Assessing Skill in Synthesis and Creative Thinking

Why Assess Skill in Synthesis and Creative Thinking?

One of the highest-level skills in Bloom's taxonomy of cognitive skills is synthesis, the ability to put parts together to form a new whole.[1] Students demonstrate their ability to synthesize new information through creating new information: writing a paper or a presentation, creating a research plan, or designing a classification scheme. Products of synthesis are creative and cannot be measured by performance on a multiple-choice test.

In Wiggins and McTighe's facets of understanding, these skills fit into the categories of interpreting, applying, and having perspective.[2] Synthesis is an important level of cognitive understanding because when students begin to synthesize and integrate information and ideas, they are learning how to learn. As they create a product that demonstrates their synthesis of new information, they incorporate new knowledge with things they knew before. Instructors can encourage students to look for new ways of answering questions, develop new perspectives, and identify new ways of doing research.

Angelo and Cross describe techniques for assessing synthesis and creative thinking as assignments that "stimulate students to create, and allow

faculty to assess, original intellectual products that result from a synthesis of the course content and the students' intelligence, judgment, knowledge, and skills."[3] McKeachie and his colleagues note the importance of helping students make "knowledge structures" explicit so that they and their instructors can assess and understand them.[4] The assessment techniques we present in this chapter should help students build and see their own knowledge structures.

We present three CATs in this chapter to help librarians assess students' skill in synthesis and creative thinking. The one-sentence summary requires students to organize new information and put it in a new format for assessment of understanding. Concept maps are a more free-form way for students to demonstrate understanding and synthesis of a new idea, and invented dialogues ask students to synthesize new information and consider how they would discuss it with a particular audience. These CATs all lend themselves to group work and can be adapted to the online environment.

One-Sentence Summary

When to Use a One-Sentence Summary

In a one-sentence summary assessment, the question for students is "Who does what to whom, when, where, how, and why?" about a given topic.[5] They synthesize their answer into a single long sentence. This CAT is useful when students are meant to understand a concept that is new to them and the instructor wants to see if students understood it. This summary technique allows students to "chunk" information, breaking it into small, interrelated parts that can be more easily recalled.

The one-sentence summary is most useful when the librarian instructor is presenting information in a lecture or presentation and wants to check for understanding. It will work best if students are told, at the beginning of the presentation, what they should be listening for and how they'll be asked to respond to it. The instructor could even give students a table with the guiding questions "Who? Does what? To what or whom? When? Where? How? Why?" so that they can make notes as the presentation is given.

Sample One-Sentence Summary

After a presentation and activity on how scholarly journal articles are created, the librarian asks students this question:

How do scholarly journal articles get published?	
Who?	researchers
Does what?	publish
To what or whom?	their findings
When?	once research is finished
Where?	in scholarly journals within their fields
How?	after peers have reviewed their methods and results
Why?	to disseminate information and further the scholarly conversation
Sentence	Researchers publish their findings once research is finished in scholarly journals within their fields, after peers have reviewed their methods and results, in order to disseminate information and further the scholarly conversation.

This sample response represents just one example of a student response to the one-sentence-summary question, "Who does what to whom, when, where, how, and why?" There are any number of ways that other students might respond to the question, and this example and the examples below are meant to provide you with an idea of how the activity might go. For most one-sentence summaries, students must supply a bit of creativity to fit the concept into the confines of the question. In this activity, students must go beyond repeating back exactly what they heard.

The one-sentence summary works particularly well when teaching difficult new ideas or threshold concepts. The examples below represent ways that students might respond after they are presented with class activities that illustrate one of the threshold concepts from the ACRL *Framework for Information Literacy for Higher Education*.[6] The concepts and the sample assignments and class activities below are drawn from the *Framework*.

Example on "Authority Is Constructed and Contextual"

Students have looked at several different types of social media regarding a recent news event. They have been asked to describe how they would analyze and evaluate the authority of the authors of the information. Could they determine whether the individuals were witnesses or participants in the event? Can they identify whether the individual has a particular political bias? Can they determine whether the author has particular status within a group or is reporting as an "average citizen"? Students discuss whether the social media coverage of the event is authoritative, or "authoritative enough," and to whom it might be useful. Students are asked to respond to thus question:

Why do different groups value different types of authority?	
Who?	different communities
Does what?	value and recognize
To what or whom?	different types of authority
When?	when they are seeking authoritative information
Where?	online, in journals, in books
How?	for different types of purposes
Why?	because information needs determine the type of authority that is necessary or appropriate
Sentence	Different communities value and recognize different types of authority when they are seeking authoritative information, whether that is online or in journals or books, because different purposes and information needs determine the type of authority that is necessary or appropriate.

Example on "Information Creation as a Process"

Students were assigned to read a popular article about how to be successful in college, and then they were assigned to find scholarly research to support one of the tips in the popular article. They wrote a reflective journal

entry comparing and contrasting the type of information found in the two different articles and then articulated the processes underlying the creation of each article. The class discussed, as a group, how the formats and processes were different, created a list of characteristics for each format, and discussed how the two articles were created and for whom and how they would be used for different purposes for different audiences. Students are asked to respond to this question:

> What is the purpose of these two different formats?

Half of the class writes about the popular article, and the other half writes about the scholarly research.

Who?	writers of popular magazine articles
Does what?	might summarize and present
To what or whom?	scholarly research
When?	after it is disseminated in a scholarly publication
Where?	in a magazine
How?	in an accessible, easy-to-read style
Why?	to share the research findings with a wider audience
Sentence	Writers of popular magazine articles might summarize and present scholarly research, after it is disseminated in a scholarly publication, in an accessible and easy-to-read style in order to share the research findings with a wider audience.

Example on "Information Has Value"

Students working on a visual presentation related to a research project need to find images to complement their oral presentation. Students are directed to several different image sources, and then they are asked to find several images they might use in their presentations. They are asked to determine which images can be used without asking permission and to consider what they need to do in order to use this material. Students respond to this question using the one-sentence summary format.

Who?	students
Does what?	can use
To what or whom?	images
When?	in their presentations
Where?	for a class
How?	legally and ethically, by citing the creator and source
Why?	in order to give credit to those who created the image and to direct the reader or viewer back to the source
Sentence	Students can use images in their presentations for a class legally and ethically, by citing the image creator and source in order to give credit to those who created the image and to direct the reader or viewer back to the source.

Example on "Research as Inquiry"

Students in a first-year course were asked to reflect on the steps they went through when researching a major event in their lives, such as where to go to college. They have identified the key steps in the research behind their decision and discussed the importance of using similar strategies in academic research. Students worked in groups to create mental maps of the research process and came up with a variety of visual representations of their processes. They are asked to answer this question:

What is the research process like, if it's not a linear, step-by-step activity?

Who?	a good researcher
Does what?	asks lots of questions
To what or whom?	of the texts she is reading
When?	while trying to answer a question
Where?	in a lot of different places: online, in the library, etc.

How?	while revisiting and refining the research topic
Why?	in order to create new and interesting knowledge
Sentence	A good researcher asks a lot of questions of the texts she is reading while trying to answer a research question; she looks in a lot of different places all while revisiting and refining her research topic in order to create new and interesting knowledge.

Example on "Scholarship Is a Conversation"

Students have watched a short video explaining the metaphor of scholarship as an ongoing conversation. They learned that, in order to get up to speed and add to the scholarly conversation, they need to listen to and read many perspectives in order to be informed participants and contribute something new. They have also engaged in an in-class activity, where they created a timeline to track evolving threads of a continuing scholarly conversation. Students are asked this question:

How do good researchers engage in a scholarly conversation when they are investigating a research question?

Who?	good researchers
Does what?	look around
To what or whom?	for different perspectives
When?	when they're studying a problem or question
Where?	online, in journals, in books, and among their peers
How?	in a cyclical and sometimes inefficient way
Why?	to negotiate meaning and understand an issue in a new way
Sentence	Good researchers look for and read different perspectives on a problem or question, online and in journals and books, in a cyclical and sometimes inefficient way, in order to negotiate meaning, understand an issue, and contribute to the scholarly conversation.

Example on "Searching Is Strategic"

Students have conducted a keyword search within a database and are then guided to identify and use subject headings on the same topic within the same database. They write a paragraph on the differences between subject searching and keyword searching and discuss where subject headings come from. Then they are asked to reflect on the differences between subject and keyword searching, within the "Who? Does what? To what or whom? When? Where? How? Why?" framework.

Who?	database creators
Does what?	categorize
To what or whom?	articles
When?	before they are added
Where?	to a database
How?	by applying a subject heading
Why?	in order to make all the articles on a subject come up together in one search
Sentence	Database creators categorize articles before they are added to a database by applying subject headings in order to make all the articles on a subject come up together in one search.

Asking students to organize this information in a sentence makes it easier for them to recall what they have learned and make it stick. The creative element of organizing information into a specific framework can also help students grasp complex ideas and explain them to others.

Before assigning a one-sentence summary to students, the instructor should be sure that she can do this task herself with the topic or text because it can be tricky. The examples above will provide a starting point for instructors in thinking about how information could potentially be organized for this exercise.

How to Score a One-Sentence Summary

Because this CAT measures student understanding of a specific concept, it is fairly easy to use a rubric for scoring. For each learning outcome, list criteria and whether the student meets each criterion. A checklist format that simply checks on whether the required element is present is quick, but if students are receiving a grade, the instructor might also consider describing levels of performance so that students can earn partial credit for different elements. The instructor can also give comments on the rubric, noting what was well done and what should be revised or reworked.

	Criteria	**Yes/No**	**Comments**
Questions Clearly Answered	The answer is concise, accurate, and understandable.		
Knowledge Correctly Transferred to Situation	The information is conveyed in a way that makes sense for the audience and the setting.		

For more guidance on creating and grading with rubrics, see appendix 2, "Rubrics."

What to Do with Results

With a quick yes/no check on whether students understood the main concept and were able to summarize the information in one sentence, the instructor can see how many students understood the information and how many did not. Then, if not many students understood, the topic can be revisited in different ways. If most students understood and performed well on the assessment, the instructor can feel confident about moving on.

Concept Maps

When to Use a Concept Map

Concept maps are drawings, flowcharts, or diagrams in which students can show the mental connections that they make between a major concept and other related concepts.[7] This provides an explicit and assessable record of

the way students are thinking about a big idea and allows the instructor to see the web of relationships that the student is bringing to the task at hand.

This can be a useful task for students to undertake at various points in a research process. As soon as students have identified a broad topic to explore, they can use a concept map to think about how connected issues or how different topics relate to each other. Students can be prompted to think about narrowing their topic by considering and mapping questions like:

- Who is affected by this topic?
- In what geographic region is this most important?
- Is there a specific time period to consider?

This approach can be used early in the process to find out about students' preconceptions and prior knowledge structures and then again, later in the research process, to see what new information has been synthesized. For more information on assessing background knowledge, see chapter 1, "Assessing Prior Knowledge and Understanding."

Students and librarian instructors may also find it useful to compare understandings of the research process by drawing mental maps of the research process. Students will bring their prior experience to this exercise and most will enjoy the creative aspect of making a visual representation of the (sometimes meandering) path that they have taken in past research assignments.

It's helpful to show students examples of what a concept map might look like so that they can see various ways of structuring their own maps. An instructor may draw her own concept map before asking students to do it and then share it as an example for students. It can also be helpful to take one student's research topic and use it as an example on the whiteboard or computer and walk through the concept map process before asking students to create their own.

These maps can help students refine a topic and focus their attention on part of a larger topic. There are many technologies that can be used, from online mind-mapping tools to apps for tablets and smartphones, so this is adaptable for online courses. Students can create their concept maps with a digital tool and then submit them in an online course.

There are various styles of concepts maps that can be used and adapted depending on the research assignment. Some examples include a cyclical process, a network tree, a spider map, and a series of events chain (see figures 2–5).

FIGURE 2
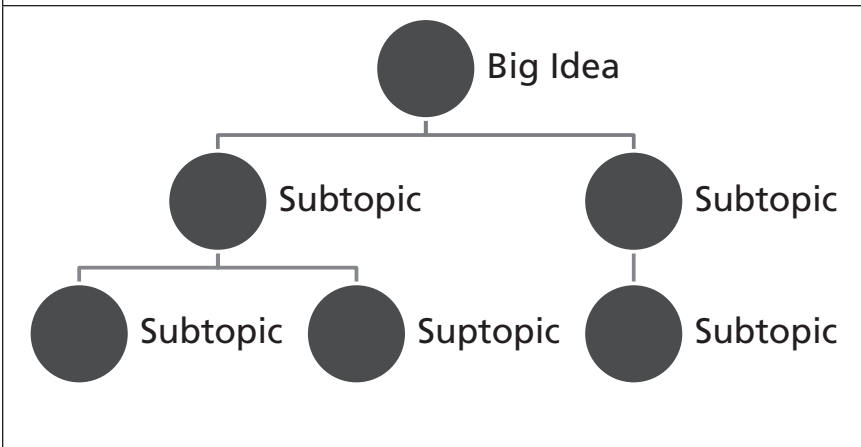Cyclical Process

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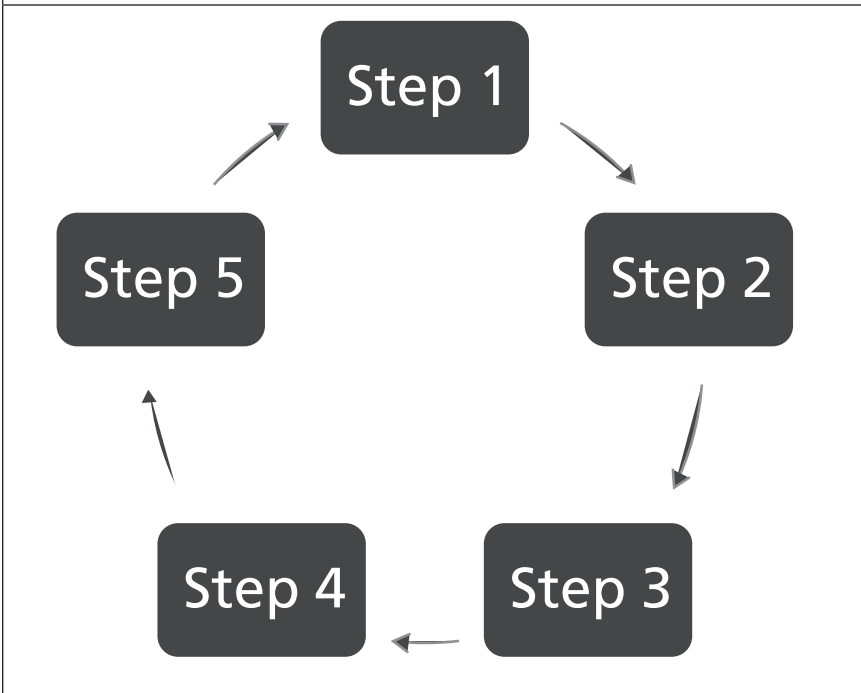
FIGURE 3
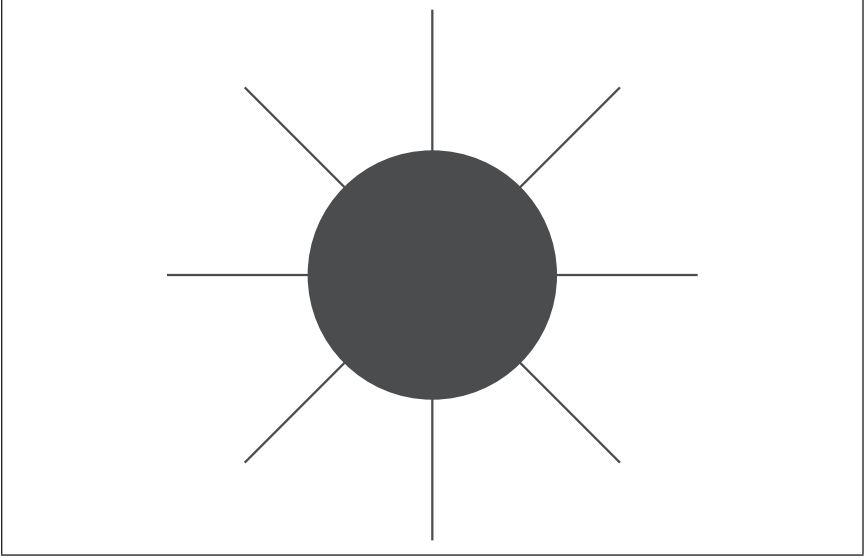Network Tree
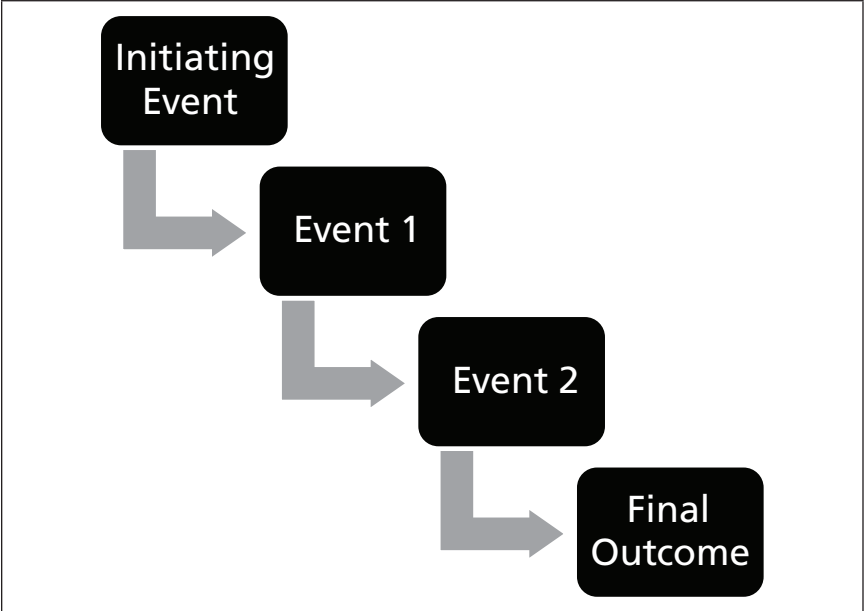
FIGURE 4
Spider Map

FIGURE 5
Series of Events Chain

Example for First-Year Experience Library Research Course

Students in a first-year introductory library research course are defining information literacy and discussing their past experiences with research at the beginning of the semester-long course. The instructor asks students to work in groups, write *research* in the center of a piece of paper, and, around the center, add related words or concepts that come to mind. After groups present their concept maps, the class makes a composite map based on common responses from students. Throughout the semester, the class refers back to initial student ideas about research, and at the end of the course they repeat the activity to see if students' perceptions have changed.

Example for First-Year Writing Course

Students in a first-year writing class visit the library at the beginning of their research writing project. The librarian has students write their own research topic in the center of a piece of paper. Then she asks them to brainstorm about the following questions, making connections on the map:

- What are the surrounding issues?
- Who cares about this topic enough to write and publish on it?
- Whom does this issue impact? Consider gender, age, and profession.
- What aspect of this topic are you most interested in? (causes, effects, implications, solutions, etc.)
- Is this current? In the past? Related to a specific event? Looking to the future?
- Is this issue bound to a particular place? (countries, regions, states, workplaces, schools, virtually)

Example for an Upper-Division Course

A librarian instructor wants students to think about their past research experiences and their usual processes for completing a research-based assignment. She has each student draw a map of her own research process, whether it's a step-by-step process, a meandering road, or a cyclical process. After students have drawn personal maps, they discuss their maps in small groups, which leads to discussions about different processes and how they can be represented. Students see that everyone approaches research

in a slightly different way, and they get ideas about how to approach their upcoming projects.

Variation

Ask each student to begin a concept map with a topic, then have all students pass their maps through the room. Each student adds a synonym, subtopic, or related topic to each map as it passes his or her desk. In this way, the concept maps benefit from the collective knowledge and attention of the group. It also broadens the class perspective of what topics and ideas are in use for a particular research assignment and fosters collaborative thinking. This is most useful when the group has a shared body of knowledge or a shared research interest, as in an upper-division or graduate course.

How to Score a Concept Map

A concept map can be used to assess many different learning outcomes, and a rubric works well to score results. If you are using the concept map to encourage students to generate keywords, a rubric may look like the table below, with different levels of points assigned for three different criteria: relevance of keywords, quality of keywords, and completeness of map.[8]

Evaluation Criteria	Insufficient or Not Available – 0	Beginning – 1	Developing – 2	Exemplary –3
Relevance	Lists no keywords or can't tell if keywords are relevant.	Lists keywords that are **not relevant** for the research question.	Lists keywords that are **mostly relevant** OR lists **not enough keywords** to express all aspects of the research question.	Lists **several** keywords that express **all aspects** of the research question.

Evaluation Criteria	Insufficient or Not Available – 0	Beginning – 1	Developing – 2	Exemplary –3
Quality	Lists no keywords or illegible concept map.	Lists key-words that are **mean-ingless** and/or keywords that will retrieve **biased** results OR uses all **natural language**	Most keywords are **mean-ingful** and will retrieve results on **most sides of the issue**. Does not use natural language.	Keywords listed are of high quality and/or will lead student to subject/ thesaurus terms.
Completeness of Concept Map	Blank or illegible	Wrote down question or topic and little else.	Includes question or topic and keywords OR stake-holders OR additional questions.	Extensive concept map with many keywords, stake-holders, questions, etc.

Rate each map based on these three criteria, assigning a numerical value for each aspect.

What to Do with Results

Concept maps can be a great self-assessment technique for students and an excellent tool for brainstorming. Results do not necessarily have to be graded by the librarian or instructor. If there is an interest in evaluating student performance and a rubric is used, it can provide insight into what the class as a whole understands and does not yet understand and can give the librarian instructor an idea of where to focus in future lessons.

Invented Dialogues

When to Use Invented Dialogues

By inventing dialogues, students synthesize their understanding of a concept into a structured and illustrative conversation.[9] The key to setting up the assignment is to select a difficult concept or theory and invent an imaginary dialogue partner for students. This is different from a directed paraphrasing assessment[10] because it asks students to think about both sides of a conversation, including the questions that would come from their imagined conversation partner. These may be written by one student alone or by a group of students, performed by students, and either turned in to the instructor for assessment or reported out verbally.

Example on Popular versus Scholarly Articles

After teaching a lesson and leading activities on the differences between popular and scholarly articles, a librarian teaching a first-year seminar class gives students the following assignment:

> Imagine you have to teach a group of new university students the difference between popular and scholarly articles. How would you explain this concept to them? What information would they need to know to locate scholarly sources through the university library? Include both sides of the dialogue, with questions the new university students would ask.

Example on Authority as Contextual and Constructed

After teaching a lesson and leading activities illustrating how authority is constructed in different disciplines and contexts, a librarian teaching an upper-division class in the humanities gives students the following assignment:

> Imagine that you have to speak to a group of students majoring in your field about who has authority within your area of study and the origins of that authority. What questions would they ask you? How would you explain the type of expertise that is valued in your discipline?

Example on Evaluating a Source for Relevance and Utility

After a course session on evaluating sources for relevance and utility, a librarian gives students the following assignment:

> Imagine that you have to defend a source that you chose for your research paper to a librarian. How will you articulate why the source is appropriate, relevant, and useful? What questions will the librarian ask you?

An example of a student response might look like this:

> **Me:** I chose this article because it answers my research question, "Should student athletes be paid when their image is used in merchandising?"
>
> **Librarian:** Will you use the article for background information, evidence for or against your argument, or another purpose?
>
> **Me:** It has evidence I'll use in my paper: the market value of college athletes in major sports and some legal cases that support paying student athletes for the use of their image.

How to Score an Invented Dialogue

This CAT is useful for measuring student understanding of specific learning outcomes, so a rubric works well for scoring. For each learning outcome, list criteria and whether the student meets each criterion. The rubric may be used to check for the presence of required elements, but the instructor may also describe different levels of performance for each outcome. The instructor can also give comments on the rubric, noting what was well done and what should be revised or reworked.

	Criteria	Yes/No	Comments
Outcome 1: information clearly articulated	The student's explanation of the concept is concise, accurate, and understandable.		

	Criteria	**Yes/No**	**Comments**
Outcome 2: language suited to audience	The language used is appropriate for the audience, neither too advanced nor too basic.		
Outcome 3: knowledge correctly transferred to situation	The information is conveyed in a way that makes sense for the audience and the setting.		

For more guidance on creating and grading with rubrics, see appendix 2, "Rubrics."

What to Do with Results

The challenges for students when writing a dialogue are thorough understanding of the concept and the choice of language to portray the conversation partner. Pay particular attention to the accuracy of the explanation, as well as to how the language used by students fits the assigned audience. A quick reading of the dialogues will allow the librarian to quickly learn whether students grasped the most important information in the library session. Following up on the dialogues requires more time. It is important to provide individual feedback on the dialogues so that students understand how better to apply and translate their knowledge in the future. The time required to respond to the dialogues makes this technique appropriate for classes in which the librarian has a long engagement, whether teaching or embedding in the course. It is also best suited to small enrollment courses.

Notes

1. Benjamin S. Bloom and David R. Krathwohl, *Taxonomy of Educational Objectives: The Classification of Educational Goals* (New York: Longmans, Green, 1956).
2. Grant Wiggins and Jay McTighe, *Understanding by Design,* 2nd ed. (Alexandria, VA: Pearson, 2005), 84.

3. Thomas A. Angelo and K. Patricia Cross, *Classroom Assessment Techniques: A Handbook for College Teachers,* 2nd ed. (San Francisco: Jossey-Bass, 1993), 181.
4. Wilbert J. McKeachie, Paul R. Pintrich, Yi-Guang Lin, and David A. F. Smith, *Teaching and Learning in the College Classroom: A Review of the Research Literature* (Ann Arbor: National Center for Research to Improve Postsecondary Teaching and Learning, University of Michigan. 1986), 22–23.
5. Angelo and Cross, 183.
6. Association of College and Research Libraries, *Framework for Information Literacy for Higher Education* (Chicago: ACRL, 2015), http://acrl.ala.org/ilstandards).
7. Angelo and Cross, *Classroom Assessment Techniques,* 197.
8. Rubric used with permission from Kaijsa Calkins and Melissa Bowles-Terry.
9. Angelo and Cross, 203.
10. For more on using directed paraphrasing as an assessment technique, see chapter 4 of this book.