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Charting the routes to revision: An interplay of writing goals, peer comments, and self-reflections from peer reviews

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Abstract Building upon self-regulated learning theories, we examined the nature of student writing goals and the relationship of these writing goals to revision alone and in combination with two other important sources of students' self-regulated revision—peer comments on their writing, and reflections for their own writing obtained from reviewing others' writing. Data were obtained from a large introductory undergraduate class in the context of two 1000-word writing assignments involving online peer review and a required revision. We began with an investigation of students' free response learning goals and a follow-up quantitative survey about the nature and structure of these writing goals. We found that: (a) students tended to create high-level substantive goals more often, (b) students change their writing goals across papers even for a very similar assignment, and (c) their writing goals divide into three dimensions: general writing goals, genre writing goals, and assignment goals. We then closely coded and analyzed the relative levels of association of revision changes with writing goals, peer comments, reflections from peer review, and combinations of these sources. Findings suggest that high-level revisions are commonly associated with writing goals, are especially likely to occur for combinations of the three sources, and peer comments alone appeared to make the largest contributions to revision.

Keywords Goal setting · Self-regulated learning · Reflection · Peer review · Revision

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Introduction

Writing and revision to writing are likely an indispensable part of learning in any discipline. While student revision benefits from teacher feedback, teacher resources are often limited for the time-consuming and labor-intensive process of feedback on writing (Graham and Perin 2007; National Commission on Writing in American Schools and Colleges 2003; Persky et al. 2003). To compensate, more attention to self-regulation and regulation by peers is often recommended in learning theories as well as in writing pedagogical practice (Zimmerman 1994; Zimmerman and Kitsantas 1999; Page-Voth and Graham 2000; Sawyer et al. 1992; Villamil and De Guerrero 1998; Cho and Schunn 2007).

Prior research has examined many relevant aspects on this broad theme, including the benefits of typical approaches for teaching self-regulation strategies like goal setting (Page-Voth and Graham 2000; Zimmerman and Kitsantas 1999) and peer comments (Villamil and De Guerrero 1998). However, these two approaches for teaching self-regulation are usually dealt with independently from each other. There is no holistic account of how writing and rewriting as a process of both goal setting and peer interaction are developed, even though the two likely interact developmentally. For example, when engaging in peer review, there are opportunities to learn both from the received comments and from the provided comments, and each of these may be shaped by the learning goals held by the student as receiver or provider of comments.

Various models of Self-Regulated Learning commonly have at least these three elements (with various names): monitoring/feedback, goal setting, and actions (Graham and Harris 1994; Pintrich 2000; Zimmerman 2002). Self-regulation in writing also draws efforts from three sources: personal (observing and adapting thoughts), environmental (monitoring effects of conditions), and behavioral (observing and adapting behaviors; Zimmerman and Risemberg 1997; Zimmerman 2013). Three important components out of each of the three sources fall into the scope of the current study: goal-setting as a personal self-regulation, (providing and receiving) peer comments as an environmental self-regulation, and writing performance and revision as a behavioral self-regulation. The current work begins to integrate goal setting and peer interaction aspects in analyses of writing and revision processes. In this work, we present two studies within the context of a class using: (1) an online peer review system, which collects peer comments and revisions; (2) a new electronic tool that captures insights by the reviewer during the review process; and (3) a writing assignment that explicitly asked students to note their writing goals. Study 1 examines the nature and structure of writing goals in the examined context, as these are relatively unstudied in writing-in-the-discipline classes. Study 2 then systematically examines writing goals, peer review activities, and revision behavior to delve into the possible interactive relationships among the various sources for self-regulation.

Goal setting and writing performance

Goal setting is a central aspect of Self-Regulated Learning in general, and within writing in particular (Flower and Hayes 1981). Writers are assumed to create goals by generating both high-level goals and supporting goals, and goal setting can account for some important differences between good and poor writers. For example, struggling writers often have trouble revising because they lack goals (Scardamillia and Bereiter 1986).

Goal setting as an instructional strategy in writing has been experimentally studied in a wide range of K-12 learners including under-achieving children with learning disabilities (Graham et al. 1995), normal achieving students (Bogolin et al. 2003; Zimmerman and Kitsantas 1999; Silver 2013), and high-achieving students (Edwins 1995), as well as college students (Matsuhashi and Gordon 1985). Results of these studies not only find positive effects of explicit and specific goal setting on the students' revision and writing achievements, but also shed light on how to set goals and what to set as goals. Matsuhashi and Gordon (1985) found that, when cued to add writing goals, beginning college writers produce more substantial revisions.

The nature of the writing goal also matters for writing and revision. Goals elaborated with more component goals improved persuasive writing for both students with learning disabilities and normally achieving peers (Ferreti et al. 2000; Silver 2013). Setting goals aligned with paper rubrics such as focus, support, and organization in writing, improved writing performance in fifth grade students (Bogolin et al. 2003). Further, giving the students a specific goal of adding information increases meaning-changing revisions and text quality relative to a more general goal of improving text quality (Graham et al. 1995). Finally, having a process goal of learning also improves writing (Schunk and Swartz 1993).

Although the importance of writing goals is now clear, many open questions remain. First, the previously studied learning goals were usually directions given by instructors, on the assumption that students' lack of specific learning goals is the problem to be addressed (e.g., Graham et al. 1995; Silver 2013; Ferreti et al. 2000; Schunk and Swartz 1993). Little is known about writing goals in college students whose writing capacity and self-regulated learning are likely more developed and influenced by writing experiences in prior coursework. From a self-regulated learning theory perspective, students should focus on areas of relative weakness, which in college students involves global issues of meaning, rather than more surface issues. In addition, college students are given more complex writing assignments, and the details of the writing assignment may strongly influence student goals.

Second, the effects of goal setting on writing performance have typically been measured using holistic writing grades, writing rubrics, or word counts (e.g., Hull 1981; Bogolin et al. 2003; Silver 2013). Little is known about what kinds of revisions are triggered by various forms of writing goals, especially for low-level surface revisions (e.g., spelling and grammar) versus more high-level revisions.

Third, learning goals interventions typically apply to the production of a single paper (e.g., Graham et al. 1995; Ferreti et al. 2000). Little is known about the stability of goals across papers, even when the form of the paper is held constant. From a self-regulation perspective, writers should be changing goals in response to (self, teacher, or peer) feedback on earlier performances (Zimmerman and Kitsantas 2002). Therefore, we conducted an investigation of the nature of college students' self-generated writing goals, the stability of these goals across papers, and the influence of these goals on revision.

Revision through receiving and providing peer comments filtered by writing goals

While from a self-regulation perspective, explicit goal setting helps student writers monitor their own writing performance, revising is critical to bring writing into alignment with the writer's goals (Sommers 1980). Revision can be writing changes both at surface and

meaning level, both global and local. Only global meaning revisions are likely to substantially improve overall document quality, although of course revisions can be of poor quality and thus even global revisions may not improve a document. Without teacher or peer support, student revision tends to be viewed as editing minor errors and little meaning-related revision is done in students' writing (Faigley and Witte 1981; Scardamillia and Bereiter 1986; Sommers 1980; National Assessment of Educational Progress and Educational Testing Service 1986). Further, more competent writers tend to do more revising at meaning level than less competent writers (Faigley and Witte 1981; Sommers 1980; Stallard 1974).

One approach to improve the depth of revision involves peer review. Revising based on feedback has long been seen as critical to improve writing skills (Fitzgerald 1987; Hayes et al. 1987; Sommers 1980). Peer response comments have been found to lead to meaningful revisions, especially if peers are trained (Berg 1999; Paulus 1999; Villamil and De Guerrero 1998). Revisions are made in terms of both local errors (i.e., grammatical) and global errors (i.e., text development, organization, and style) in their own and peers' texts (Yang and Meng 2013). Peer review can also take different forms, like face-to-face peer dialogue, online peer discussion, anonymous peer review, as evidenced in a large body of literature (e.g., Berg 1999; Tseng and Tsai 2007).

Though students worry about the fairness and accuracy of peer review (Cheng and Warren 1997; Liu and Carless 2006; Smith et al. 2002), the benefits of various forms of scaffolded peer review have been experimentally validated in a number of studies (Falchikov and Goldfinch 2000; Topping and Fisher 2003; Cho and Schunn 2007; Tseng and Tsai 2007; Panadero et al. 2013). For example, peer review, when guided by clear rubrics, has been found to provide valid ratings and feedback as effective as teacher review (Topping 2005; Gielen et al. 2010) and sometimes even more effective feedback (Cho and MacArthur 2011; Cho and Schunn 2007; Hartberg et al. 2008).

As noted in theories of self-regulated learning, feedback is filtered through the learner's goals (Zimmerman 2002). Therefore, we would expect the benefits of engaging in peer review to be influenced by the students' writing goals (e.g., whether they have goals of improving meaning or only spelling and grammar). These filtering effects of goals could apply to both what students learn from the received feedback from peers as well as what they learn from giving feedback to peers, since both aspects of peer review offer learning opportunities (Lundstrom and Baker 2009; Crinon 2012; Wooley et al. 2008; Sadler and Good 2006). Indeed, a student's writing goals could shape what issues they notice during providing feedback or what issues in the received feedback they remember during revision.

Students engaged in the peer response process can take an active role in their learning: they can "reconceptualize their ideas in light of their peers' reactions" (Mendonça and Johnson 1994, p. 746); they could also incorporate their reflections on others' writing into their own writing. While there is a broad consensus that reflection is a crucial factor for the improvement of students' self-regulated learning, in educational practice most students do not reflect spontaneously on their learning processes (Van Velzen 2002).

To overcome this lack of immediate reflections after peer review, additional educational measures that stimulate students to reflect on their learning processes can be considered. Prompting has been identified as a promising method to evoke these reflective activities (Butler 1998; Van den Boom et al. 2004). Therefore, in the current study, a special prompt interface was applied to stimulate students to reflect on their learning from peer review.

More generally, we know little about how the three main sources discussed here interact to produce self-regulation: students' writing goals, issues observed in others' writing, and comments received from peers. In a typical classroom using peer review, all three sources

are present, and so the point is pragmatically important. Overall, pairwise overlap between the sources may be more powerful predictors of revision behavior than issues occurring in only one source (e.g., problems only arising in received peer comments). However, it may be that overlap occurs too rarely to account for much revision. Figure 1 illustrates the three factors that are hypothesized contribute to writing and rewriting.

The current study

The current study is an observational study of goals, peer reviewing, and revision to help build new self-regulated learning theories about the role of goal setting together with peer review. After first unpacking the nature of college students' self-generated writing goals in Study 1, we carefully examine in Study 2 the relationship of student writing goals (alone and together with peer comments received and insights gathered from providing comments to peers) to revision behaviors. In particular, we address the following research questions:

- (1) What are common student writing goals (personal regulation)?
 - a. Are writing goals stable over time across assignments?
 - b. Do student writing goals focus on areas of weakness or areas of strength?
 - c. Do writing goals occur in coherent clusters (e.g., various forms of low-level issues vs. various forms of high-level issues, or general writing vs. assignment specific-writing goals)?
- (2) Do writing goals correspond with revision behaviors?
 - a. Do writing goals (personal regulation) work together with provided or received peer feedback (environmental regulation) to lead to revisions (behavioral regulation)?
 - b. Does the overlap of revision behaviors with writing goals vary by type of revision (high vs. low level)?

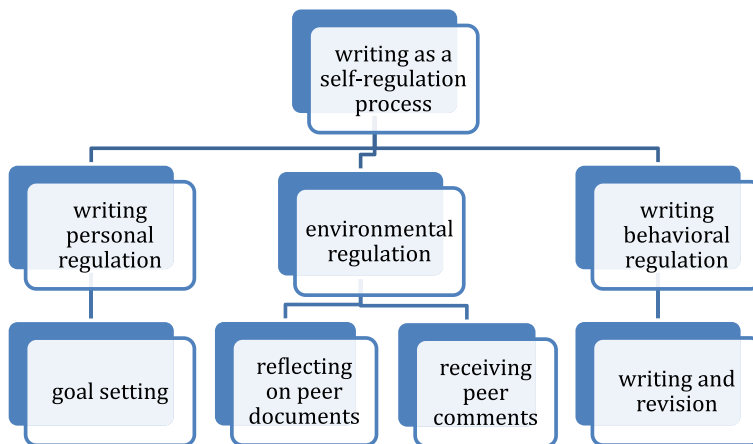


Fig. 1 Theoretical framework for self-regulation of writing and revision processes through goal setting, reflection on the work of others, and receiving peer comments

From the perspective of writing and rewriting as a process of dynamic interaction between three sources of self-regulation, we posit that learning goals, as a way of personal self-regulation, lead and monitor writing process and have a positive effect on writing performance. Peer comments, as a way of environmental regulation, exert positive effects on revision too. Self-reflection after peer review is another environmental regulation behavior mediated by peer review. As a larger self-regulation process, we posit further that writing issues that appear repeatedly across learning goals, peer comments, and self-reflection will be especially likely to produce revision.

Study 1

Methods

Participants

The participants were undergraduate students from a variety of majors enrolled in an introductory Cognitive Psychology course at a large public university in the Northeastern United States. 163 students were enrolled in the course with the following demographics: 68% female; 72% Caucasian, 13% African American, and 8% Asian; 65% of fathers and 62% of mothers having a college degree. Students varied in abilities with slightly above average mean on the college entrance examination SAT scores ($max = 800$, national means of approximately 500): SAT math $mean = 606$, $SD = 69$; SAT verbal $mean = 611$, $SD = 80$; SAT writing $mean = 596$, $SD = 75$. Only 135 of the 163 students in the class agreed to include their writing tasks in the research, submitted papers, and did peer reviewing.

Materials

SWoRD SWoRD (Scaffolded Writing and Revision in the Discipline) is a Web-based client–server application that allows students to submit documents online; each document is then distributed to three to six students (number is set by the instructor) who review and evaluate their peers' work (Cho and Schunn 2007; Schunn 2016). Review activities are not the focus of Study 1, but the peer review context and its evaluation dimensions are an important context of the writing assignment, and thus the system is described here.

Within SWoRD, students as reviewers are asked to evaluate the document by giving ratings and comments using a set of evaluation dimensions specified by the instructor. The system automatically assigns students writing grades based on the mean ratings across reviews (weighted by a reviewer accuracy score). Students as authors receive and rate each reviewer's comments for helpfulness, which provides an incentive to reviewers to take the reviewing task seriously. After receiving their reviews, students rewrite their papers and turn in a final draft, which is reviewed and evaluated again by a random set of peers, not based on a previous set.

Writing assignment The students in this class used *SWoRD* to submit first and second drafts of two papers, as well as to review and comment upon four of their peers' papers at each step. The writing prompt for each paper asked students to write a short newspaper style article of approximately 1000 words to explain the main findings of a research topic and its implication for practical application. Both papers have the same general task

requirement, but with different research topics (corresponding to topics from the first vs. second half of the course).

The peer review evaluation dimensions were selected to match the goals of the assignment: the interestingness of the research presentation and application, the clarity and accuracy, the image support, the logic and the language-related issues (see Appendix 1 for complete reviewing rubrics). In the interestingness dimension, for example, the direction stated: "Comment on whether the application or issue is likely to be interesting to many readers, and whether the author presented the research in a compelling way. Be specific about where problems occurred and suggest ways to improve." One to three comments could be provided. Students were also directed to rate the application interestingness and the research presentation interestingness. The directions stated: "to what extent is the application interesting to all readers?" Students made the rating from a pulldown menu with seven levels:

- 7 Excellent—Around 100% readers would find the application interesting.
- 6 between good and excellent.
- 5 Good—around 90% readers would find the application interesting.
- 4 Between good and ok.
- 3 Ok—only people who often think about the topic think the application interesting.
- 2 Between ok and poor.
- 1 Poor. Very few people would find the application interesting.

The instructor used the peer assessments on these dimensions to calculate students' grades on the document (40% of the assignment grade), and additional grade for peer review accuracy (20%), peer review helpfulness (20%), and task completion (10%). Each writing assignment produced 20% of students' course grade.

Measures

Several measures are used to examine the contents and characteristics of students' writing goals, including free response writing goals, paper ratings, and writing goal surveys.

Free response writing goals At the end of each submitted paper, students were asked to describe their writing goals. Because we wished to learn about typically occurring student goals during writing, no examples or detailed guidance on the writing goals was provided. Further, there was no word limit for the length of the writing goals, with students' written goals ranging from as brief as one sentence to as long as a three-paragraph miniature essay.

For this study, the contents of the learning goals were categorized in accordance with the writing prompt and review guidelines, the instructional goals for the assignment, rather than in more superficial terms, such as whether goals are worded as positive or negative, whether goals are general or specific, or whether goals are process-based or product-based. The categories of writing goals of the first paper were developed by means of iterative comparison to refine the coding across several subsample sets. In an inductive manner, categories were created that captured the core of students' intentions. The tentatively-coded categories are used to analyze the remaining goal samples, with refinement to the coding until the resulting scheme produced a working definition for each category and several illustrative goal examples.

These initial writing goal definitions and examples were provided to a second coder as a reference for a first round of inter-rater reliability trial. The coding scheme was then revised taking into account writing goals from the second paper, which then included new

Table 1 Coding scheme for writing goals categorization, with coding reliability Kappas in parentheses

Category	Description	Examples
Interestingness ($\kappa = 0.76$)	To convey ideas in an interesting, entertaining, amusing way	I had strong difficulty with two things: creating clear writing of the big ideas and making the article entertaining. I hope I improved on these two things
Clarity and support ($\kappa = 0.86$)	To convey clear focus, concise ideas, informatively, with easy-to-understand sentences, adequate information, thorough information, using personal/real life/relatable examples	I notice I write way too much and can't keep things short and sweet My writing goal this time was to focus on the big/main idea(s) and not get wrapped up in the small/minor details, dragging on the paper with extra, unimportant details
Flow ($\kappa = 0.88$)	To show good reasoning, strong connection, good flow, good transitions	My writing goals this time are to write an equally informative and interesting paper and to draw strong connections between my topic and my examples
Word choice ($\kappa = 0.63$)	Wording, usually sentence-boundary for clarity or conciseness	I think I'm too wordy usually, so I'd like to be more concise
Grammar and mechanics ($\kappa = 0.79$)	To use Standard Written English with good mechanics	Moreover, I have to improve my grammar in order to make the sentence sound appropriate
Introduction ($\kappa = 1.0$)	Specific mention of introduction	My writing goal this time: to create an introduction that grabs the readers' attention
Conclusion ($\kappa = 1.0$)	Specific mention of conclusion	A better conclusion
Image ($\kappa = 1.0$)	Illustrative pictures, tables and graphs	Imagery is well depicted when it is used
Length ($\kappa = 0.49$)	Word limit/word count	That being said, the biggest challenge I faced was the word count limit

categories. This revised writing goals coding scheme is presented in Table 1. This coding scheme was assessed for inter-rater reliability on 40 papers, producing acceptable Kappas all above 0.6 on all but one category, and strong Kappas near or above 0.8 for all but one other category (see Table 1). All goal categories are mutually exclusive to each other.

Paper ratings Because of our research question about the relationship of specific writing goals to writing ability, it was necessary to obtain a document score. Writing scores for each paper were generated from the mean peer ratings, which prior research has established as producing reliable and valid scores (e.g., Cho et al. 2006). Each paper was rated by at least four peers on ten 7-point rating rubrics (see Appendix 1 for details). There are ten general rating dimensions and each dimension accounts for 10% of the overall writing score. Means across peer ratings for a given paper were generated for each dimension and for the document as a whole across dimensions and peer ratings.

Writing goal survey To cross validate the open-coding of writing goals, a 23-question survey was created based on early rounds of coding of the writing goals and ambiguities that emerged (See Appendix 2). The survey asked for students' level of agreement on a 4-point Likert scale (1 = YES! 2 = yes, 3 = no, 4 = NO!) with statements about specific writing goals that began with the shared prompt, "As I wrote my paper, I tried to...".

Table 2 Clusters of survey items measuring each of the emergent goal constructs (and number of survey items per cluster)

Construct	Survey statements for each construct
Interestingness (3)	To convey novel (counter-intuitive/not commonly told) information
Clarity (5)	To convey clear focus (specific/personal/real life/examples), with easy-to-understand language or illustrative pictures, tables and graphs
Logic (3)	To show good reasoning, strong connection, good flow, transition
Accuracy (2)	To be entirely consistent with the research literature, to have thorough inclusion of relevant literature
Wording (3)	To use fewer words in expressing one idea, to cut irrelevant ideas to use words in a precise, natural way.
Word count (2)	To cut to 1000 words even if omitting important information
Newspaper style (3)	To write in a news style at paper, sentence and word levels
Grammar (2)	To use correct sentences with good spelling and mechanics

Table 2 lists the different survey questions that were included for each of the constructs that emerged from the initial open coding of writing goals.

Beyond measuring students' agreement with writing goals, the survey also contained one question asking students to specify their most important goal.

Procedure

As part of the instructions for the paper assignment, given both in class and on the assignment sheet, students were instructed to provide a learning goal at the end of their papers. Additional instructions described the procedures of submitting the paper online, peer rating, peer commenting, and back-evaluations in the SWoRD environment. Students also watched a video explaining best practices in peer review (available at <http://www.peerfeedback.net>). Documents and peer ratings were downloaded from SWoRD in anonymous form for use in the research study.

The first paper was submitted in late October and reviewed one week later, which may influence the second papers' writing goals. The second paper was submitted in mid-November. The paper deadlines did not overlap. One week was allotted for each step of each assignment (e.g., 1 week to complete reviews).

Besides reviewing work, the time between the two papers involved lectures on the concepts of cognitive psychology and a midterm exam focused on these concepts. The midterm was all multiple choice focused on the lecture/book concepts. Neither lecture nor exams focused on writing and thus would not very likely impact writing goals.

The writing goal survey was administered in paper format in class shortly after the second paper was submitted (i.e., before peer comments were received on the second paper).

Results and discussion

What are common self-generated writing goals?

Figure 2 presents the distribution of free response writing goals in each of the papers; the percentages sum to more than 100% because many students endorsed multiple learning

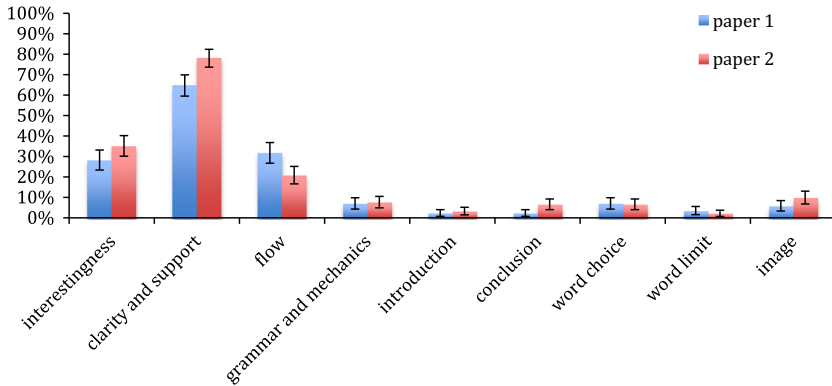


Fig. 2 Percentage of students including each of the learning goals (with SE bars) in their free response statement at the end of each of the two papers

goals. Students relatively rarely focused on low-level writing issues. Across both papers, we see that students had a diverse range of high-level writing goals, but also that three goals were particularly common in similar amounts across the papers: clarity and support, interestingness, and flow. The other six goals were each rare, but collectively 34 authors endorsed at least one of these six goals. Although the relative frequency of categories will likely change across contexts, these general categories are likely to serve as a useful foundation for measuring writing goals found in other writing-in-the-discipline assignments.

Also, there is a clear sign of overlap between students' self-generated goals and the instructor's writing prompt and specified task review rubric. The review rubric asks students to review the paper based on interestingness, clarity and accuracy of the research explanation and image, logic and writing quality. Likewise, the free response writing goals commonly target interestingness, clarity and support, and flow.

Are writing goals stable over time across assignments?

Although the relative frequency of goals is stable across papers, a correlation analysis reveals that there are only moderate correlations in goals held by particular students across the two papers (see Table 3; separate Chi square tests were conducted for each writing goal). The goals held most consistently (although not with high frequency at either time point) were Conclusion, Introduction, and Word Limit goals. Interestingness and Grammar and mechanics showed more modest but still statistically significant consistency across papers. Clarity and support, Flow (two very common goals), and Word choice and Image (two rare goals) show no significant stability across papers. Thus, students commonly changed their writing goals for the second paper, possibly based on received or provided feedback in the first paper.

Are learning goals based in relative strengths or weaknesses?

Was writing performance associated with learning goals? Students might focus on their weakest areas, or they might show higher performance as the result of focusing on certain writing aspects, or these two elements might cancel each other out. We examined the

Table 3 Phi coefficients for the association of presence of learning goals across papers

	Interestingness	Clarity and support	Flow	Grammar and mechanics	Introduction	Conclusion	Word choice	Word limit	Image
Phi coefficient	0.28*	0.16	0.16	0.28*	0.39*	0.62**	-0.07	0.39*	-0.08

* $p < 0.05$, ** $p < 0.01$

relative writing performance (using the mean ratings from the peers) on each of the rubric dimensions, and then examined whether students have systematically higher or lower scores on each dimension as a function of having a writing goal focused on that dimension. For example, we examined whether students who had the Interestingness goal had more Interesting Research Explanations or Interesting Research Applications (two rating rubrics from the peer reviews; see Appendix 1) than students who did not have this goal. There were no statistically significant relationships between having the goal and doing well on that aspect of writing (t test ps all >0.1).

Do learning goals cluster in meaningful ways?

118 students completed the writing goals survey, which is a return rate of 72%. Among all 23 goals on the survey, the seven most commonly endorsed collectively occupied 79% of goals listed as most important. They are respectively: specific examples (19 students), personal or real life examples (17 students), strong connections (14 students), novel information (13 students), thorough information (11 students), single focus of ideas (10 students), and easy to understand language (9 students). These common goals are all high-level writing issues and overlap conceptually (although also provide more specifics) with the top four coding constructs of the open response coding, namely: clarity, accuracy, flow, and interestingness.

Exploratory Factor Analyses with both orthogonal (Varimax) and oblique (Promax) rotations were conducted on the survey data to see what clusters of statements might organize students' learning goals at a higher level. Both methods produced nearly identical three-factor solutions, and therefore we report only the orthogonal rotation details. The three factors had strong eigenvalues (6.4, 2.1, and 1.6) and semantically meaningful grouping. Additional factors accounted for 5% or less of the variance. Four items were dropped because they did not load on any factor, and were rarely endorsed.

The three factors are shown in Table 4. No item significantly double-loaded across factors. The first cluster, which we named general writing skills, involved skills that broadly apply to most writing tasks. The second cluster, which we named news style focus, emphasized aspects of writing specific to the genre used in the assignment, writing newspaper articles. By contrast, the third cluster, named task-specific focus, involved the aspects of writing that were quite specific to the particular writing assignment and the dimensions to which students were held accountable in that writing assignment. That is, the second factor applied to any kind of newspaper writing, whereas the third factor involved issues that would not be applied to all newspaper writing.

Interestingly, the general writing goals rarely received any negative ratings (i.e., "NO!" or "no" Likert ratings), suggesting these were at least somewhat applicable to most students. The genre factor was the second most common factor among students. That the task-specific factor received the lowest mean endorsement from students is likely a good pedagogical outcome, as students should be mastering more general aspects of writing rather than obsessing about unique assignment features. That students endorsed many goals on the survey does not mean they actively maintained all of these goals while writing; from a working memory perspective, that seems very unlikely. It does suggest, however, that they would be receptive to improving aspects of their writing beyond just the few most salient goals they held while writing.

Study 2 turns to the next major research question, examining the overlap of writing goals, peer review and insights obtained from peer review activities with revision behavior.

Table 4 Percentage of strong agreement and factor loadings for each of the writing goals on the goals survey (values below 0.3 are suppressed; goals are ordered in descending factor loading)

Writing goals	Percentage Yes!	Factor Loadings		
		General writing	Newspaper style	Task specific
Natural wording	60	0.79		
Strong connections	66	0.73		
Precise wording	48	0.73		
Conventions	76	0.71		
Flow	48	0.64		
Reasoning	51	0.58		
Easy to understand language	70	0.57		
Images, graphs, charts	62	0.55		
Thorough information	59	0.53		
Specific examples	79	0.51		
Single focus of ideas	57	0.49		
Novel information	57	0.45		
Sentence in newspaper style	21		0.76	
Word in newspaper style	27		0.72	
Paper in newspaper style	35		0.67	
1000 word limit	3			0.58
Uncommon to readers	24			0.43
Counter-intuitive	12			0.40
Personal examples	61			0.33

Study 2

Methods

Participants

Study 2 draws on the same students and assignments from Study 1, but focusing on revision behaviors. In this class, students used a tool for documenting insights gathered during reviewing (called the Lessons Learned tool). Students were randomly assigned to use this tool in either assignment 1 or 2 in a cross-over design that provides all students with equivalent support over the semester. Since the use of the tool did not change revision behaviors, we use it as a measure of sources of input to revision and therefore must focus only on the papers where students used the tool. Since not all students actually used the Lessons Learned tool when directed to do so, the resulting dataset consists of 52 students (21 for paper 1 and 31 for paper 2).

Measures

In addition to the open response paper writing goals measure used in Study 1, another three measures are used to investigate Study 2 questions about sources of revisions.

Peer comments and ratings Peer comments serve as an important source of revisions. Each student was to review at least four papers (but could do additional reviews for extra credit), and provided written comments for each paper on five writing dimensions (see Appendix 1). Reviewers were asked to write one to three comments for each dimension. With an average of slightly more than five peer reviews per document, at least 25 comments per document were generated from this peer comment activity. In fact, many reviewers wrote 2 or 3 suggestions in each dimension. Altogether, 1653 comments were produced for these 52 students. Students comments across the four reviews received for each paper were treated as independent comments because they tended to be supplementary (i.e., different reviewers noting different issues) rather than redundant or contradictory. The comments were coded using the same categories applied to learning goals.

Peer ratings (based on the same rubrics described in Study 1) were also collected for each draft to examine whether the documents improved from first to second draft.

Reflections from reviewing Students were asked to use a Lessons Learned tool while reviewing (see Fig. 3). The tool prompted students to draw reflections for their own papers' future revision based on the papers they read, such as what they want to learn or what they want to avoid in their own writing. Students who used the tool typically gave two reflections, although this ranged from one to eight. Compared with the contents of peer review comments, insights written in the Lessons Learned tool were more global and general, usually addressing a specific aspect of a document section or focus of attention and then discussing how it can be done better. Some reflections are about good writing habits in general and others are more specific to the writing genre. These insights were also coded using the same categories applied to writing goals and review comments.

Revision work In order to trace students' revision work systematically, we used Compare Suite (<http://www.comparesuite.com/>) to compare document drafts and label each sentence in terms of three kinds of changes: deleted words, added words, and modified words.

All the highlighted revisions were coded first in terms of the operation or changes that occur: adding/deleting/changing content details beyond versus within a sentence boundary (e.g., clarity and support changes of whole sentences or beyond sentence boundaries vs. simply changing wording choice within a sentence), adding/deleting/changing transitional sentences (e.g., for flow), image clarity changes, image caption changes, image narrative support changes, grammar changes (e.g., plural, tense, punctuation, writing conventions), or citation changes. A random subset of revisions were coded for revision type by a second rater, and inter-rater reliability for these codes was high ($Kappa = 0.90$).

Next, the revisions are investigated in terms of whether they coincided in content with the writing goals, received peer comments, and reflections from the Lessons Learned tool. That is, each change was compared by hand against every source for content overlap. For example, if a student added an example, we looked for insights about adding examples in the Lessons Learned reflections ($Kappa = 0.87$), comments about adding examples in the

Fig. 3 The Lessons Learned interface used to capture insights gathered for the student's own writing from review peer papers

Table 5 Illustrative examples of high and low level revisions and their associated Lessons Learned reflection notes

Ex. #	Changes	Change low/high	Change category	Lessons learned or peer comment content
<i>Lessons learned examples</i>				
1	Add a relatable example	High	Clarity and support	<i>Emulate</i> I learned how to tie my application back to my research. This problem was one I struggled largely with when writing my paper and looking at how others wrote that gave me an idea of how I can reformat the mid-section of my paper
2	Add a transitional sentence	High	Flow	<i>Emulate</i> Make sure all points are tied together through transitions
3	Add an image	High	Image	<i>Emulate</i> My images were simply research-related(results from a research finding), but I thought it was interesting that many people used images to illustrate a point they were making
4	Delete three sentences	High	Clarity and support	<i>Avoid</i> Learn to say more with less words for a more interesting and stylish piece
5	Divide into two sentences	Low	Grammar	<i>Avoid</i> Avoid run on sentences!
<i>Peer comment examples</i>				
1	Add two sentences as examples	High	Clarity and support	I'm not sure if many readers would find this topic very interesting, because it did not seem to contain very many real world examples that people can relate to
2	Add more image explanations	High	Clarity and support	Great images, they are very useful in supporting the narrative. Possible suggestions would be to further explain the graph. I am not quite sure what W.H.L and O.H.L means. Be sure to include this description in the discussion of the paper
3	Title change	High	Other	However, I feel like a more interesting/exciting title could help grab people's attention
4	Wording	Low	Wording	Consider changing "There are four main parts to this theory" to "There are four main Gestalt principles";
5	Tense, spelling	Low	Grammar	Slight minor errors found. A typo written on page three, about half-way down the page, in the sentence with 67% of the test items that were relevant to what they had studies; (should be studied, instead?)

received peer comments ($Kappa = 0.79$), and a writing goal related to examples ($Kappa = 0.94$). Inter-rater agreement for peer comments was in part lower because it was a much larger set of objects to examine for possible overlap. See Table 5 for examples of each type of overlap.

As the research questions are focused on higher level distinctions of revision type, a second round of coding was used to aggregate these more detailed codes into two categories: (1) high-level content goals (usually beyond a sentence) or (2) low-level grammar or wording goals (usually within the sentence boundary). In addition, multiple instances of a revision matching a single revision purpose were counted as one change, instead counting each instance across sentences. For example, when several sentences change due to the same goal (such as the addition of three sentences as an example for further clarification),

they were labeled as one change. Note that revisions were not coded in terms of quality of revision, but rather just in terms of type of revision. Also note that the coding scheme focused on cases of overlap (e.g., how often did a revision overlap with a goal, Lesson Learned comment, or peer comment) rather than cases of non-overlap (e.g., how often did a goal, Lesson Learned comment, or peer comment not lead to any revisions) because the non-overlap involved a more exhaustive search that proved difficult to do reliably, especially for high-level revisions (e.g., were none of the revisions interpretable as making the document more interesting?).

Procedures

For a given paper assignment, data was obtained in the following order: first draft document, which includes the writing goals; Lessons Learned obtained during reviewing of the first draft; peer comments obtained during reviewing of the first draft; and the second draft which produces the revisions data when compared with first drafts. As a reminder, for Lessons Learned, students only had the opportunity to use the tool on one of the two papers. In addition, even when they had the opportunity, some students did not actually use the Lessons Learned tool.

Results and discussion

We begin with basic descriptive statistics regarding revision quality and revision types. A paired t-test ($t(51) = 3.92, p < 0.002, \text{Cohen's } d = 0.54$) of paper ratings from draft 1 to draft 2 also shows paper ratings improve by a mean of 0.21 (out of 7), suggesting that students' revisions did produce some meaningful change, although overall the document changes were more incremental than revolutionary (e.g., less than 20% of the papers saw a mean gain of greater than 0.5 on the 7 point scale).

Across the 52 students, a total of 476 revision changes were found between draft 1 and draft 2. That is, each student made an average of 9 revisions (keeping in mind that some revisions could affect multiple sentences), implying that students were making targeted revisions, rather than entirely rewriting their papers. Among the revision change categories, clarity and support (22%), grammar (28%), and wording (33%) were the most common categories in revision change, while organization (5%), image (7%), interest-*ingness* (< 1%), introduction (<1%), and conclusion (1%) were the least frequent. Citation change (1%) emerged as a new category relative to the other categories based on the writing goals. There were 12 cases that are coded as "other" because they could not be put unambiguously in just one category or did not fit these categories (e.g., a change in paper title). In terms of high versus low level revision, 61% of the changes were low level revisions. Next, we turn to the relative degree of association of these high and low level revisions with writing goals and insights from received and provided peer feedback.

Do writing goals work together with provided or received peer feedback to lead to revisions?

Revisions came from a variety of sources, and we focused on writing goals, received comments, and Lessons Learned from reviewing. Some revisions could not be associated with any of the three coded sources. These revisions could have come from a variety of outside sources (e.g., other classmates, help from the writing center, friends, or family

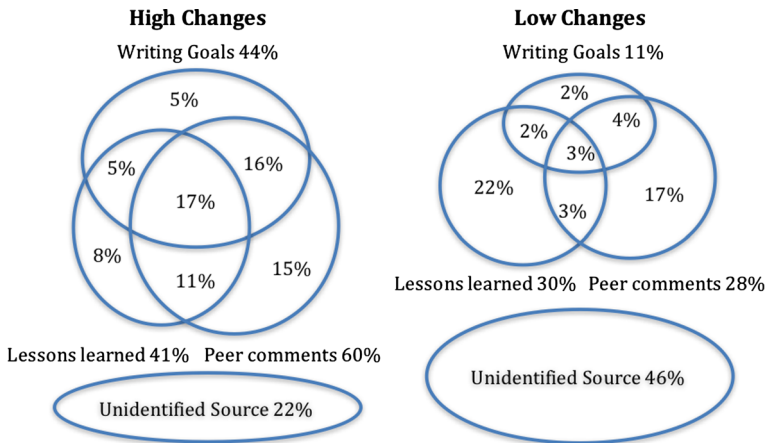


Fig. 4 Relative distribution of likely sources of high and low revisions

members), or as the result of re-reading/editing the document, as suggested by prior work on students' typical revision practices (Dave and Russell 2010).

Peer comments, which focus on the review rubrics, have at least 80% comments on high-level revisions. By contrast, low-level review comments, only occupy 10% of all review segments (the remaining comments were summaries or simple praise). The Lessons Learned for almost all students included a high-level content focus; four students focused on grammar and wording.

Figure 4 presents a Venn diagram of the relative levels of associations of writing goals, peer review, insights from Lessons Learned with high-level and low-level changes. We refer to these associations as a "likely source" because we did not directly observe the editing process and it is possible (although somewhat unlikely) that a specific revision only coincidentally matched with a source. It is in the combination cases that there is the most ambiguity: did a student make the revision because only one of the two sources or actually because two sources suggested the change be made.

To test the robustness of the patterns shown in Fig. 4 using inferential statistics, we calculate the relative frequency of association of revisions with each source combination (i.e., a cell in the Venn) for each participant (e.g., for a given participant, what proportion of their high-level revisions were associated with a writing goal but not with either a received peer comment or a Lessons Learned insight?). We then use a paired t-test to contrast the relative cell sizes by source inside a type of change (e.g., writing goals vs. peer comments for high level changes; see Table 6) or the relative cell sizes for a source across types of change (e.g., writing goals for high vs. low level changes; see Table 7). Note that for the latter within-subjects contrasts, only the 44 participants who made both low and high level changes can be included. Relative magnitude of effects are shown using Cohen's *d*.

Overall, 78% of high revisions and 54% of low revisions were associated with at least one of the three sources. As a source of high changes, a majority of changes (60%) were associated with peer comments (see Table 6), but also with Lessons Learned and writing goals in similarly large pluralities (41 and 44% respectively). The greater association with peer comments was statistically significant in contrast to both Lessons Learned, and writing goals. By contrast, low changes were associated equally often with peer comments and Lessons Learned comments, and each of those more common than the association with writing goals.

Table 6 Relative frequency of sources associated revisions, statistical significance and effect size information for each of the pairwise source contrasts

Revision type	Goal (%)	Lessons learned (%)	Peer comments (%)	G versus LL	G versus PC	LL versus PC
High-level	44	41	60	n.s.	$t = 3.3,$ $p < 0.002$ $d = 0.41$	$t = 3.3,$ $p < 0.002$ $d = 0.59$
Low-level	11	30	28	$t = 2.6,$ $p < 0.012$ $d = 0.64$	$t = 6.0,$ $p < 0.001$ $d = 0.64$	n.s.

Table 7 Relative frequency of high versus low-level revisions associated with each source, statistical significance and effect size information for the high versus low contrast

Source	High-level (%)	Low-level (%)	t	p	Cohen's d
Not identified	22	46	5.4	0.001	0.88
Writing goals	44	11	4.6	0.001	1.24
Lessons Learned	41	30	3.3	0.002	0.27
Peer comments	60	28	3.9	0.001	1.02
All 3 sources	17	3	2.9	0.007	0.79

Another way to examine these numbers is to contrast each source's contribution to high versus low changes. As a within-subjects t-test on the proportion of each author's high and low revisions with no identified source, this difference was statistically significant (see Table 7). The large number of low revisions without an identified source may have come from the student simply re-reading the document. Given the challenges relatively-novice writers have shown in many prior studies, it is also not surprising that relatively few high-level revisions likely stemmed from this more internal source. Peer comments and writing goals were both more likely to be associated with high changes than low changes. The pattern was directionally similar for Lessons Learned, but was much smaller.

Where are changes especially associated with multiple sources?

A salient feature of the Venn diagram for high changes is that a large percentage (49%) of the high changes were associated with two or three sources, and almost one fifth were associated with all three sources. By contrast, only 12% of low changes were associated with two or more sources, and only 3% with all three sources (see Table 7). For each source of high change, a change was more likely to be associated with combinations than solo inputs (e.g., more high changes come from peer plus another source than just peer). But for low changes, more changes came from each single source than the source combinations; except for writing goals, which were rarely a source of low changes. In sum, high changes appear to depend much more upon having multiple sources of input, whereas low changes were more often done just on the basis of one source. However, it is unclear whether this difference is caused by differential need for motivation or implementation support, or whether the difference is caused by differential rates of content overlap across sources.

General discussion

College students in Writing-In-the-Discipline environments may improve their writing skills by acting as: (1) writers who have specific goals; (2) peer reviewers who abstract lessons from that experience; and (3) revisers who productively make use of reviewers' evaluators. Each of these sources has been previously examined in studies of writing behaviors (although to varying degrees), and no prior study has examined how they come together to shape student writing and revision behaviors, even though self-regulated learning theories would suggest that goals should shape the effects of feedback on revision. The current work elaborated the nature of college student's writing goals, and then examined the individual and combined impact of the three sources for revision behaviors in the context of an undergraduate cognitive psychology course. Here we revisit each of the sources and what the current work contributed to our understanding of self-regulated learning during revision.

The nature and role of writing goals

According to seminal model developed by Flower and Hayes (1981), writing is an ongoing goal-directed activity. These goals occur at many different grain-sizes, and ebb-and-flow during writing. Here we focus on the primary writing goals that are most salient to the writer, and thus may be particularly influential in shaping revision behaviors. Different from goal setting interventions in the literature (e.g. Page-Voth and Graham 2000; Zimmerman and Kitsantas 1999), the current study examines student-produced writing goals as the object under scrutiny, instead of taking teacher-directed goal setting as the independent variable. Student-produced goals may be more likely to influence revision than teacher provided goals, given potential errors in communication from teacher to student, and willingness for students to adopt other-provided goals.

What kinds of writing goals did students adopt? Unlike the struggling writer novices documented in the literature (e.g., Scardamillia and Bereiter 1986), these college students had generally substantive and diversified goals in writing. Typically occurring goals include high level writing features like attending to clarity and support, or interestingness and flow; goals like grammar and mechanics were primary goals for very few students. Of course, the learning goal survey shows that an overwhelming majority of students do consider grammar as one of their writing goals. However, these low-level goals were very rarely selected as the most important goals in the survey data.

Another interesting discovery about students' primary writing goals is that they change across papers even though the nature of the paper was almost identical. The distribution of preferences for categories across students remained quite stable, so it is unlikely that students were randomly changing goals. Instead, it is more likely that students were adaptive in their goal changes based on some form of input. Future research is needed to examine what kinds of input are most influential in shaping changing goals (e.g., observation of other student's goals or peer review input).

The common revision categories provide some converging evidence for this higher-level focus in writing goals; students in this study rarely made minor spelling and grammar editorial changes. Among the 476 revision changes, 175 (37%) instances were high-level changes that were beyond the sentence-level and meaning changes. 155 (33%) were instances of wording changes for clarity and accuracy (e.g., "to" into "in order to");

“truly” into “actually”; “about to” into “able to”). Only 134 (28%) instances involved grammar or spelling revisions.

How strongly did these writing goals relate to revision behavior? While it was rare to find high or low-level revisions that only stemmed from writing goals, a quarter of all revisions (and almost half of high-level revisions) were associated with the primary writing goals listed by the students. This dataset cannot speak to the causality of these writing goals. However, that they play a stronger role for high level revisions and that they are commonly associated with revisions when there is another associated source (e.g., 5% Writing Goal only vs. 38% Writing Goal together with Lessons Learned and/or Peer comments) is suggestive that the writing goals create a motivational context for making certain kinds of changes, and that other input is required to cement a change.

The nature and role of reflections from review

A number of studies have suggested that students learn a great deal from providing reviews to others (Lundstrom and Baker 2009; Patchan 2011; Sadler and Good 2006; Wooley et al. 2008). However, little research has examined the details of this learning process, primarily from lack of access to the contents of what students take away from reviewing. In the context of this study, the online peer review system was augmented to require students to document their reflections for their own writing obtained while reading others' papers, providing a unique opportunity to analyze the more direct connection between reflections from reviewing and subsequent revision. The overall content of student reflections might be viewed with some suspicion in that these were required behaviors, and thus perhaps not always fully endorsed by students. However, focusing, as we did, on just those reflections that connected to actual revisions might be more conservatively a good estimate of student learning from reviewing.

Quantitatively speaking, approximately a third of the revision changes co-occur with reflection notes from Lessons Learned, with a slightly greater rate of association with high-level than low-level changes. Interestingly, in the case of high-level changes, the changes were more likely to occur when associated with peer comments alone or with both peer comments and writing goals, but for low-level changes, the most common association was with Lessons Learned alone. Thus, the path from inputs to enactment appears to have important differences for high versus low-level changes.

Once again, however, the causal role of these reflections has not been established in this study. This concern is mitigated, though, by the consistent findings in the literature that providing reviews does improve student's own writing. There is a related concern that might be raised about the addition of the documentation tool: perhaps requiring students to explicitly document their reflections changed the rate at which they followed up on their revisions. Yet analyses reported elsewhere suggests that this is not the case (Baikadi et al. 2015): students using the Lessons Learned tool made no more revisions than students who did not use the tool. Thus, the primary effect of this tool appears to be one of illuminating student cognition.

The nature and role of receiving peer comments

Receiving peer comments have long been part of recommended writing instruction, although more typically in face-to-face forms. Here we examine anonymous online-peer review as a source of feedback for revision, in the context of one of a growing set of tools available to support such reviewing. Perhaps more unique to this system are the incentives

students receive for competent reviewing; thus, the quality of these received comments may be higher than what is found in systems not include some form of incentives or oversight to insure higher quality reviewing.

Compared to writing goals and Lessons Learned from reviewing, peer comments were the largest source of revision behaviors, especially for high level revisions. The peer review rubrics did emphasize high-level writing dimensions. Although we examine the relative frequency of association with changes that occurred within each type, it is still possible that the level of association of low-level revisions with peer comments could have gone up if the rubrics had placed more emphasis on lower level writing. Alternatively, it is possible that peers are not reliable detectors of low-level writing problems. Future research is needed to unpack the cause of this apparent differential benefit for higher level changes, in addition to verifying the causality of these relationships.

Across dimensions and reviewers, each student received an average of over 30 pieces of feedback. As a reminder, in this assignment, the provided comment prompts required peer comments to address a range of specific issues in writing in this assignment: the interestingness of research and its application, the clarity and accuracy of the presented research, the usefulness and accuracy of the included images, the quality of logic connecting research and application, organization, appropriateness of word choice, and the consistent use of Standard Written English (i.e., spelling and grammar). Reflecting the focus of these reviewing dimensions, the vast majority of comments focused on high-level writing issues in the papers: less than 20% of comments focused on minor, local issues like grammar and words.

Previous research of the content of peer reviews has focused on other important questions: whether peers can evaluate writing with reliability and validity comparable to instructors (Cho and Schunn 2007); what features make a peer review especially helpful (Nelson and Schunn 2009; Lundstrom and Baker 2009); or whether students have a positive attitude towards peer review (Katstra et al. 1987; Kaufman and Schunn 2011). Here we attended to a different issue: How did students use these reviews to shape their revisions? It is not necessarily the case that students actually implement revisions to address high level issues, either from lack of motivation or lack of knowledge of how to address the problems. In this context, we found that peer comments were especially associated with high level changes, contrary to conclusion drawn by others (Beason 1993; Cho and MacArthur 2010). These prior studies suggest that students are more likely to enact the lower level suggestions from peers. However, our analyses examine the source of revisions, not the percentage of suggests that were enacted. It is likely that students received many good high-level suggests that they did not follow. Future research is needed to examine how other features of review content interact with writing goals and reflections from reviewing to shape which peer suggestions students choose to enact.

The aggregation effects of three sources of revisions

Previous studies on the three sources of revision investigated here have tended to examine each in isolation from each other, ignoring the fact that writing and rewriting is very much a complex process of self-regulation in many learning contexts. This study explores the cumulative effects of learning goals, reflections from peer review and peer comments on revision through the generation and application of the same coding framework across sources. At a high level, this qualitative coding approach to writing and revision analysis is a common approach in analyzing revision (Fitzgerald 1987), but the current work is the first to apply the shared coding approach across sources to analyze revision processes.

Our results showed that an overwhelming 65% revision changes can be associated with these three sources, and the rate was even higher for high level changes; this high level of association suggests that the most important sources are included here. At the same time, the lack of 100% coverage means that at least one other source is missing, and future studies should develop methods for studying these other sources (e.g., tracking changes that come from re-reading).

Our results also point to the general importance of combinations of sources. 27% of all changes co-occur with at least two sources, and for high-level changes, it is almost half the changes. Further, 17% of high-level changes co-occurred with all three sources at the same time, occupying the largest category of association in the Venn diagram for high-level changes shown in Fig. 4. Thus, these findings clearly reveal that combinations of sources can be quite high and should be investigated in greater depth.

On the one hand, we need to understand what is the rate of overlap among the three sources (here we ignored source content that were not associated with revisions) and why it happens. It is easy to understand why there would be coherence among sources: students may know their own weakness, be attuned to seeing that issue in others' writing (either as errors they also make or models of success), and receive feedback from others about their weakness. On the other hand, we need to understand, from a self-regulated learner perspective, whether combinations of sources are especially useful for directing revision and learning (i.e., to more directly test the causality of a combination effect, for example, by manipulating whether received peer reviews do or do not overlap with reflections).

Implications and conclusion

This work uncovers a new perspective on how a combination of writing regulation sources including goal setting, reflection from peer review, and received peer reviews shapes students' writing and revising. It suggests that a combination of the regulation sources is associated with a majority of high-level revisions. Using this college student data set, this study also addresses three main issues in writing instruction literature. First, writing goals elicitation at the college student level also reveals important facets of student writing. Second, writing and rewriting without teacher feedback can lead to substantial changes with appropriate online technologies' facilitation, at least within college student groups. Third, peer review can be very content-oriented, as long as students are advised to do so with appropriate rubrics.

The present results also have important pedagogical implications for courses with writing as a primary element. Since these regulation sources do contribute to substantial revision, teachers could consider using these strategies in multiple draft writing assignment as important sources of information about students' revision intentions, so as to help teachers provide more effective further guidance.

Several limitations of the current exploratory study need to be addressed in future work. Overall, while the self-regulated learning framework serves as the foundational theory for this research, how students latter become more self-regulated was not measurable within this effort and should be examined more directly in the future. Further, the current general approach should be replicated with other kinds of writing assignments, different kinds of peer review rubrics, and writers at different points along the expertise continuum. In that case, how the different sources affect the quality of the revision in different pedagogical contexts can be examined. Other approaches to eliciting student's writing goals should be explored to maximize efficiency and validity. For example, the self-reported goals in an open-response may capture only the most important goals and the survey approach may

include goals that were rarely in focus during writing or revising. The Lessons Learned tool likely under-reported insights gathered during reviewing, and techniques such as think aloud during reviewing may provide more complete records. Similarly, the use of sources during revision (especially including self-editing) could be observed more directly by observing students during their revision process. Students could be also asked to name other sources of input (e.g., use of the writing center or outside-of-class friends). Finally, the causal effects on revision, and more importantly, on learning need to be investigated.

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Appendix 1: peer review task, involving comment prompts and rating rubrics

Interestingness

Comment on whether the application or issue is likely to be interesting to many readers, and whether the author presented the research in a compelling way. Be specific about where problems occurred and suggest ways to improve.

Interesting research presentation To what extent did the author make the presented research interesting to a general audience?

- 7 Excellent. Everyone would find the research presentation interesting
- 6 Between good and excellent
- 5 Good. Most people would find the research presentation interesting
- 4 Between ok and good.
- 3 Ok. Only people who think about this research would find the research presentation interesting
- 2 Between poor and ok.
- 1 Poor. Almost nobody would find the research presentation interesting

Interestingness of application To which extent is the application interesting to many readers?

- 7 Excellent. Everyone would find this application interesting
- 6 Between good and excellent
- 5 Good. Almost everyone would find this application interesting
- 4 Between ok and good
- 3 Ok. Only people who often think about this application would be interested
- 2 Between poor and ok
- 1 Poor. Very few people would find this application interesting

Good research explanation

To what extent was the research explained clearly and accurately? Be specific about where problems occurred and suggest possible improvements.

Clear research explanations To what extent was the explanation of research clear for a general audience?

- 7 Excellent. Everyone would correctly understand the provided explanation
- 6 Between good and excellent
- 5 Good. Most people would correctly understand the provided explanation
- 4 Between ok and good
- 3 Ok. Some people would be confused by some key part
- 2 Between poor and ok
- 1 Poor. Many people would be confused by some key part

Accurate research explanation To what extent was the explanation of the research consistent with the research literature? Was some research discussed in class or the book that was obviously relevant to the application topic not included?

- 7 Excellent. The presented research was entirely correct and included all relevant aspects.
- 6 Between good and excellent.
- 5 Good. The presented research was entirely accurate but missed some relevant research.
- 4 Between ok and good.
- 3 Ok. Some of the presented research was not quite accurate.
- 2 Between poor and ok.
- 1 Poor. Much of the presented research was not accurate.

Images and graphics

To what extent were the included images (pictures, tables, graphs) useful in supporting the narrative and accurately conveying information to a general audience. If no images were included, what kinds of images would be useful additions? Be specific about problems and suggest possible improvements.

Image narrative support To what extent were the included images (pictures, tables, graphs) useful in supporting the narrative?

- 7 Excellent. The images were very helpful in getting the point across.
- 6 Between good and excellent.
- 5 Good. The images helped somewhat in getting the point across.
- 4 Between ok and good.
- 3 Ok. The images were interesting eye-candy.
- 2 Between poor and ok.
- 1 Poor. No images included or they were just confusing.

Image accuracy To what extent were the included images (pictures, tables, graphs) accurately conveying information to a general audience.

- 7 Excellent. The images would be understood correctly by everyone.
- 6 Between good and excellent.
- 5 Good. Some people might misunderstand the images.
- 4 Between ok and good.
- 3 Ok. The images actively causes some misunderstandings.
- 2 Between poor and ok.

- 1 Poor. No images included or they are seriously inaccurate.

Research application connection

To what extent was the connection between the research findings and the application area logical and complete (no obvious counterarguments)? Be specific about problems and suggestion possible improvements.

Research application logic quality To what extent was the connection between the research findings and the application area logical and complete (no obvious counterarguments)?

- 7 Excellent. The proposed application of the research was logical and not ignoring obvious counterarguments.
- 6 Between good and excellent.
- 5 Good. The proposed application of the research was logical but ignored an obvious counterargument.
- 4 Between ok and good.
- 3 Ok. The proposed application of the research has some logical leaps.
- 2 Between poor and ok.
- 1 Poor. The proposed application did not follow at all from the research.

Writing quality

Comment on any issues related to document organization, appropriateness of work choice for the topic and audience, or violations of Standard Written English.

Organization The order developed and sustained within and across paragraphs using transitions and including an introduction and conclusion.

- 7 Excellent. Sophisticated arrangement of content with transitions that supports following the main narrative.
- 6 Between good and excellent.
- 5 Good. Functional arrangement of content that sustains a logical order with some use of supporting transitions
- 4 Between ok and good.
- 3 Ok. Confusing or inconsistent arrangement of content or poor use transition markers
- 2 Between poor and ok.
- 1 Poor. Little control of arrangement and structure

Word Choice Words convey the intended message in a precise, interesting, and natural way. The words are powerful and engaging.

- 7 Excellent All important content words are chosen precisely and the general tone of these words is engaging and natural to the topic and audience.
- 6 Between good and excellent.
- 5 Good. A few words are imprecise or unnatural in this context
- 4 Between ok and good.
- 3 Ok. Many words are imprecise or unnatural in this context

- 2 Between poor and ok.
- 1 Poor. The prose is boring or very ambiguous because of poor word choice.

Writing Conventions The writer demonstrates a good grasp of Standard Written English conventions (e.g., spelling, punctuation, capitalization, grammar, usage, paragraphing) and uses these conventions effectively to enhance readability.

- 7 Excellent. Demonstrates facility with the conventions of standard written English and has no minor errors.
- 6 Between good and excellent.
- 5 Good. Generally demonstrates control with the conventions of Standard Written English but may have some errors.
- 4 Between ok and good.
- 3 Ok. Contains occasional major errors or frequent minor errors in grammar, usage, or mechanics that sometimes interfere with meaning.
- 2 Between poor and ok.
- 1 Poor. Contains serious errors in grammar, usage, or mechanics that frequently obscure meaning.

Appendix 2: learning goal survey

To what extent was each of the goals important to you for the second paper?

Please circle the rating on the right that most closely approximates your agreement with each statement.

Statements of writing goals

As I wrote my paper, I especially tried to...

1. Convey information that is novel to a general audience.	YES!	Yes	No	NO!
2. Convey information that is counter-intuitive to a general audience.	YES!	Yes	No	NO!
3. Convey information that is not commonly told to a general audience.	YES!	Yes	No	NO!
4. Follow the style of a newspaper article.	YES!	Yes	No	NO!
5. Convey a single overall focus.	YES!	Yes	No	NO!
6. Make ideas understandable to a general audience using specific examples.	YES!	Yes	No	NO!
7. Make ideas understandable to a general audience using personal or real life examples.	YES!	Yes	No	NO!
8. Illustrate information to a general audience with pictures, tables and graphs.	YES!	Yes	No	NO!
9. Convey information in plain, easy to understand language instead of difficult jargons or terms.	YES!	Yes	No	NO!
10. Explain the research in a way that is entirely consistent with the research literature.	YES!	Yes	No	NO!
11. Explain the research thoroughly by including research that is obviously relevant to the application topic.	YES!	Yes	No	NO!
12. Use fewer words in expressing each idea.	YES!	Yes	No	NO!
13. Cut some irrelevant ideas to keep the 1000 word limit.	YES!	Yes	No	NO!
14. Cut down to below 1000 word limit even if I have to remove important content.	YES!	Yes	No	NO!

Statements of writing goals

As I wrote my paper, I especially tried to...

15. Have a good flow between sentences and paragraphs.	YES!	Yes	No	NO!
16. Show good reasoning underlying the main ideas.	YES!	Yes	No	NO!
17. Show a strong connection between the research findings and the application.	YES!	Yes	No	NO!
18. Use words in a precise way.	YES!	Yes	No	NO!
19. Use words in a natural way.	YES!	Yes	No	NO!
20. Use words in a newspaper style.	YES!	Yes	No	NO!
21. Use only grammatically correct sentences.	YES!	Yes	No	NO!
22. Write sentences in a newspaper style.	YES!	Yes	No	NO!
23. Adhere to writing conventions like punctuation, spelling, capitalization etc.	YES!	Yes	No	NO!

Which was the most important goal? Write the statement #: _____

Specify any other goals in your writing not covered above:

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