflections - Typically text processes for surface errors (2) - Typically text processes all the way through (2)	Written Reflections - Increased attention to making text-based changes (2)	Written Reflections - Believed they did not need to change their approach (2) - Increased attention to making text-based changes (2)

Note. O & SRI is an abbreviation for 'Observation and Stimulated Recall.'

emerged and were named for the consistency of the shift exhibited by their occurrences and rubric scores; see Table 4.8 for mean occurrences and mean rubric scores for each pattern. The 'Consistent Shifters' pattern includes seven students – H, J, M, O, P, Q, R – whose total occurrences decreased each essay and total rubric scores increased each essay. The 'Delayed Shifters' pattern represents three students – A, B, D – whose total occurrences decreased from Essay 1 to Essay 3; however, their total occurrences for Essay 2 either decreased from Essay 1,

Table 4.8

Occurrence Frequency and Rubric Score Means for Each Essay by Pattern

Pattern	Occurrence Frequency Means ^a				Rubric Score Means ^b			
	TC	E1	E2	E3	RC	E1	E2	E3
Consistent Shifters	M	20.00	10.86	5.57	P/O	1.86	2.57	3.14
	U	6.14	1.14	2.14	E&E	2.00	2.00	2.57
	SF	0.00	0.29	0.14	C	0.50	1.29	2.00
	Total	<i>26.14</i>	<i>13.71</i>	<i>7.86</i>	Total	<i>4.36</i>	<i>5.86</i>	<i>7.71</i>
Delayed Shifters	M	16.33	14.67	6.33	P/O	2.33	2.33	2.67
	U	8.33	12.00	12.67	E&E	2.00	1.67	2.33
	SF	0.00	0.00	0.00	C	0.67	1.33	1.67
	Total	<i>24.67</i>	<i>26.66</i>	<i>19.00</i>	Total	<i>5.00</i>	<i>5.33</i>	<i>6.67</i>
Almost Consistent	M	14.80	6.60	2.60	P/O	3.10	2.80	3.60
	U	5.20	4.20	2.20	E&E	2.80	2.00	2.90
	SF	0.20	0.40	0.00	C	1.20	1.10	2.00
	Total	<i>20.20</i>	<i>11.20</i>	<i>4.80</i>	Total	<i>7.10</i>	<i>5.90</i>	<i>8.50</i>
Atypical	M	10.00	6.50	4.50	P/O	3.00	3.00	3.00
	U	4.50	1.50	7.50	E&E	3.00	2.50	2.50
	SF	2.00	0.00	0.00	C	1.00	1.00	2.00
	Total	<i>16.50</i>	<i>8.00</i>	<i>12.00</i>	Total	<i>7.00</i>	<i>6.50</i>	<i>7.50</i>

^a The Occurrence Frequency Means section of the table includes several abbreviations. Those abbreviations are as follows: TC – Toolbar Category, M – Mechanics, U – Usage, SF – Sentence Formation, E1 – Essay 1, E2 – Essay 2, and E3 – Essay 3.

^b The Rubric Score Means section of the table includes several abbreviations. Those abbreviations are as follows: RC – Rubric Criteria, P/O – Purpose/Organization, E&E – Elaboration & Evidence, C – Conventions, E1 – Essay 1, E2 – Essay 2, and E3 – Essay 3.

increased from Essay 1, or were equivalent to Essay 1. The ‘Almost Consistent’ pattern includes five students – E, F, I, K, N – whose total occurrences decreased each essay and total rubric scores increased from Essay 1 to Essay 3; however, their Essay 2 total rubric scores were either equivalent to Essay 1 or decreased from Essay 1. Finally, the ‘Atypical’ pattern represents two students – C, L – who had patterns of both total occurrences and total rubric scores that were unlike any other students in the class.

The trends and themes associated with each pattern are explicated below. Three of the four patterns include students that participated in the recorded observations and stimulated recall interviews; these patterns use the themes that emerged from the analysis of recorded observations and stimulated recall interviews as well as the themes from the written reflections of all students in the pattern to help illustrate the extent with which the quantitative data confirms the qualitative data. The second pattern – Delayed Shifters – is the only one that does not include a student that participated in recorded observations and stimulated recall interviews, so this pattern only uses themes from the written reflections of students in the pattern.

Pattern 1: Consistent Shifters. The first pattern was the most commonly occurring pattern and included seven students: H, J, M, O, P, Q, and R. The seven students in this pattern had the number of occurrence frequencies decrease with each essay and rubric scores increase with each essay (see Figure 4.6). Overall, the occurrence means decreased from Essay 1 ($M = 26.14$) to Essay 2 ($M = 13.71$) to Essay 3 ($M = 7.86$), and the rubric score means increased from Essay 1 ($M = 4.36$) to Essay 2 ($M = 5.86$) to Essay 3 ($M = 7.71$) (see Table 4.8).

Before peer review and revision of Essay 1, all (7) of the Consistent Shifters indicated that their typical strategy for revision was to text process to identify surface errors and make surface changes during revision. For example, Student P described, “My typical revision is looking for my mistakes to fix. Like grammar and spelling.” Six students described changing their approach to the revision phase as a result of becoming more aware of their peer’s perspective after the review of Essay 1 but before the review of the Essay 2. Student M disclosed, “I made sure to double-check my spelling this time because I didn’t want it to have too many colors on it and I wanted [my partner] to like it.” The same six students who became aware of their peer’s perspective (H, J, M, O, Q, R) also revealed that using *RAtoo* helped them become

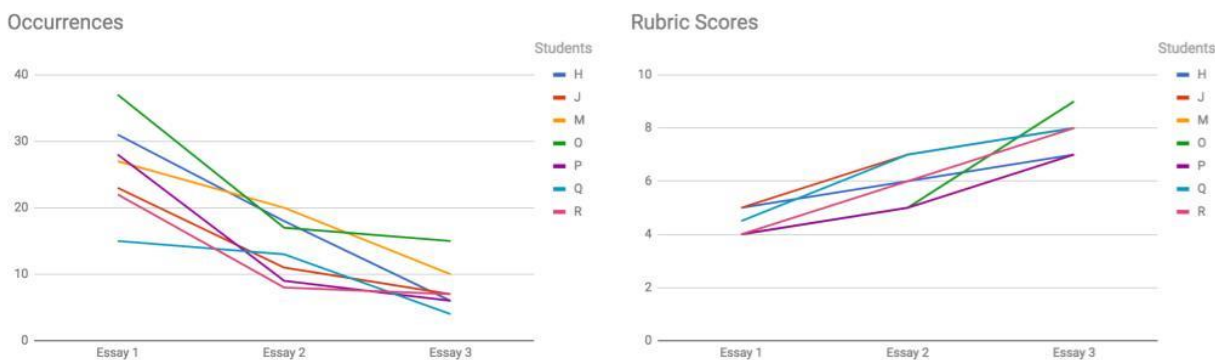


Figure 4.6. Consistent Shifters occurrence frequencies and rubric scores by student and essay.

This figure illustrates the distribution of each Pattern 1 student’s occurrence frequencies and rubrics scores for each essay.

more aware of the common surface errors they made while writing. For instance, Student R reported, “The *Revision Assistant* impacted my essay a lot because it showed me mistakes that I always make on very important essays.” Student R identified his awareness after revising Essay 1. Additionally, five students (H, J, M, O, R) noted this recognition of common surface errors for Essay 2, while only Student Q noted it for Essay 3.

All (7) of the Consistent Shifters explained that the visual nature of the surface suggestions helped them identify surface errors after review and during revision. Student O emphasized the impact of the colors: “It honestly really helped and I like how it used the colors. It’s so helpful instead of just highlighting and typing a comment that says “correction” your partner can show you where and what more clearly.” By Essay 3, all but one student (O) described making text-based changes in addition to surface changes. For instance, Student H said, “I changed some punctuation and spelling errors and I changed how my paper was shaped by changing the order of my paragraphs to the order of my thesis statement.” Two students (H,

Q) described making surface and text-based changes after revising all three essays. Three additional students (M, P, R) described making both surface and text-based changes after Essay 2 and Essay 3. Finally, Student J noted making both surface and text-based changes after revising Essay 3.

Consistent Shifters: The case of Student R. Student R typifies the pattern of transition from focusing on making surface changes to also focusing on making text-based changes in the Consistent Shifters pattern. Student R's recorded observations and stimulated recall interviews revealed how, each time he revised, he began by immediately making changes without critically reading or evaluating any of his feedback. However, his approach to these immediate changes and what followed those changes was different for each essay. On Essay 1, Student R text processed for surface errors identified by his peer and immediately accepted a surface suggestion. He recalled, "I looked for the colors, and that was just a simple mistake that I sometimes forget to do. Capitalize things that I should capitalize." Student R accepted all 22 surface suggestions provided by his peer through *RAtoo*. When he was finished accepting all suggestions, his revision process was complete. Student R spent 1.10 minutes revising Essay 1.

Student R again immediately started by making a surface change for Essay 2; however, it was not in response to peer feedback. He explained, "When I used *Revision Assistant [too]* on [my partner's] paper, I realized I didn't capitalize the name of the [colonies] at all in my paper. So I tried to find that everywhere in my paper before doing the rest." Throughout the revision of Essay 2, Student R made three of his own surface changes and one of his own text-based changes. Additionally, he accepted all eight surface suggestions and one text-based change in response to a comment, which he resolved with the solution provided by his peer. The shift from a focus on surface changes for Essay 1 to one that also includes text-based changes for Essay 2 is

reflected in Student R's rubric scores for Purpose/Organization (Essay 1 = 2; Essay 2 = 3) and Conventions (Essay 1 = 0; Essay 2 = 1); the shift is also reflected in the decrease in overall occurrences (Essay 1 = 22; Essay 2 = 8). For Essay 2, Student R's revision lasted 2.07 minutes, which is twice as long as the time spent on Essay 1.

On Essay 3, Student R immediately started making text-based changes that were not in response to peer feedback by adding a Works Cited and in-text citations. While he accepted all seven surface suggestions and implemented all three text-based suggestions from comments, Student R externalized several solutions to one of the comment inspired revisions. He remembered, "I wrote what [my partner] had but then thought of something that sounded better, so I changed it to what I thought." By continuing to focus his revisions on both surface and text-based changes, Student R improved his rubric scores from Essay 2 to Essay 3 in both Evidence & Elaboration (Essay 2 = 2; Essay 3 = 3) and Conventions (Essay 2 = 1; Essay 3 = 2); his rubric score in Purpose/Organization remained equivalent to his score from Essay 2 (3). Student R also saw a decrease in his Essay 3 occurrences (Essay 2 = 8; Essay 3 = 7). In addition to increasing his rubric scores and decreasing his occurrence frequencies, Student R increased the length of time he spent revising Essay 3 to 7.10 minutes; this is more than triple the time spent on Essay 2.

Pattern 2: Delayed Shifters. The second pattern included three students (A, B, D) whose number of occurrence frequencies decreased and rubric scores increased from Essay 1 to Essay 3 (see Figure 4.7); no observation and stimulated recall students were in this pattern. The occurrence means decreased from Essay 1 ($M = 24.67$) to Essay 3 ($M = 19.00$); however, student occurrences for Essay 2 ($M = 24.66$) either increased from or were equivalent to the Essay 1 (see Table 4.8). Additionally, rubric score means for students in this pattern increased from Essay 1

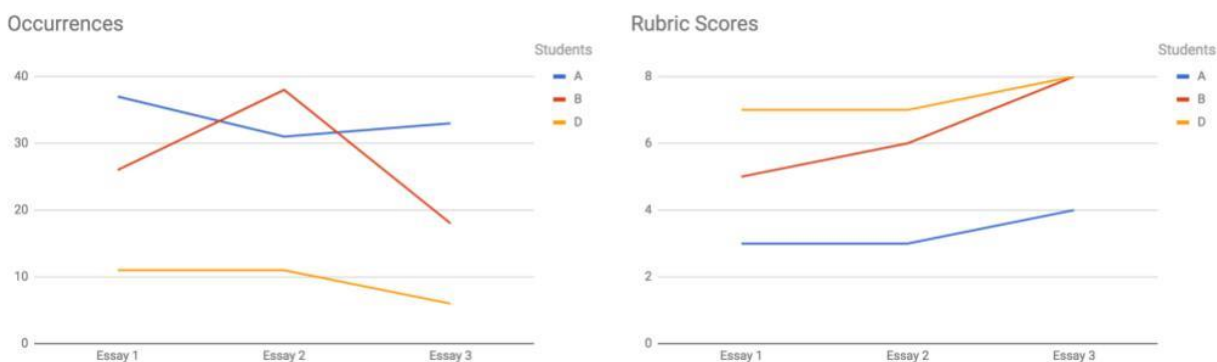


Figure 4.7. Delayed Shifters occurrence frequencies and rubric scores by student and essay. This figure illustrates the distribution of each Pattern 2 student’s occurrence frequencies and rubrics scores for each essay.

($M = 5.00$) to Essay 3 ($M = 6.67$); student rubric scores for Essay 2 ($M = 5.33$) either increased from or were equivalent to Essay 1.

Two students (A, D) indicated that they typically look for surface errors during revision; Student B indicated her typical strategy when revising was to seek the assistance of peers or family members. Two students (B, D) believed they did not need to change their approach to review and revision of Essay 2, while two (A, D) described that they changed their approach in preparation for Essay 3 because they became more aware of their peer’s perspective. For instance, Student D revealed, “I [changed my approach] because I wanted it to look as good as possible before I let my peers read it.” Two students (B, D) also believed that using *RAtoo* helped them become more aware of the common surface errors they make while writing by Essay 3. Student B recognized, “Revision Assistant helped because it told me I needed to double check my writing for capitalization errors because they were what I had the most of in my last paper.”

All of the Delayed Shifters mentioned that the visual features of *RAtoo* helped them identify surface errors when they started revising. Student D recalled, “It makes it easy for spelling mistakes or punctuation mistakes to be easily fixed because it helps you see where they are.” All of the Delayed Shifters only described making surface changes while revising their first two essays; however, they all transitioned from believing they only made surface changes to believing they also made text-based changes during revision of Essay 3 (see Table 4.7). Student A detailed the surface changes he made for the first essay: “I had to fix my spelling and grammar.” By Essay 3, Student A explained, “I had to correct my capitalization and change the order of some sentences in one paragraph to make sure my evidence made sense.”

Pattern 3: Almost Consistent. The Almost Consistent pattern was the second most commonly occurring pattern and included five students (E, F, I, K, N) whose number of occurrences decreased each essay and rubric scores increased from Essay 1 to Essay 3 (see Figure 4.8). Students in this pattern saw the average number of occurrence frequencies decrease from Essay 1 ($M = 20.20$) to Essay 2 ($M = 11.20$) to Essay 3 ($M = 4.80$) (see Table 4.8). Rubric score means for the Almost Consistent students increased from Essay 1 ($M = 7.10$) to Essay 3 ($M = 8.50$); however, student rubric scores for Essay 2 ($M = 5.90$) were either equivalent to or decreased from the Essay 1 ($M = 7.10$).

All (5) students in the Almost Consistent pattern indicated their typical strategy when revising was to text process all the way through their writing and to identify surface errors (see Table 4.7). For example, Student N described, “Normally, I read back through to the end and if anything sounds weird change it. I also look for grammar and spelling.” All (5) students in this

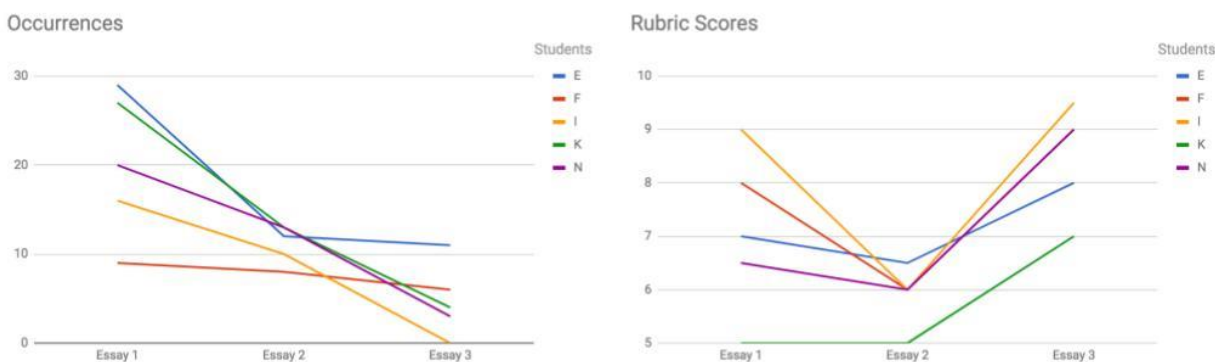


Figure 4.8. Almost Consistent occurrence frequencies and rubric scores by student and essay.

This figure illustrates the distribution of each Pattern 3 student’s occurrence frequencies and rubrics scores for each essay.

pattern believed they did not need to change their approach to revision of Essay 2. Student F explained, “I did not do anything different, because I didn’t have a need to do anything different.” By Essay 3, however, one student (K) became more aware of her peer’s perspective: “Knowing that [my partner] was going to look at my paper, I made sure to double check my writing a few more times.” Only two students (E, K) believed that using *RAtoo* helped them become more aware of their common surface errors.

All (5) students in this pattern believed that the visual features of *RAtoo* helped them identify the surface feedback provided by their peer. Student E asserted, “If I hadn’t gotten peer reviewed with Revision Assistant too, it would be harder to understand what I needed to fix.” Student N specifically appreciated that the visual feedback not only identified the error, but also that the visual feedback was not finalized: “It helped improve it by showing the errors, without just changing them.” After revising each essay, all (5) students in this pattern indicated that they made surface changes; however, three students (E, I, N) believed they also made text-based

changes for all three essays. In addition to these three students, the other two (F, K) believed they also made text-based changes for Essay 2, and one (F) believed she also made text-based changes for Essay 3. Student E's reflections portray her sustained attention to making both types of changes. After Essay 1, she described, "I had to completely rewrite a paragraph because it didn't sound good and I had to change the order of the whole thing because it didn't flow perfectly and make a lot of small changes with commas, correct wording, and even spelling." After Essay 3, Student E recounted, "The first changes I made were simple punctuation and spelling errors, and then [I] rewrote a few sentences and made sure my evidence was cited."

Almost Consistent: The case of Students F and I. The shift from making surface changes to additionally making text-based changes can be seen in the recorded observations and stimulated recall interviews of Student F and Student I. Each recorded observation reveals that both Student F and Student I began their revision process by critically reading and evaluating their writing and feedback. In her Essay 1 recorded observation, Student F began by reading through her writing before she was interrupted by a surface suggestion; she recounted, "I was reading until I saw the colored semicolon, and so I added it. Now I'm just rereading it to make sure it sounds ok." Student F accepted all nine surface suggestions provided to her on Essay 1 and made no text-based revisions; however, not all of these suggestions improved her writing (i.e., accepting a comma created a comma splice). Student F's revision of Essay 1 lasted 4.68 minutes. Student I did not become a recorded observation and stimulated recall participant until Essay 2.

Both Student F and Student I engaged in critical reading and evaluation of their writing for Essay 2 before coming across a surface suggestion that they implemented. Throughout the revision of Essay 2, Student F accepted all eight surface suggestions, and Student I accepted nine

surface suggestions and rejected one surface suggestion. Additionally, both students implemented feedback from two comments to make text-based changes using a single solution that was provided by their peer. Student I discussed her process of making a text-based change: “[My partner] told me to change the way I worded this part of the sentence, so I was just changing it to how she told me to do it in the comment.” The shift in focus from only making surface changes to also making text-based changes is reflected by the decrease in their occurrence frequencies. Student F’s occurrences decreased from nine in Essay 1 to eight in Essay 2, and Student I’s occurrences decreased from 16 in Essay 1 to 10 in Essay 2. The shift to include both surface and text-based changes was not reflected in their writing achievement. Student F’s rubric scores decreased in both Purpose/Organization (Essay 1 = 4; Essay 2 = 3) and Evidence & Elaboration (Essay 1 = 3; Essay 2 = 2); her Conventions score stayed the same (Essay 1 = 1; Essay 2 = 1). Student I’s rubric scores decreased in all rubric criteria: Purpose/Organization (Essay 1 = 4; Essay 2 = 3), Evidence & Elaboration (Essay 1 = 3; Essay 2 = 2), and Conventions (Essay 1 = 2; Essay 2 = 1). Student F’s second observation revealed the time she spent revising Essay 2 decreased to 3.98 minutes, and Student I’s first observation lasted 2.82 minutes.

For both Student F and Student I, the revision of Essay 3 again started with some critical reading and evaluating of their writing. Only Student F received surface feedback; however, instead of accepting all of it like she did on her previous essays, she accepted three and rejected three surface suggestions. Student F recalled, “Here I didn’t like how [my partner] chopped up the sentence with a comma, so I kept it how it was because I thought it would make a comma splice.” Student F was correct in her reasoning. Both Student F and Student I produced an additional surface change on the third essay that was not in response to any feedback. Student I

remembered, “After I made the changes from the comments, I was reading back through and realized that this was a run-on. I’m kind of paused here because I was trying to figure out if I wanted to combine the sentences or split them up. Now I’m adding a period and capitalizing the first word to make them two sentences.”

Both students received text-based feedback on Essay 3; however, their approaches to implementation were different. For example, Student F received two comments and decided to not use the advice provided in either comment. Student F recalled, “[My partner] told me to change my words around, but I was trying that in my head while I reread it, and it didn’t make sense to switch them.” In contrast, Student I attempted to implement all text-based feedback provided and used several strategies. For example, Student I externalized a single solution, which was provided in the feedback, for two comments and later externalized multiple solutions to one comment. Student I described, “I agreed with [my partner’s] comment and that my sentence could be worded better and shorter. I tried the way [my partner] phrased it, but then I didn’t like that and deleted it to try something else. But I didn’t like that either.” Both students also produced a text-based change not in response to any feedback. Student F explained, “I realized I forgot the word ‘they’ there, but then I realized ‘they wanted’ was extra words and I didn’t need it. So I took it out altogether.” Similarly, Student I stated, “I just didn’t think I needed these words, so I was trying to figure out how I could support it without it being there.”

The occurrence frequencies and rubric scores for Essay 3 reflect the time both students spent of making surface and text-based changes. Student F’s occurrences decreased from eight to six, and Student I’s occurrences decreased from 10 to zero. Their scores not only increased in each criterion from Essay 2 but also in one criterion from Essay 1. Finally, Student F’s length of revision increased to 5.77 minutes, and Student I’s length of revision increased to 12.63 minutes.

Pattern 4: Atypical. The final pattern included two students (C, L) whose number of occurrence frequencies and rubric scores did not follow a pattern similar to any other students, which made them Atypical (see Figure 4.9). Their combined occurrence means decreased from Essay 1 ($M = 16.50$) to Essay 2 ($M = 8.00$) and Essay 1 to Essay 3 ($M = 12.00$); however, their occurrence means increased from Essay 2 to Essay 3 (see Table 4.8). The rubric scores means for students in this pattern increased from Essay 1 ($M = 7.00$) to Essay 3 ($M = 7.50$) essay; however, rubric scores means decreased from Essay 1 to Essay 2 ($M = 6.50$).

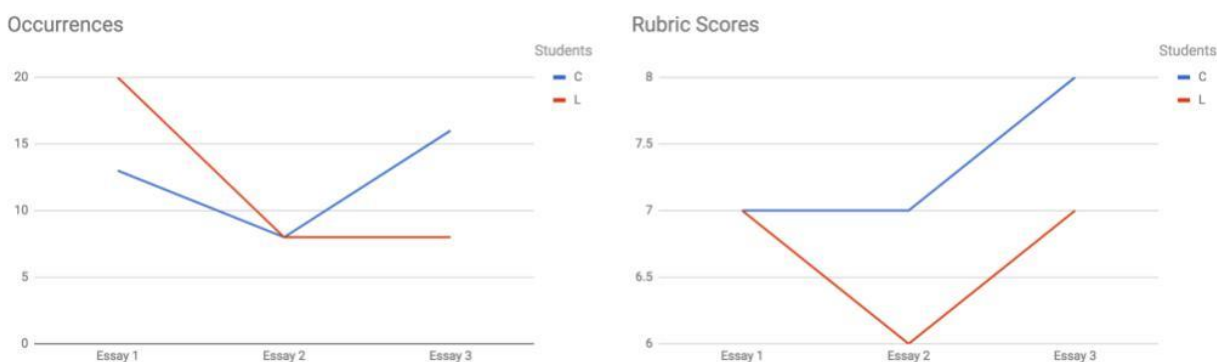


Figure 4.9. Atypical occurrence frequencies and rubric scores by student and essay. This figure illustrates the distribution of each Pattern 4 student's occurrence frequencies and rubrics scores for each essay.

Recorded observations and stimulated recall interviews for students in this pattern revealed that these students began with some critical reading and evaluation before they were interrupted by making a surface change, increased their length of revision for each essay, and began using more complex problem solving during text production (see Table 4.7). Their written reflections indicated that these students believed they typically text processed for surface errors, text processed all the way through, believed they did not need to change their approach to

revision, and transitioned from making only surface changes to also making text-based changes by the second essay. The combined quantitative and qualitative data make it seem as though these two students could fit into the Delayed Shifters pattern; however, examining each of these students separately brings more insight into what made their revision processes atypical.

Atypical: The case of Student C. For each essay, Student C started out by engaging in some critical reading and evaluation of her writing, which was interrupted by accepted a surface suggestion provided by a peer with *RAtoo*. This process demonstrated what she believed to be her typical strategy of engaging in text processing through her writing and text processing for surface errors during revision. She explained, “I started out by reading through [my introduction] and saw the blue [feedback] and realized I forgot the comma.” Student C noted that she made surface changes during Essay 1; however, the recorded observation revealed that she also made comment-inspired revisions and externalized multiple solutions, which portrayed how she used more sophisticated text processing and reflection during text production. Student C accepted all 13 surface suggestions provided to her without any hesitation. The revision of Essay 1 lasted 6.65 minutes.

Student C explained that she did not change her approach in preparation for revision of Essay 2 because she did not think she needed to; however, her total occurrences decreased from Essay 1 (13) to Essay 2 (8). When revising, Student C again began with her typical approach to revision and accepted all eight surface suggestions provided to her. Her written reflections revealed Student C’s transition to making text-based changes during revision, and her recorded observation and stimulated recall interview confirm this. During the revision of Essay 2, Student C decided against making one of the text-based changes suggested to her by her peer’s comment. She explained, “[My partner] said I needed to change my wording here so it sounded more like

my thesis, but I thought it already did.” She made five other comment-inspired revisions – three in which she externalized a single solution and two in which she externalized multiple solutions. When watching one of the instances where she externalized multiple solutions, Student C recalled, “I wrote a new one, and then I was like, ‘That doesn’t sound right.’ And then I wasn’t happy with this one either.” Additionally, Student C made her own additional text-based change that was not inspired by a comment. Despite making these changes and increasing her length of time spent revising to 8.82 minutes, Student C’s rubric scores for Essay 2 were equivalent to the ones she received on Essay 1 in every criteria (Purpose/Organization = 3; Evidence & Elaboration = 3; Conventions = 1).

Student C’s approach in preparation for revising Essay 3 did not change, and she used her typical approach of critically reading and evaluating some of her writing before being interrupted by a surface change. While her total occurrences increased from Essay 2 (8) to Essay 3 (16), Student C only accepted 11 surface suggestions provided to her; she became more critical of surface feedback and rejected five surface suggestions. She recalled, “I didn’t think I needed a comma here, so I didn’t use one.” The recorded observation revealed that her decision to reject this feedback was correct. Student C believed she made both surface and text-based changes during her Essay 3 revision. She described, “On my paper I changed my sentences so that they referred back to my thesis and so that they flowed well.” When making comment-inspired revisions, Student C externalized both single and multiple solutions. During her stimulated recall interview, she explained both the single solution (“I made the [change] my partner said to”) and multiple solution (“I rewrote the sentence to make it flow better, but then I deleted it because it didn’t sound good. So then I wrote it again and thought that sounded better”). Despite Student C’s attention to making text-based changes during revision, her rubric scores only increased in

the area of Conventions from Essay 2 (1) to Essay 3 (2); however, this yielded an overall rubric score increase from Essay 1 (7) to Essay 3 (8). The length of time Student C spent revising increased to 13.92 minutes.

Atypical: The case of Student L. Student L believed her typical approach to revision was to engage in text processing all the way through her writing and to text process for surface errors. She believed she only made surface changes when revising Essay 1. In her written reflection, Student L explained, “I had to add a few commas and periods in some places, change and cross out a few words, and capitalize a few words.” In all, Student L had a total of 20 occurrences on Essay 1. Student L did not become a recorded observation and stimulated recall interview participant until Essay 2.

The recorded observation of Essay 2 showed that Student L began her revision with some critical reading of her writing before being interrupted by accepting a surface change. She accepted all eight surface suggestions provided to her without any hesitation, and her occurrences decreased from Essay 1 (20) to Essay 2 (8). During her interview, Student L stated, “I start with reading to find the editing stuff because I like to get the easier stuff done first and keep the harder things for later.” Student L believed she made both surface and text-based changes during Essay 2 and only externalized single solutions to text-based feedback. She explained, “I was just trying to do what [my partner’s comments] told me to do.” Despite her perceived attention to making text-based changes, Student L’s total rubric scores decreased from Essay 1 (7) to Essay 2 (6), specifically in the Evidence & Elaboration criterion (Essay 1 = 3; Essay 2 = 2). She spent a total of 11.28 minutes revising Essay 2.

When revising Essay 3, Student L again began with some critical reading of her writing and was interrupted by making a surface change. After revising the essay, Student L believed she

made both surface and text-based changes. She accepted all eight surface suggestions provided to her, which is the same number of total occurrences she had on Essay 2. Student L began using more sophisticated text processing and reflection as evidenced by the externalization of multiple solutions to comment-inspired revisions. She remembered, “I tried to do what [my partner] was asking, but it didn’t sound good. I tried to fix it again was getting frustrated so I left it for a while...Now I’m going back to that one sentence again to make it sound better.” Additionally, Student L became more critical of the text-based feedback provided to her: “I didn’t agree with what [my partner’s] comment suggested I do. I thought that would make my paper disorganized, so I didn’t do it.” The attention to implementing text-based changes increased Student L’s revision time to 15.07; however, her rubric scores only increased in Conventions and was equivalent to the total score she received on Essay 1 (7).

Discussion

Overall, writing achievement improved with repeated use of *RAtoo* for students in this study. The difference in mean rubric scores was statistically significant from the second to the third essay and the first to the third essay. Follow up testing revealed that the difference in mean rubric scores was statistically significant in two rubric criteria: Conventions and Purpose/Organization. The attention these middle school students gave to Conventions was to be expected. Previous research (MacArthur, 2012; Sommers, 1980) indicated that students focus on making surface changes to their writing during revision. A more surprising result is the improvements students made in the Purpose/Organization criterion. The fact that students had fewer occurrences suggests that students were able to move beyond making surface changes so they could also make text-based changes during revision. Additionally, students were able to

effectively problem solve and make decisions before producing text that impacted the purpose and organization of their writing.

The occurrence data further suggest that students became more adept in the area of Conventions over time. Overall, there was a statistically significant decrease in the amount of surface feedback from first to second essay, second to third essay, and first to third essay. These differences were primarily associated with four errors from first to second essay: Capitalize, Comma, Period, and Spell Out. Likewise, the difference in mean occurrences for the Capitalize and Comma buttons was statistically significant from first to third essay. These results suggest that repeated use of *RAtoo* may support student internalization of common surface errors they make, which helps explain why Conventions scores consistently improved with each essay.

The qualitative results suggest that specific features of *RAtoo* supported the decrease in the number of occurrences dealing with surface feedback. In their written reflections, students repeatedly noted how the use of visual cues helped them identify and address surface errors. This suggests that the visual features acted as a cue that directed student schema to surface errors during text processing, which ultimately led into reflection and text production. Many students began their revision process by looking for and correcting the surface errors identified by their peer with *RAtoo* before moving on to text-based changes. Several students indicated that they preferred to engage in reflection of surface errors first because they were easier to make decisions about (i.e., “I start with reading to find the editing stuff because I like to get the easier stuff done first and keep the harder things for later”; “The first thing I did was look for the colored punctuation and spelling errors because they were simple to fix. Then I did the comments.”). For the most part, these students were correct; it takes less time for students to

solve surface errors because less prior knowledge is needed, and surface corrections are more automated because students have had more practice with them (Roussey & Piolat, 2008).

The combination of the visual cues and the occurrence tracker also appears to have helped make students more aware of the common errors they made while writing. This awareness is important because it can help students manipulate the processes that lead to text production (Bracewell, 1983). Recognizing common errors encouraged students to develop new strategies, such as consciously focusing on avoiding those errors while writing and double-checking their writing for those errors prior to peer review. By doing this, students intentionally activated their revision task schema with a specific goal (Roussey & Piolat, 2008) and used their common errors as a checklist for evaluation, which can support schema development (Ferretti & Lewis, 2013). Supporting the development of specific editing schema in these ways helped students transition from only making surface changes to also making text-based changes during revision.

With a diminished presence of visually identified surface errors, students were able to engage in more substantive text processing, reflection, and text production. For instance by the third essay, three of the five recorded observation and stimulated recall students became more critical of surface feedback and four became more critical of text-based feedback. Their increased reflection could be a result of these students becoming more mature writers. Kellogg (1994) noted that inexperienced writers put forth more effort and reflection into revision as they gain more experience. Additionally, four of the five recorded observation and stimulated recall students began externalizing multiple solutions to text-based feedback, which suggests that they were engaging in more sophisticated text processing and reflection prior to and during text production. Hayes (1996) suggested that experience with language can support the development

of schema that detects errors and generates solutions. Most (4) of these students became more self-aware of their own writing during revision and began making surface and text-based changes that were not in response to feedback by the third essay. The self-awareness experienced by these students is likely due to their experience with peer review and language. Along with experience in language, peer review can encourage students to reflect and learn more about their own writing habits (MacArthur, 2012; McVey, 2008). The increased attention to making text-based changes was reflected in the increased length of revision time from first to third essay for all five observation and stimulated recall students. For three students, the length of time spent revising increased by over six minutes, suggesting they spent more time on revision with repeated use of *RAtoo*.

It should be noted that the middle school students in this study did not entirely shift their focus from making surface changes to making text-based changes; however, the students in this study likely had more room to make text-based revisions because of the experiences they had with language and with using *RAtoo*. For instance, the Consistent Shifters' occurrences decreased each essay and rubric scores increased each essay, which were the intended effects of using *RAtoo*. After using *RAtoo* on the first essay, five of the seven students in this pattern shifted the way they approached peer review by becoming more aware of their peer's perspective.

After revising their second and third essays, six of the seven Consistent Shifters indicated that they became more aware of their common surface errors and either attended to those errors during drafting or engaged in additional text processing to look for those errors prior to peer review. The mean rubric scores of students in this pattern support these claims. The mean rubric scores for the Conventions and Purpose/Organization criteria increased from first to second to

third essay, and the mean rubric scores for Evidence & Elaboration increased from first and second to third essay. Alongside the decrease in mean occurrences from first to second to third essay, the increased rubric scores in each rubric criterion suggest that students were able to develop schema for some of the common surface errors they made and engage in text processing, reflection, and text production for more challenging, text-based errors related to Purpose/Organization and Evidence & Elaboration. Rijlaarsdam et al. (2004) similarly found that experiences implementing text-based feedback can support the development of schema for these errors and offer solutions for how to solve these errors in future writing.

Like the Consistent Shifters, the Delayed Shifters' occurrences decreased and rubric scores increased from first to third essay. Unlike the Consistent Shifters, the Delayed Shifters took longer to develop. The written reflections of the Delayed Shifters bring some insight into why this may have occurred. Before peer review on the second essay, most (2) of the Delayed Shifters believed they did not need to change their approach to revision; however, two explained how they became more aware of their peer's perspective as well as the common surface errors they made before peer review by the third essay. After revising the third essay, all three Delayed Shifters described the changes they made during revision to be both surface and text-based, which is confirmed by their rubric scores. The mean rubric scores for students in this pattern increased in Conventions from first to second to third essay; however, the mean rubric scores for both Purpose/Organization and Evidence & Elaboration increased from first to third essay only.

For both the Consistent Shifters and Delayed Shifters, a key aspect of their revision task schema development was developing an awareness of their peer's perspective about both surface and text-based improvements to their writing. Rubric scores suggest that this awareness was associated with their improved writing achievement in some manner. It is likely that taking a

peer's perspective helped them 'see' issues with their writing more clearly. Consistent Shifters in particular saw consistent improvement in both Purpose/Organization and Conventions scores. This suggests that taking a peer's perspective may be one way to encourage more awareness of both types of errors among middle school writers. Others have similarly found that writers who anticipate their audience are more likely to perceive both surface and text-based errors when they evaluate their own writing (Chanquoy, 2001; Schriver, 1992).

It is not clear, however, the extent to which *RAtoo* played a role in students' increased awareness of peers' perspectives and identifying their own text-based errors. It is possible that forcing students to manually correct both error types played some role in developing their ability to more effectively reflect and problem solve issues with their own writing. Rather than allowing students to simply accept a suggested change with a click of a button, they were required to enter the text and decide what should be changed and how. However, the data only marginally support the ways in which this feature of *RAtoo* may have led to improved revision task schema; it is more likely that the peer review process in and of itself led to students' increased awareness of how others might perceive their writing. While the current results clearly indicate that the visual separation of surface and text-based feedback influenced the types of changes students made during revision, future research might more closely examine the other design features in *RAtoo* to better isolate their effects on students writing and development of revision task schema.

Implications

One implication of this study is that repeated use of *RAtoo* can positively impact the writing achievement of middle school students. Although less than half (7) of the students improved their rubric scores from the first to the second essay, almost all (16) students increased their rubric scores from first to the third essay. Combined with a decrease in occurrences from

first to third essay, this suggests that middle school students can use the features of *RAtoo* to help them improve their writing quality.

The results also suggest that using *RAtoo* may help students become more aware of the common surface errors they make, which can support the development of schema for those errors and assist students in focusing their revision process to also include making text-based changes. The occurrences of students in the Consistent Shifters pattern decreased with each essay, and these students described developing strategies after using *RAtoo* to improve surface errors before and after review. Students in this pattern also described shifting their attention to also make text-based changes after the first essay. Observations of Student R confirm the transition described by the other students in his pattern. By the third essay, Student R began spending more time on making text-based revisions, started using a more sophisticated text processing and reflection processes while externalizing text, and became more aware of his own writing by producing changes that were not in response to any feedback. The repeated experience with the tool and additional experience with language supported students as they improved text-based errors, which can help support the development of schema for those errors (Hayes, 1996; Rijlaarsdam et al., 2004).

Limitations

The most notable limitation of this study was the use of a convenient sample with a small number of subjects. Even though repeated-measures designs use the same subjects across multiple treatments and therefore require fewer subjects (Minke, 1997), the size of the sample makes it impossible to generalize the results beyond the scope of this school context. However, the contextual nature of this study is in-line with the design-based research approach that was used. The purpose of the study was to investigate the effects of repeated use of *RAtoo* on writing

achievement and schema development for middle school students at this school. Assessing sphericity, controlling for Type 1 error, and addressing inter-rater reliability improved the validity of the quantitative results (Field, 2013). Providing rich descriptions and triangulating the data established quality and credibility of the qualitative results (Lincoln & Guba, 1986; Patton, 2015). Using a comparative side-by-side analysis triangulated the quantitative and qualitative data to improve the credibility and trustworthiness further (Creswell, 2015; Patton, 2015). The methods taken to establish validity and reliability also improve the study's ability to inform the literature on peer review and revision.

A second limitation in this study was the teacher's role. While the teacher provided more thorough instruction on peer review and how he wanted students to use *RAtoo* for the first essay, the instruction before the second essay consisted of passing out the peer review checklist and reminding students of two procedures when peer review was complete. This lack of attention to the criteria that he stressed for the first essay corresponded with lower Essay 2 rubric scores for most students. Most notably, the difference in means for the Evidence & Elaboration criterion was statistically significant from first to second essay; many students failed to either use specific evidence or cite specific evidence. Because of these scores, the teacher increased the time he spent instructing students about peer review before their review and revision of the third essay. This suggests that the amount of instruction on peer review strategies may have impacted student performance in both peer review and revision.

A third limitation of this study was that it focuses on receiving feedback; however, all students in the class also used *RAtoo* to provide feedback to a peer. The process of providing feedback made some students more aware of their own writing habits, which sometimes resulted in additional revisions that were not in response to any feedback. Providing feedback may have

also had other effects on student writing and revision practices; however, the impact of providing feedback was not studied.

Methodological limitations. One methodological limitation relates to the sampling of cases. While all the cases were drawn from the same group of students, the collective case only used observations and stimulated recall interviews from a sample of cases chosen. Insight drawn from that sample may not be representative of the entire group. However, the sample used in this study portrayed the characteristics present when the use of *RAtoo* impacts student writing achievement, task schema, and internalization. Additionally, it allowed for more in-depth insight into the patterns that emerged from the quantitative data.

The second methodological limitation relates to the method of stimulated recall interviews. Rose (1984) noted three criticisms of stimulated recall interviews that can affect results: (1) they introduce the unnatural element of video recording the writing process, (2) are not a concurrent articulation of the process that is occurring, and (3) can lack accuracy in accounting the process that occurred. While stimulated recall interviews may lack accuracy and therefore miss aspects of a cognitive process, the stimulated recall interviews did not interrupt participants' revision process, allowed participants to elaborate on the process, and allowed the researcher to probe for additional elaboration (Rose, 1984; Smagorinsky & Coppock, 1994). This insight about their uninterrupted revision process after each round of revising their writing helped provide understanding for how repeated use of *RAtoo* helped students internalize the revision process and develop a revision task schema.

Ethical Considerations

There were no reasonably foreseeable psychological, social, legal, economic, or physical risks and/or discomforts from the research procedures. The data from the entire class were

collected anonymously with parental opt-out instead of informed consent and were given to the research team with direct identifiers removed and replaced with codes. This type of research has occurred at this school in the past; the principal permits anonymous research with parental opt-out instead of informed consent. The principal informed the parents and/or guardians of the process and how to opt-out.

Students identified as participants for the recorded observations and stimulated recall interviews completed an assent form and a parent/guardian completed a consent form before students were allowed to participate in the study. The researcher informed the participants that she was the designer of *RAtoo* during recruitment; this information was also publically available through the add-on description in Google. The assent and consent forms included contact information for The University of Georgia's Institutional Review Board. Both the assent and consent forms indicated that the decision to participate or not to participate in the study would not affect student grades. Additionally, the assent and consent forms explained that if students or parents chose to withdraw from the study, the data collected from or about the student up to the point of his or her withdrawal would be kept as part of the study and may continue to be analyzed unless students or parents made a written request to remove, return, or destroy the information.

All direct identifiers from the data were removed and replaced with codes. The key to the codes were only kept long enough to create a complete record of data for each student. Transcripts for the stimulated recall interviews were created using Express Scribe transcription software. Written reflections, writing assignments, field notes, memos, and stimulated recall interview transcripts were loaded into ATLAS.ti on a password-protected computer for analysis.

Additionally, toolbar frequencies and rubric scores were organized in an Excel file on a password-protected computer and later loaded into SPSS Statistics for analyzation purposes.

Researcher Subjectivities and Assumptions

My interest in researching the teaching of writing, specifically revision, stems from my previous experiences as a middle school and high school English teacher. As I narrowed in on revision instruction, I recognized that there are some assumptions I have about secondary students and revision. In my experience, students do not revise unless they are required to do so. Additionally, students often focus their attention on matters of mechanics when they are forced to revise; they do not actually re-envision their writing. While this was the case pre-social media and the satisfaction of instantaneous publication, the problem seems to have grown with the affordances of these technologies that allow people to share and even encourages abbreviated text and thought. Encouraging students to re-envision their writing has become a goal of mine and was the reason I designed *Revision Assistant* and *Revision Assistant, too*. By distinguishing surface changes from text-based changes, I hoped that students learn the difference between the two and the importance of each. I also hoped that students would internalize both of these processes in ways that make them more proficient writers.

The design of the study, as well as the tool, has clearly been influenced by my experiences as an English teacher. I designed *RAtoo* and am the person researching and evaluating the impact of its use on student revision practices. My pragmatic beliefs helped me balance my subjectivity with objectivity during data collection, analysis, and triangulation so I did not influence the process with my own ideas (Shannon-Baker, 2015). During the data analysis, I was careful to not look for instances that supported my beliefs about and intentions for the tool. I needed to provide an accurate portrayal of what the data said, even if that meant that

the tool did not support schema development or internalization. While my beliefs and involvement could be seen as disadvantages, I believe I have fairly portrayed the data I collected and used my passion for the topic and involvement in the tool's design as advantages in this study.

Conclusions

Revision of student work has been studied in a variety of ways since the 1980s. Regarding technology, some have compared the effects of the medium (i.e., with technology vs. paper-based) on student revision (Grejda & Hannafin, 1992; Nobles & Paganucci, 2015; Owston et al., 1992; Suwantarathip & Wichadee, 2014). Others have studied student perceptions of using technology for peer review (Zheng et al., 2015) as well as the types of feedback students provide when using technology for peer review (Ruegg, 2015; Zheng et al., 2015). Many of these studies have found that students tend to focus their revision on making surface changes. The results of this study confirm that students focus on making surface changes; however, they also suggest that using *RAtoo* can support the development of revision task schema and the internalization of the common surface errors students make so that their revision process also has room to include making test-based changes. Additionally, using *RAtoo* can positively impact student writing achievement. Instead of studying the medium or types of feedback, scholars should study how designed interventions, like *RAtoo*, can help support student engagement in the fundamental or cognitive processes of revision as well as the development of a revision task schema. This could help provide a better understanding of the development of a revision task schema and provide insight into the types of embodiments that are effective in cognitive tools for revision.

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APPENDICES

Appendix 4.A

Reprint Permission for A Model of Revision (Hayes, 1996)



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Appendix 4.B

Written Reflection Prompts

Timing	Reflection Prompt
Before revision of Paper 1	<ol style="list-style-type: none"> 1. What does your typical revision process look like? 2. What kind of changes do you make, what do you do first, what is the most important to you, and how do you know when you're done?
After revision of Paper 1	<ol style="list-style-type: none"> 1. How did you use <i>Revision Assistant, too</i> to help you revise your paper? 2. What kind of changes did you make, what did you do first, what was the most important to you, and how did you know when you were done? 3. How do you think using <i>Revision Assistant, too</i> impacted the quality of your writing? 4. Summarize the 3 biggest changes you made and how you think using <i>Revision Assistant, too</i> helped you.
Before revision of Paper 2	<ol style="list-style-type: none"> 1. As you were writing your paper, did you do anything differently in preparation for the revision phase? Explain why or why not.
After revision of Paper 2	<ol style="list-style-type: none"> 1. How did you use <i>Revision Assistant, too</i> to help you revise your paper? 2. What kind of changes did you make, what did you do first, what was the most important to you, and how did you know when you were done? 3. Did you make any changes in how you used <i>Revision Assistant, too</i> for this paper? 4. How do you think using <i>Revision Assistant, too</i> impacted the quality of your writing? 5. Summarize the 3 biggest changes you made and how you think using <i>Revision Assistant, too</i> helped you.
Before revision of Paper 3	<ol style="list-style-type: none"> 1. As you were writing your paper, did you do anything differently in preparation for the revision phase? Explain why or why not.
After revision of Paper 3	<ol style="list-style-type: none"> 1. How did you use <i>Revision Assistant, too</i> to help you revise your paper? 2. What kind of changes did you make, what did you do first, what was the most important to you, and how did you know when you were done? 3. Did you make any changes in how you used <i>Revision Assistant, too</i> for this paper? 4. How do you think using <i>Revision Assistant, too</i> impacted the quality of your writing? 5. Summarize the 3 biggest changes you made and how you think using <i>Revision Assistant, too</i> helped you.

Appendix 4.C

Peer Review Checklist

Overall Task	Complete (Yes/No)	Specific Task-related Item
Reading		Read all the way through your partner's essay before making any suggestions for improvement. After reading through once, begin your official review.
Providing Comments		Purpose & Organization: The writing is organized; it uses proper format. If something is missing, make sure to note that for your partner.
		Purpose & Organization: The essay is clear, uses transitions, and there's a logical progression. If the writing is not clear, ask clarifying questions for your partner.
		Purpose & Organization: There is an effective introduction paragraph, thesis statement, conclusion, and concluding sentence. If something could be more effective, provide suggestions for your partner.
		Evidence & Elaboration: The evidence used effectively supports the thesis statement. If you think there is better evidence that your partner could use, make sure to suggest it.
		Evidence & Elaboration: References used are relevant and specific. Do your partner's references support their reasons? If not, make sure to let them know.
		Evidence & Elaboration: Word choice and vocabulary is appropriate for the audience, and the writer uses the correct words. If your partner could use more sophisticated words, make sure to let them know.
Using the "Revision Assistant, too" toolbar		Conventions, Citations: Check to make sure all citations use proper punctuation. If they don't, provide suggestions for correction.
		Conventions, Works Cited: Check your partner's works cited page to see that it is properly formatted and all citations are properly punctuated. If there are errors, make suggestions for corrections.

		Conventions: Make sure your partner uses proper spelling throughout their response. Make suggestions for corrections.
		Conventions: Make sure your partner's sentences are fluid and do not sound awkward and that they use proper grammar and sentence formation. Make suggestions for corrections.
		Conventions: Make sure your partner uses proper punctuation (period, comma, semicolon, etc.) in all sentences. Provide suggestions for corrections.
		Conventions: Make sure your partner uses proper capitalization (proper nouns, beginning of sentence, I, etc.). Provide suggestions for corrections.

Appendix 4.D

4-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11)

4-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11)

Score	4	3	2	1	NS
Purpose/Organization	<p>The response has a clear and effective organizational structure, creating a sense of unity and completeness. The response is fully sustained, and consistently and purposefully focused:</p> <ul style="list-style-type: none"> controlling or main idea of a topic is clearly communicated, and the focus is strongly maintained for the purpose, audience, and task consistent use of a variety of transitional strategies to clarify the relationships between and among ideas effective introduction and conclusion logical progression of ideas from beginning to end; strong connections between and among ideas with some syntactic variety 	<p>The response has an evident organizational structure and a sense of completeness, though there may be minor flaws and some ideas may be loosely connected. The response is adequately sustained and generally focused:</p> <ul style="list-style-type: none"> controlling or main idea of a topic is clear, and the focus is mostly maintained for the purpose, audience, and task adequate use of transitional strategies with some variety to clarify the relationships between and among ideas adequate introduction and conclusion adequate progression of ideas from beginning to end; adequate connections between and among ideas 	<p>The response has an inconsistent organizational structure, and flaws are evident. The response is somewhat sustained and may have a minor drift in focus:</p> <ul style="list-style-type: none"> controlling or main idea of a topic may be somewhat unclear, or the focus may be insufficiently sustained for the purpose, audience, and task inconsistent use of transitional strategies and/or little variety introduction or conclusion, if present, may be weak uneven progression of ideas from beginning to end; and/or formulaic; inconsistent or unclear connections between and among ideas 	<p>The response has little or no discernible organizational structure. The response may be related to the topic but may provide little or no focus:</p> <ul style="list-style-type: none"> controlling or main idea may be confusing or ambiguous; response may be too brief or the focus may drift from the purpose, audience, or task few or no transitional strategies are evident introduction and/or conclusion may be missing frequent extraneous ideas may be evident; ideas may be randomly ordered or have an unclear progression 	<ul style="list-style-type: none"> Unintelligible In a language other than English Off-topic Copied text Off-purpose
Evidence & Elaboration	<p>The response provides thorough and convincing support/evidence for the controlling idea and supporting idea(s) that includes the effective use of sources, facts, and details. The response clearly and effectively elaborates ideas, using precise language:</p> <ul style="list-style-type: none"> comprehensive evidence from sources is integrated; references are relevant and specific effective use of a variety of elaborative techniques* vocabulary is clearly appropriate for the audience and purpose effective, appropriate style enhances content 	<p>The response provides adequate support/evidence for the controlling idea and supporting idea(s) that includes the use of sources, facts, and details. The response adequately elaborates ideas, employing a mix of precise and more general language:</p> <ul style="list-style-type: none"> adequate evidence from sources is integrated; some references may be general adequate use of some elaborative techniques vocabulary is generally appropriate for the audience and purpose generally appropriate style is evident 	<p>The response provides uneven, cursory support/evidence for the controlling idea and supporting idea(s) that includes uneven or limited use of sources, facts, and details. The response elaborates ideas unevenly, using simplistic language:</p> <ul style="list-style-type: none"> some evidence from sources may be weakly integrated, imprecise, or repetitive; references may be vague weak or uneven use of elaborative techniques; development may consist primarily of source summary vocabulary use is uneven or somewhat ineffective for the audience and purpose inconsistent or weak attempt to create appropriate style 	<p>The response provides minimal support/evidence for the controlling idea and supporting idea(s) that includes little or no use of sources, facts, and details. The response is vague, lacks clarity, or is confusing:</p> <ul style="list-style-type: none"> evidence from the source material is minimal or irrelevant; references may be absent or incorrectly used minimal, if any, use of elaborative techniques vocabulary is limited or ineffective for the audience and purpose little or no evidence of appropriate style 	<ul style="list-style-type: none"> Unintelligible In a language other than English Off-topic Copied text Off-purpose

*Elaborative techniques may include the use of personal experiences that support the controlling idea.

2-Point Informative-Explanatory Performance Task Writing Rubric (Grades 6-11)

Score	2	1	0	NS
Conventions	<p>The response demonstrates an adequate command of conventions:</p> <ul style="list-style-type: none"> adequate use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling 	<p>The response demonstrates a partial command of conventions:</p> <ul style="list-style-type: none"> limited use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling 	<p>The response demonstrates little or no command of conventions:</p> <ul style="list-style-type: none"> infrequent use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling 	<ul style="list-style-type: none"> Unintelligible In a language other than English Off-topic Copied text <p>(Off-purpose responses will still receive a score in Conventions.)</p>

Holistic Scoring:

- Variety:** A range of errors includes formation, punctuation, capitalization, grammar usage, and spelling
- Severity:** Basic errors are more heavily weighted than higher-level errors.
- Density:** The proportion of errors to the amount of writing done well. This includes the ratio of errors to the length of the piece.

Appendix 4.E

Observation Checklist

Checklist Item	Frequency
The student begins making changes after opening their document.	
The student reads through some of their feedback after opening their document and before making changes.	
The student reads through all of their feedback after opening their document and before making changes.	
The student accepts surface feedback by changing their writing to reflect the suggestion.	Apostrophe: _____ Capitalize: _____ Colon: _____ Comma: _____ Exclamation Point: _____ Hyphen: _____ Lowercase: _____ Paragraph: _____ Period: _____ Question Mark: _____ Quotation: _____ Semicolon: _____ Spelling: _____ Spell Out: _____ Accuracy: _____ Agreement: _____ Insert: _____ Omit: _____ Space: _____ Transpose: _____ Verb Tense: _____ Word Choice: _____ Comma Splice: _____ Complex: _____ Compound: _____ Compound-Complex: _____ Fragment: _____ Run-on: _____ Simple: _____ Vary Sentences: _____

<p>The student rejects surface feedback by restoring the writing to its original form.</p>	<p>Apostrophe: _____ Capitalize: _____ Colon: _____ Comma: _____ Exclamation Point: _____ Hyphen: _____ Lowercase: _____ Paragraph: _____ Period: _____ Question Mark: _____ Quotation: _____ Semicolon: _____ Spelling: _____ Spell Out: _____ Accuracy: _____ Agreement: _____ Insert: _____ Omit: _____ Space: _____ Transpose: _____ Verb Tense: _____ Word Choice: _____ Comma Splice: _____ Complex: _____ Compound: _____ Compound-Complex: _____ Fragment: _____ Run-on: _____ Simple: _____ Vary Sentences: _____</p>
<p>Surface feedback becomes irrelevant because of other revisions made.</p>	<p>Apostrophe: _____ Capitalize: _____ Colon: _____ Comma: _____ Exclamation Point: _____ Hyphen: _____ Lowercase: _____ Paragraph: _____ Period: _____ Question Mark: _____ Quotation: _____ Semicolon: _____ Spelling: _____ Spell Out: _____ Accuracy: _____</p>

	Agreement: _____ Insert: _____ Omit: _____ Space: _____ Transpose: _____ Verb Tense: _____ Word Choice: _____ Comma Splice: _____ Complex: _____ Compound: _____ Compound-Complex: _____ Fragment: _____ Run-on: _____ Simple: _____ Vary Sentences: _____
The student makes text-based revisions in direct response to a comment.	
When making a text-based revision in direct response to a comment, the student solves the problem using the first solution they externalized on the document.	
When making a text-based revision in direct response to a comment, the student solves the problem after externalizing several solutions and deciding on one (e.g., starts typing a solution and deletes, types a new one, and uses the new solution).	
The student does not make text-based revisions suggested by a comment.	
The student makes revisions to their writing that are not in direct response to any feedback (surface or text-based).	Surface: _____ Text-based: _____
The student navigates away from the writing assignment to access resources (e.g., thesaurus, dictionary) that will assist them in the revision of their writing.	
The student navigates away from the writing assignment to access resources unrelated to the writing assignment.	
The student responds to their peer’s comment with a request for clarification or additional feedback.	

Appendix 4.F

Stimulated Recall Interview Questions and Script

Introduction Script: As you know, I am conducting research on your use of *Revision Assistant, too*. The purpose of these interviews is to understand your revision process without interrupting you as you were actively revising. My role during our interviews is not to judge or give you feedback on your writing; it is to learn more about how and why you made the changes you made during revision.

As you watch your recording, explain to me what you are doing and why. If you need more time to explain something, you can stop the recording we are watching. I may interject with questions as we view the recording.

1. As we watch the video recording of your revision process, please try to explain in as much detail as you can what you were thinking while you were revising. You may ask me to stop the video recording as needed.
2. Can you explain what you are doing and why you are doing it?
3. What were you thinking at this point?
4. Why did you decide to make the change that you did?
5. Why did you decide to take the advice of your peer?
6. Why did you decide to not take the advice of your peer?
7. You said that you _____, can you elaborate on that?
8. I noticed that you focused on _____ first; what made you decide to do that?
9. I noticed that you _____; what were you thinking when you did that?
10. Did the toolbar have any impact on why you decided to do _____?
11. Did your exported comments make you consider _____?

CHAPTER 5

CONCLUSION

The purpose of this dissertation research was to develop and study the effects of a technological innovation that addresses the lack of writing proficiency evidenced by American twelfth graders (National Center for Education Statistics, 2012). The innovation, initially called *Revision Assistant*, was developed as a cognitive tool that supports the development of revision task schema at the secondary level. The data collected in the three articles that compose the body of this dissertation – Chapters 2, 3, and 4 – represent a sustained research effort to develop and refine *Revision Assistant* over multiple iterations in the local context of an International Baccalaureate Middle Years Programme in the Pacific Northwest. Chapter 2 focuses largely on examining how middle school students used Google Docs to engage in peer review. The results of that study led to the development of the five design principles described in Chapter 3. Chapter 3 also describes how these five principles were embodied in *Revision Assistant* and tested with teachers and students from the same context as the previous study. *Revision Assistant* was improved based on the results detailed in Chapter 3 and re-released as *Revision Assistant, too*. Chapter 4 then looks more deeply at the ways in which *Revision Assistant, too* supports the development of middle school students' revision task schema through peer review.

The trajectory of problem-identification to design and development of an intervention to implementation of the intervention serves as a model for other designers using a design-based research (DBR) approach as well as those who are developing tools to support cognitive processes and schema development. This chapter provides a reflection on using a DBR approach,

summarizes the five design principles associated with *Revision Assistant, too*, looks across all three articles to identify the one principle that is at the heart of the intervention, and provides implications and recommendations for practice and future research.

Design-Based Research and a Multiple Article Dissertation

To use a DBR approach as a doctoral student is not an easy task; however, that does not mean it should detour interested students. After reviewing the literature of scholars using a DBR approach, Reinking and Bradley (2008) identified seven defining characteristics of DBR; DBR studies are (1) focused on interventions in real-world contexts, (2) guided by theory (grandiose and humble), (3) oriented by the goal of improving learning, (4) adaptive and iterative, (5) transformative and have the potential to transform learning environments, (6) methodologically flexible, and (7) pragmatic. Conducting research that embodies these characteristics requires a doctoral student to solidify the direction of their research early on in their doctoral studies – likely by the end of the second year – because DBR is iterative in nature and therefore is not a one-and-done research study. Likewise, writing a multiple article dissertation is also not an easy task nor is it one that can come to fruition quickly; it requires planning and a clear connection between each of the articles that comprise the body of the dissertation. That said, I cannot fathom how one could use a traditional style dissertation to clearly and thoroughly portray research that uses a DBR approach.

As a first semester doctoral student, I was lucky to begin my doctoral studies by analyzing data for a research study I helped design that was important to me and what I thought I wanted to research. The first article of my dissertation (Chapter 2) was written from the data I collected in this study, which I conducted after being accepted to The University of Georgia but prior to beginning my first semester. The analysis of the data from this study led me to develop a

“humble and local” (Reinking & Bradley, 2008, p. 18) theory that grounded the design of a peer review intervention: by making surface feedback visual (like proofreading marks), surface and text-based feedback in an online setting will be separated from each other, which will help students engage in both editing and revision during the revision phase. The goal in designing the intervention was to improve revision instruction and practice in secondary school settings by transforming the peer review process. Throughout the course of my first semester, I continued analyzing my data while simultaneously designing, developing, and conducting user experience research with my paper-based intervention. I finished the first version of Chapter 2 at the end of my first year. Since then, it has been submitted to several journals and has improved each time.

Design, development, and testing of my intervention continued into the beginning of my second year, which is when a working version of *Revision Assistant* was released on Google. Creating a free application that could be used in Google Docs was an important, driving force behind the intervention; I wanted the tool to be readily and easily available for teachers and students so the potential to transform learning environments could actually be realized – funding would not be a limiting factor. User experience research on *Revision Assistant* with secondary teachers and students occurred during the second semester of my second year; the purpose of this research was to identify strengths, weaknesses, and shortcomings of the tool. My pragmatic nature coupled with my inclination for design thinking allowed me to value the design failures and shortcomings identified during this research. After analyzing the user experience data, I developed a list of design improvements that I submitted to the programmers at the beginning of my third year because I was determined to adapt and improve the tool as much as possible prior to researching its learning effects.

Because I was relying on others to make programming changes that actualized the solutions for design failures and improvements suggested by secondary teachers and students, the next iteration of *Revision Assistant* stalled. While waiting to hear back from the programmers, I polished Chapter 2, connected *Revision Assistant* to a grandiose, guiding theory and concept (schema theory and revision task schema), wrote the beginnings of the design case (Chapter 3), wrote my dissertation study proposal, and gained IRB approval for the research conducted in Chapter 4. A lack of response from the programmers then led me to figuring out how to manipulate the original *Revision Assistant* code to implement as many suggestions as my limited skills would allow, which turned out to be 91% of the actual changes and additions reflected in *Revision Assistant, too*. After doing this work, the company helped me complete the additional feasible changes and publish *Revision Assistant, too* – just in time for the start of my dissertation study.

Collectively, the three articles in my dissertation tell the story of the DBR approach I used; singularly, each article portrays a single iteration (Chapter 2 and Chapter 4) or aspect (Chapter 3) of the story and would likely not qualify as DBR without reference to the other two articles. Chapter 2 identified a problem I found when conducting peer review with middle school students who used Google Docs comments. Chapter 3 allowed me to develop a design case about the intervention that details each phase of the design and user experience research. Finally, Chapter 4 allowed me to thoroughly detail the mixed methods research I conducted on the learning effects of the redesigned tool with middle school students. In this way, using a DBR approach in conjunction with a multiple article style dissertation provided me the opportunity to portray a sustained and iterative research effort and tell the story of that effort collectively within a larger work. However, not all DBR studies look the same, so doctoral studies should note that

this dissertation project only serves as a single example of what could be done when employing and portraying a DBR approach for a dissertation.

Summary of Design Principles

The first design principle developed for this dissertation project was to visually distinguish surface and text-based feedback. To do this, *Revision Assistant, too* indicates surface errors in-line using parentheses and color to set them apart from existing text. This allowed the comments that are normally part of a Google Doc to be used more exclusively for text-based feedback. The second principle was to include an image of each error type on the toolbar buttons; in addition, each button had a hover-over feature that triggered a pop-up window. Each pop-up window contained a description and usage examples of the associated error type so users could more easily make appropriate revisions while using *Revision Assistant, too*. The third principle was to require users to manually accept or reject surface feedback rather than incorporate an ‘accept all’ feature. This was intended to trigger reflection on both surface and text-based feedback. The fourth principle was to include functionality that allowed users to export all comments into a separate table for future use and analysis. The final principle was the inclusion of an occurrence tracker and exported table of occurrences that counted all occurrences of surface marks inserted onto the document with the toolbar and exported that number into a table at the end of the document.

The Heart of the Intervention

The first design principle – that is, visual cues that distinguish surface suggestions from text-based suggestions – lies at the heart of both *Revision Assistant* and *Revision Assistant, too*. Of the five design principles, visually distinguishing surface and text-based feedback both established the idea for the intervention and grounded its design. This section tracks the

progression of the design principle throughout the chapters in this dissertation and describes how it supported the development of revision task schema in middle school students.

Chapter 2: Triggering an Idea

During the data analysis of the first article (Chapter 2), it became evidently clear that using Google Docs comments to conduct peer and teacher review was problematic. The majority of the comments that students received were focused on surface errors – over half of the students received 20 or more comments dealing with surface errors (e.g., “Add a comma” or “Capitalize”). Because students received so many surface-level comments, the more substantive feedback about text-based errors was often overlooked or unintentionally ignored. The identification of this problem triggered a memory of my own schooling, where I received proofreader’s marks on my work and also used the marks to conduct paper-based peer review in middle and high school. The proofreader’s marks provided visual cues for different types of feedback – surface-level feedback in particular was placed in-text, leaving room in the margins for deeper levels of text-based feedback. This memory ultimately led to the initial design idea for *Revision Assistant*, which was to design a peer review tool that could visually indicate surface errors by using proofreader’s marks within a Google Doc.

Chapter 3: Designing and Developing

The growing design of the tool, described in Chapter 3, led to meetings with programmers about development. Early meetings unveiled a logistical flaw of inserting proofreader’s marks on a document; there would not be enough space on a single-spaced document to insert the marks, and there was not a way to control the line-spacing of a document with the tool. This initial hurdle led to several design solutions that would still embody a visual cue to identify a surface error.

After spending several months prototyping and improving the design, the tool was developed by professional programmers. In our initial discussion with these programmers, we presented the original idea of inserting the proofreader's marks on the page. This was not possible due to the limitations of Google application programming interfaces (APIs); however, the programmers designed a solution – one that we had not previously conceived – that still embodied a visual cue for a surface error. In the new design solution, a surface suggestion was visually distinguished through both a change in color (e.g., red) and by encircling surface suggestions with parentheses. With some refining of the colors used and organization of the buttons, this solution became a key feature of the tool.

After the tool was published under the name *Revision Assistant*, it was tested with 11 secondary teachers and 56 students (grades 6-9) in the same context as the Chapter 2 research study. Overall, both audiences were pleased with the functionality of the tool and its ability to visually distinguish surface and text-based feedback; however, each audience recommended one change that would improve the visual cues. The teachers suggested reorganizing the toolbar buttons into three categories that aligned with how they talked about surface errors (Mechanics, Usage, Sentence Formation) and that each category of buttons be a different color. The students suggested that we change the color green that was originally used to indicate the presence of a Structure error because it was too bright. Both of these suggestions were implemented in the next iteration of the tool, which was published under the name *Revision Assistant, too*.

Chapter 4: Supporting Revision Task Schema

The study conducted for Chapter 4 investigated if and how repeated use of *Revision Assistant, too* affected student writing achievement and supported the development of revision task schema. The visual cues that distinguished surface feedback from text-based feedback were

associated with some promising results and findings. First, the participants indicated that the visual separation of surface suggestions activated editing schema during text processing. Many students described intentionally looking for the visual cues after receiving their paper for revision, and four of the five observation and stimulated recall students engaged in critical reading until they encountered a surface suggestion that they then accepted.

The results of Chapter 4 also indicated that activating text processing helped support text production. By the third essay, three of the five students who were observed and interviewed described how they became more critical of the surface feedback they received. They also engaged in several rounds of text processing and reflection before ultimately deciding to reject a surface suggestion provided by their peer. These changes were reflected in their writing achievement, which consistently improved over time. These results suggest that the visual cues of *Revision Assistant, too* can help students engage in the cognitive processes of revision by activating their editing schema during text processing and, as a result, lead them to reflection and text production that helps improve their writing. By engaging in these cognitive processes of revision, students are developing their schema for the errors they encounter, which can encourage internalization of those errors.

An important result of the visual cues is that they encouraged students to acknowledge the difference between surface and text-based feedback. The students in Chapter 4 did not stop making surface changes and improvements; they continued to focus on correcting these errors in each essay. These students did, however, start developing strategies for managing revision so they could address the more complex text-based errors. To manage their revision process, some students described how they looked for the visual cues and produced surface changes first – before doing anything else – because they were quicker/easier to address and would give them

more time to address the feedback they received in comments. The visual cues helped students understand the difference between the feedback types while also developing a strategy to attend to the error types that they already have a schema for.

One of the most important results that stems from the visual cues is that it supported the development of schema. Not only did the occurrences of almost all students decrease from the first to the third essay, but also the visual cues of the tool encouraged students to develop strategies to help them internalize the common errors they make. The combination of the visual cues on their essay and the occurrence tracker tallies forced the students in the study to reflect on their own writing habits and take notice of the common errors they make while writing. Because of this, these students intentionally focused on not making these errors during writing and also reviewed their own writing to look for these errors prior to peer review.

Implications for Practice

Faigley and Witte (1981) distinguished two types of errors identified during revision: surface and text-based. The articles presented in this dissertation identified the need to help students who were still developing revision skills distinguish these two types of errors in a web-based format. After an iterative process of design and development, a cognitive tool was developed to help students distinguish these types of errors as well as engage in the cognitive processes of revision. The results of this dissertation project have implications for both the instructional practice of revision and the design practice of scholars who are designing and developing interventions to support student learning.

Instructional Practice

The results of studying the learning effects of *Revision Assistant, too* in Chapter 4 have some important outcomes for the instructional use of the tool. First, without much instruction,

repeated use of the tool can help students acknowledge the two types of feedback. Student acknowledgement of the different types of feedback support instruction on the qualities of each type of feedback as well as categories or purposes associated with each. For instance, the three toolbar button categories – Mechanics, Usage, and Sentence Formation – each have a color associated with them. The visually distinguished types of feedback can help teachers frame instruction around the purposes of those categories and how they differ from one another.

Another implication for instructional practice is that repeated use of the tool can help students recognize the common surface errors they make in their own writing. To support students who are still working to master the surface skills they struggle with, teachers can use the tool to support engagement with the cognitive processes of revision by designing instruction that requires students to use *Revision Assistant, too* to produce visually distinguished text that improves the surface-level quality of the text. This practice could directly transfer in students' ability to improve the surface suggestions they provide during peer review, which could leave more instructional time to focus on the text-based aspects of peer review.

Using strategy instruction that is coupled with *Revision Assistant, too*, teachers can develop a revision pedagogy within the larger context of their writing pedagogy. First, the teacher can use the visually distinguished feedback to prompt a discussion about the difference between editing and revision as well as the two types of feedback: surface and text-based. After ensuring that students understand the types of feedback and their purposes, the teacher can model the strategies he or she wants students to engage with the tool for peer review and revision. The strategy should provide subgoals for peer review and revision of writing that the teacher will model with a think aloud. For instance, a teacher may use a checklist that includes one or both types of errors and think aloud while providing feedback to a sample text with the toolbar and

comments. After modelling how to provide feedback to writing using the tool, the teacher will provide students the opportunity to collaboratively and individually work through how to provide feedback using the same strategy on a different sample text. The teacher will monitor students and facilitate as necessary. Once students have demonstrated understanding and ability to provide feedback using the strategy and *Revision Assistant, too*, the teacher will allow students to conduct peer review.

After helping equip his or her students with strategies for providing feedback, the teacher must teach students strategies for receiving feedback. Using the same process of instruction, modelling, collaborative and individualized work with sample texts, and implementation of the strategy on their own writing, teachers can provide strategies for the ways in which students can reflect on surface and text-based feedback to produce text that improves the quality of their writing. At any time, the teacher may decide to return to direct instruction, modelling, or student practice with individuals or the whole group if he or she determines there is a need. Because of this, students might be at different stages within the revision process. Additionally, a teacher initially may decide to use one strategy to focus student review or revision (i.e., organization) and then repeat the process after students complete a round of revision using those strategies – the next time using different strategies to focus student review and revision. In this way, the revision process is flexible and can be individualized and adapted for different groups of students to improve their revision practices overall.

Teachers and students that do not have access to computers and reliable Internet can use this pedagogy of revision because the strategies used can be employed in a paper-based format; however, there are several features of the tool that provide strategies that encourage students to engage in the cognitive processes that may not be fully realized using a paper-based format. For

instance, the aggregated occurrences and comments encourage students to engage in text processing, reflection, and text production. Additionally, *Revision Assistant, too*'s feature to manually accept or reject surface feedback encourages students to engage in reflection before text production, which could be lost as students in a paper-based format rewrite or even type their writing. Finally, the toolbar of buttons cues students to the types of errors they might look for, and this feature is scaffolded with hover over definitions and usage examples that help students engage in problem solving and decision making when providing and receiving feedback.

Design Practice

If designers were to take away one design principle from *Revision Assistant* and *Revision Assistant, too*, it should be that visually distinguishing between surface and text-based feedback can support the process of revision. The visual markers embodied by the toolbar buttons not only activate editing schema during text processing but also guide users to engage with the two other cognitive processes directed by the revision task schema – reflection and text production. Prior research on schema theory in the field of Learning, Design, and Technology used external cognitive strategies with visual representations to help students learn new information and enhance the impact of a text (DiVesta & Rieber, 1987; Gagné, 1985; West, Farmer, & Wolff, 1991), and Fleming (1987) discussed matching a task with an external cognitive strategy. *Revision Assistant* and *Revision Assistant, too* do just this; they match the task of revision to a cognitive tool that uses visual representations to help students learn new information about revision and their own writing.

Additionally, the results of this dissertation project have implications for designers using a DBR approach. The first article (Chapter 2) identified and examined a problem with peer

review in a web-based format, which is an important quality of focusing a design (Anderson & Shattuck, 2012). While the design and development of *Revision Assistant* and *Revision Assistant, too* had the goal of improving instruction, was iterative, and was based on collaboration with practitioners in real-world settings, the design of the interventions was not initially guided by a grandiose theory (Anderson & Shattuck, 2012; Reinking & Bradley, 2008; Wang & Hannafin, 2005). Faigley and Witte's (1981) distinction between surface and text-based errors supported the humble theory of distinguishing the types of errors after the initial design was conceptualized, but Hayes's (1996) model of revision did not theoretically ground the tool until after the development of *Revision Assistant* and the research that identified the improvements realized in *Revision Assistant, too*. Thus, the DBR approach used in this dissertation project supports the few others (e.g., Bollen, van der Meij, Leemkuil, & McKenney, 2015) that have successfully worked through design and construction several times prior to using literature and/or theory to ground an intervention.

Recommendations for Future Research

The first design principle, which consists of the visually distinguished features embodied by *Revision Assistant, too*, has implications for future research on both instructional and design practice. In the context of instructional practice, future research should focus on the ways in which teachers use the visual features of *Revision Assistant, too* to support instruction. Additionally, research should focus on the effects of that instruction on student revision, peer review from the perspective of the 'receiver,' and peer review from the perspective of the 'giver.' Future design research should focus on how visually distinguishing an aspect of a web-based design can engage users in cognitive processes and encourage schema development in other contexts and disciplines.

Although the purpose of this chapter was to identify and discuss the one aspect of the intervention that connected all three articles in this dissertation, it should be noted that there are design principles of the tool that provide implications for both instructional and design practice and future research that this conclusion does not address. As noted in Chapter 4, the four other design principles also encouraged students to engage in the cognitive processes directed by the revision task schema. However, visually distinguishing surface and text-based feedback was the most prominent feature across studies – it was the root of the problem noted in Chapter 2, the feature that received most attention during usability testing in Chapter 3, and the feature most clearly connected to positive student outcomes in Chapter 4. Future research might focus on the ways other design principles and features affect student attitudes and achievement during writing activity and how they might be improved to support revision task schema development. For instance, future research could focus on the ways in which students use the hover over definitions and usage examples to assist their problem-solving and decision-making processes as well as the ways in which using those features transfers into future writing. Additionally, research could focus on how writing explanations in the comments table about text-based feedback decisions and/or changes affects students' understanding of and schema development for text-based errors and affects students' identities as writers. Finally, future research might focus on the instructional ways *Revision Assistant, too* is being used that move beyond using it as a tool for peer review.

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