Teaching students to synthesize research articles: An online interactive tutorial

Nikole D. Patson1, Emily S. Darowski2, and Elizabeth Helder3

1 Ohio State University at Marion

2 Brigham Young University

3 Augustana College

Author contact information

Nikole Patson

Department of Psychology

1465 Mount Vernon Avenue

Marion, OH 43302

Patson.3@osu.edu

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Table of Contents

[Overview 3](#_Toc137727241)

[Background 4](#_Toc137727242)

[*Research on successful writing interventions* 4](#_Toc137727243)

[*Additional instructional challenges* 5](#_Toc137727244)

[Using synthesis in your writing: An online tutorial 6](#_Toc137727245)

[Assessment of the tutorial 8](#_Toc137727246)

[Instructor and student feedback 8](#_Toc137727247)

[Future work 9](#_Toc137727248)

[Sample Lesson Plan (80 minute course) 10](#_Toc137727249)

[References 11](#_Toc137727250)

# Overview

One of the most important skills undergraduates learn during their studies is how to write effectively. In our experience, students struggle with aspects of academic writing involving abstract and critical thinking: integrating ideas across multiple sources, organizing information in terms of themes rather than articles, and developing an original argument logically derived from the reviewed literature. These aspects of writing are often referred to as *synthesis* (Boscolo et al., 2007; Rosenblatt, 2010; Spivey & King, 1989; Torraco, 2005). This resource describes an evidence-based online tutorial that walks students through the synthesis process using a color-coding scheme. We also describe a sample in-class lesson plan that reinforces the concepts for students.

# Background

One of the most important skills undergraduates learn during their studies is how to write effectively. According to the learning outcomes described by the American Psychological Association, psychology majors are expected to engage in scientific inquiry, increase their critical thinking skills, and “make systematic improvement in the caliber of their writing to achieve professional levels of expression” (American Psychological Association, APA, 2013, p. 31). To achieve these goals, psychology instructors often include a writing assignment in their courses that requires students to evaluate and integrate evidence from multiple sources (Ishak & Salter, 2017). Although being able to integrate information from multiple sources is considered crucial for psychology students, this type of writing is difficult to learn (Boscolo et al., 2007; Cook & Murowchick, 2014; Goddard, 2003; Granello, 2001; Hayes-Bohanan & Spievak, 2008; Itagaki, 2013; Maher, Feldon, Timmerman & Chao, 2014; Rosenblatt, 2010; Tapp, 2015).

In our experience, students struggle with aspects of academic writing involving abstract and critical thinking: integrating ideas across multiple sources, organizing information in terms of themes rather than articles, and developing an original argument logically derived from the reviewed literature. These aspects of writing are often referred to as *synthesis* (Boscolo et al., 2007; Rosenblatt, 2010; Spivey & King, 1989; Torraco, 2005). Scholarship about the teaching of writing confirm our own observations that instead of integrating across articles, many students’ papers include serial summaries of the sources they consulted, indicating that synthesis is indeed an area where students struggle (Rosenblatt, 2010; Young & Leinhardt, 1998).

One of the challenges students face when synthesizing across multiple studies is that it can be difficult for learners to identify relevant information from source articles and then organize that information into a coherent narrative. For example, Goddard (2003) found that students get lost in the details of academic articles, struggling to pick out important points. Additionally, Segev-Miller (2004) found that most students struggled with identifying a central organizing argument that applied to a body of literature being reviewed. As a result of having difficulty with these foundational skills, in their own writing, students are often unable to frame the importance of an issue clearly and convincingly to the audience (Maher et al., 2014).

Additionally, students often fail to find their own voice when writing; instead, they mimic the writing they have read in their sources (Boscolo et al., 2007; Goddard, 2003). This is characterized by attempts to achieve synthesis by merely rephrasing sentences and trying to connect information from each source (Boscolo et al., 2007) and can be attributed to students lacking the expertise required to generate a *novel* argument that moves beyond information contained in the original sources (Segev-Miller, 2004). The ability to ground one’s thinking in existing scholarship while extending what is known about a particular issue remains a challenge to most undergraduate students (Maher et al., 2014). Given the necessity of learning how to write clearly, and students’ struggle to do so, it is important to develop interventions that improve students’ writing skills.

## *Research on successful writing interventions*

There is limited research focused on improving students’ synthesis skills. Recent literature reviews about teaching synthesis writing found only 16 to 21 quasi-experimental, peer-reviewed studies in this area (Barzilai et al., 2018; van Ockenburg et al., 2019) that targeted students from middle school to higher education in various content areas including history, social science, and natural sciences (Cumming et al., 2016). The limited number of studies in combination with the variety of settings and approaches tested makes it difficult for psychology instructors to figure out how best to apply the findings to their courses.

Despite the limitations of the work on improving synthesis writing, it does appear that some conclusions can be made about the features of successful interventions. In the literature, successful interventions appear to emphasize one or more of the following aspects of synthesis writing: analyzing sources to identify key information, providing explicit instruction about organizing and integrating information from sources, and modeling the process of constructing arguments from or about sources (Cumming et al., 2016; Spivey & King, 1989; van Ockenburg et al., 2019). Interventions that help students organize information from multiple sources, often using graphic organizers, seem to be particularly successful (Barzilai et al., 2018; Darowski et al., 2016; Segev-Miller, 2004.

Graphic organizers may be especially helpful due to their concrete nature. This is because the complex nature of writing places a high mental load on limited capacity cognitive functions such as attention and working memory (Kellogg, 2008). Graphic organizers may improve student writing because they eliminate the need for ideas to solely reside in working memory. Removing key ideas from working memory arguably frees up space to generate ways of connecting those ideas. Indeed, working memory capacity is correlated with various aspects of writing (Vanderberg & Swanson, 2007), and graphic organizers may serve as an external extension of working memory.

A second feature common to successful interventions is combining explicit instruction of source integration with opportunities for collaborative discussions and practice (Barzilai et al., 2018). This approach involves the instructor explaining to students what makes good synthesis writing and giving students the opportunity to critique writing samples (e.g., Boscolo et al., 2007; Cargill & Smernik, 2016). The effectiveness of this approach may also stem from its concrete nature. Critiquing a writing sample gives students a concrete process to follow, which helps transform what might at first be an abstract ideal—synthesis writing—into more tangible techniques and processes that underlie quality synthesis writing. To this end, Farrell (2012), applying Dreyfus’ model of skill acquisition to information literacy, argued that students ideally learn first through concrete applications and gradually mature to more situated, embodied, and intuitive applications. What this shows is that students require explicit instruction and importantly sufficient time and practice to develop these skills.

## *Additional instructional challenges*

One challenge to implementing a writing intervention in a course is the amount of time and effort it can require. The reality is that many psychology instructors are only able to teach writing “on the side.” Time spent teaching writing is time taken away from teaching the core psychology content of the course. Unfortunately, only two of the interventions from the literature can be implemented in class in under 45 minutes—most of the successful interventions required upwards of 100 min of class time and involved instructors providing extensive feedback on multiple iterations of the same assignment (Barzilai et al., 2018; van Ockenburg et al., 2019). Although there may be a connection between time spent teaching writing and the effect size of the intervention (van Ockenburg et al., 2019), in our experience many instructors simply cannot or will not devote this much time and effort to writing instruction. This highlights the need for briefer strategies that can be implemented without relying heavily on instructor involvement and instead can rely on time outside of class.

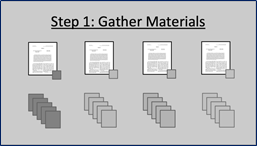
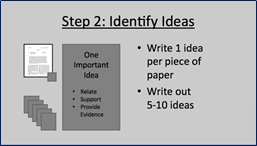
# Using synthesis in your writing: An online tutorial

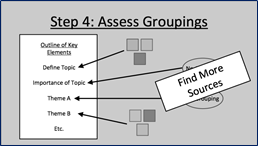
This resource describes an online video tutorial titled “Using Synthesis in Your Writing” which can be assigned for students to complete outside of class. The tutorial introduces students to the concept of synthesis, provides concrete and step-by-step instructions for a color-coding method designed to increase synthesis in writing, and concludes with examples of this method being used in writing. It was designed based on a theoretical understanding of what makes learning how to synthesize ideas from multiple sources cognitively difficult. In addition, it was designed so that the tutorial could be viewed outside of class and instructors could focus in-class time on giving students the opportunity to practice these more advanced writing skills.

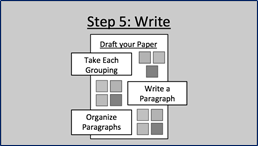
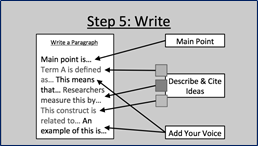
The tutorial breaks the method of synthesis into five different steps. First, students are instructed to assign each of their articles a different color and prepare 5-10 pieces of paper in each color. Second, students are instructed to take each article, and using the colored pieces of paper, write down one important idea or research evidence that relates to their topic per piece of paper. Third, students are instructed to group the pieces of paper by ideas (e.g., synthesize information across the articles), rather than by color. Fourth, students are instructed to evaluate each grouping to determine whether it helps build towards their argument and whether there is enough support for the idea, and if not, to make note of where more evidence from sources was needed. Fifth, students are instructed to draft one paragraph per grouping and organize the paragraphs into a draft of their literature review. See Figure 1 for screenshots depicting these five steps of the color-coding synthesis method.

**Figure 1.**

The five steps of the color-coding process described in the Using Synthesis in Your Writing online tutorial.

The tutorial consists of seven brief videos, with a total running time of approximately 11 minutes and can be accessed at <https://www.youtube.com/playlist?list=PLHIcqvtKwJAzkID-TvEtPqJ2_bSGbsROk>. Each step of the color-coding synthesis method is viewed separately. Breaking the process down into separable stages helps students work through the research and writing process in manageable stages. It also allows instructors to give feedback (if desired) at various timepoints during the writing process. This version of the tutorial also includes supplemental materials, including an extended example of how synthesis could be used to integrate research on the effects of spending time in nature on stress.

# Assessment of the tutorial

The tutorial was designed to providing explicit instruction about organizing and integrating information from sources using a graphic organizer, which are features of successful writing interventions. In addition, our tutorial includes explicit instruction of source integration with opportunities for collaborative discussions and practice (Barzilai et al., 2018). The tutorial explains what makes good synthesis writing (e.g., Boscolo et al., 2007; Cargill & Smernik, 2016). Additionally, the color-coding technique is a useful way to reduce the demands synthesis places on working memory and attention (Kellogg, 2008). In our courses, we have found that the tutorial is most successful when it is followed by an in-class session giving students the opportunity to apply their new knowledge (Darowski et al., 2022).

This tutorial has been formally evaluated in two studies. Darowski et al. (2016) implemented the tutorial in an undergraduate psychological research methods course, assigning the tutorial as out-of-class homework. They used a between-subjects design that compared students’ writing across semesters. Although overall ratings of synthesis were not higher for students using the tutorial, these students did cite more sources per paragraph than students who did not use the tutorial. This suggests that students were benefitting from the concrete approach to organizing key information from their sources but were still struggling to understand and recognize the characteristics of quality synthesis writing.

Darowski et al. (2022) evaluated the implementation of the tutorial in an Honors section of Introduction to Psychology. In that course, students created a literature review poster that explored a common myth about psychology (Lilienfeld et al., 2011). These posters were more like condensed literature reviews than traditional conference posters presenting an introduction, methods, results, and conclusion. The final poster contained an introduction that identified the common myth, a section that presented research that could be interpreted as evidence for or against the myth, and a conclusion that took a position on whether the myth was likely to be true or false. Students were required to include at least five sources.

After viewing the tutorial outside of class, these students also spent a subsequent class period receiving direct instruction about synthesis. The instructor spent approximately 10 min reviewing the information presented in the tutorial in a short lecture to ensure that all the students understood the concept described in the tutorial. After the lecture, students spent 15–20 min reading examples of student writing taken from an upper-level psychology course and worked in small groups (three to four people) to discuss the extent to which the writing sample used synthesis and how the use of synthesis in the sample could be improved.

Darowski et al. (2022) compared the final posters from the experimental class to the posters of students enrolled in a previous semester who had not viewed the tutorial or received explicit instruction on synthesis. Compared to the students in the control condition, the posters of students who completed the tutorial and the in-class practice showed more evidence of synthesis. That is, in their writing, students were more likely to integrate information across sources and to use better organization and transitions. Because of the design of the study, it is impossible to determine what contribution the tutorial and the in-class lecture made to the improvement in students’ writing. However, it is important to note that the in-class lecture and discussion relied on students having viewed the tutorial and completing the activity described in it. Because students had this knowledge, class instruction on synthesis was contained within a single class session. Additionally, class instruction was focused on giving students the opportunity to critique writing samples which has been shown to improve synthesis writing (Boscolo et al., 2007; Cargill & Smernik, 2016).

## Instructor and student feedback

We have found this tutorial easy to implement in our courses. After students have selected their research topic and completed some preliminary research, we provide the link to the YouTube playlist for the students and find we do not need to do any additional instruction to help them complete the tutorial. Students are not required to buy any new materials or software. They can do the tutorial with materials they already have or can use free digital tools (e.g., Trello). Because of the graphical nature of the tutorial, it is easy to assess whether students have completed it: We require them to turn in photographs (or screenshots) of their workspace that corresponded to completing each of the 5 color-coding synthesis steps. During an in-class discussion about a writing sample, and during peer review sessions, we ask students to provide feedback on the following questions:

1. Is the relationship between sources made clear?​
2. Are synthesis words or phrases used to link two or more different sources?
3. Does the synthesis word or phrase accurately summarize the relationship between/among sources?​
4. Does synthesized source material overwhelm your voice?​
5. Is one source synthesized or otherwise used more than the other sources on the References page?

Across multiple semesters, students have responded positively to the tutorials. Students found the tutorial easy to follow and find the color-coding to be a particularly beneficial aspect of the tutorial. Darowski et al. (2016) reported a formal assessment of students’ perceptions. Students self-reported significantly more synthesis in their writing post-tutorial than pre-tutorial. Students also rated their confidence in writing literature reviews pre- and post-tutorial. While their confidence also increased across the semester there was not a significant difference in this measure. Finally, students responded to open-ended prompts asking what they liked about the synthesis activity and which aspects of the activity were most helpful. Students noted that the tutorial helped them identify key information, integrate key information, and organize that information. Additionally, students indicated that the color-coded aspect of the task helped them to keep track of information and consider multiple ways of organizing it.

## Future work

One limitation of this tutorial is that it does not include explicit instruction in building a scientific argument using supportive evidence. Explicit instruction on developing an argument could improve students’ synthesis writing as it would help them understand to what end they are synthesizing. This might, in fact, be why the synthesis tutorial was more effective in the myth project because students were given an explicit argument to make in their project—they were not expected to survey the literature and derive a conclusion on their own as upper-level students are expected to do.

*Classroom follow-up*

Darowski et al. (2016) found that the tutorial was more effective when the instructor spent one class period following up with the students. Below is a sample lesson plan for an 80-minute course.

# Sample Lesson Plan (80 minute course)

**Reflective writing (10 minutes)**. Students respond independently to the following prompt:

What does it mean to “support instead of report”?

This writing assignment allows the instructor to assess whether students watched the tutorial and allows students to reflect on what they learned before applying those new skills. Graded as credit/no credit.

**Lecture (20 minutes)**. We have developed a short lecture that reiterates some of the important concepts introduced in the tutorial to refresh students’ memory and provide additional examples of how to use synthesis to support an argument. (See attached slides)

**Writing feedback activity (30 minutes)**. We have students work in groups of 3-4. We give each group three samples of student writing from a previous course. We ask the group to assess how “synthesized” the writing appears to be and to suggest ways that synthesis could be improved. We ask them to consider the following questions:

1. Is the relationship between sources made clear?
2. Are synthesis words or phrases used to link two or more different sources?
3. What is the writer’s argument?
4. Are the sources cited used to support the argument?
5. How could this paper be improved?

**Large group discussion (15 minutes)**. After working in their groups, we bring the class together and have a large group discussion about each piece of writing. We ask students to summarize their feedback for each writing sample.

**Wrap up (5 minutes)**

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