BioTAP: A Systematic Approach to Teaching Scientific Writing and Evaluating Undergraduate Theses

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Undergraduate theses and other capstone research projects are standard features of many science curricula, but participation has typically been limited to only the most advanced and highly motivated students. With the recent push to engage more undergraduates in research, some faculty are finding that their typical approach to working with thesis writers is less effective, given the wider diversity of students, or is inefficient, given the higher participation rates. In these situations, a more formal process may be needed to ensure that all students are adequately supported and to establish consistency in how student writers are mentored and assessed. To address this need, we created BioTAP, the Biology Thesis Assessment Protocol, a teaching and assessment tool. BioTAP includes a rubric that articulates departmental expectations for the thesis and a guide to the drafting-feedback-revision process that is modeled after the structure of professional scientific peer review. In this article we (a) describe BioTAP's parts and the rationale behind them, (b) present the results of a study of the rubric's interrater reliability, (c) describe how the development of BioTAP helped us create a faculty learning community, and (d) suggest how other departments and institutions can adapt BioTAP to suit their needs.

Keywords: faculty-mentored undergraduate research, Writing in the Disciplines program, honors thesis, formative and summative assessment, learning community

Faculty-mentored research projects are a key component of the undergraduate curriculum at many colleges and universities, particularly in the disciplines of science, technology, engineering, and mathematics (STEM). These projects give students the opportunity to synthesize content from prior courses, further develop communication and problem-solving skills, and see firsthand how knowledge is produced (Lopatto 2003, Seymour et al. 2004, Hunter et al. 2007). Given these educational benefits, colleges and universities are being encouraged to increase the diversity of students engaged in research beyond the most advanced and highly motivated undergraduates (see, e.g., the Boyer Commission on Educating Undergraduates in the Research University 1998). Many institutions are including language in their strategic plans that promotes greater student participation in faculty-mentored research, including capstone projects such as senior theses (e.g., Rodriguez 2005, Duke University 2006).

The educational benefits of writing a thesis, however, are not automatic. The extent to which these benefits are realized depends in large part on how effectively students are mentored throughout the writing process (Young 1999, Bean 2001). Programs that previously had been able to provide strong mentoring when only a few students were writing theses are likely to find that increasing participation rates strain departmental resources, and the diversity of students involved requires new approaches to mentoring, teaching, and assessment.

To address these issues, we created BioTAP, the Biology Thesis Assessment Protocol, a formative and summative assessment tool for undergraduate theses in biology. The central feature of BioTAP is a detailed rubric that delineates the categories by which theses will be assessed and defines the criteria for varying levels of success in each category. Although rubrics have been a mainstay of writing assessment for decades, little attention has been given to the particular context of undergraduate thesis writers in STEM disciplines, where a well-designed rubric could facilitate more effective teaching and evaluation. Rubrics are particularly appropriate as a teaching tool for undergraduate thesis writers because they can help students understand a genre of writing that is new to most of them, identify and explain the strengths and weaknesses of drafts, and serve as meaningful guides for improvement (Moskal 2000, Durst 2006). Rubrics are also appropriate for summative assessment since they allow faculty and administrators to determine which learning objectives are adequately addressed in the current curriculum and which need attention (Benander et al. 2000,

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Berheide 2007). Furthermore, rubrics designed with the collective input of faculty can promote valuable conversations about teaching and learning.

One of the unique aspects of BioTAP is that it responds to the specific needs and expectations articulated by biology faculty. Nevertheless, to ensure that we were making connections with the goals of our foundational academic writing courses, we consulted with our Writing in the Disciplines program; we also consulted with our Office of Assessment to ensure that we were using language that lent itself to accurate evaluation. So although BioTAP was tailored to meet the specific needs of the biology department at Duke University, we think it can serve as a model for other STEM departments as well.

In the first part of this article, we describe BioTAP's major sections and the rationale behind them. Next, we present the results of a study in which we determined the interrater reliability of BioTAP's rubric. Finally, we describe how the development of BioTAP helped us create a faculty learning community, and suggest how other institutions and departments can adapt BioTAP to suit their needs.

What is BioTAP?

BioTAP is a document that guides and supports students and faculty through the thesis-writing process. BioTAP includes both a rubric that articulates departmental expectations for the thesis, and a guide to the drafting-feedback-revision process that is modeled after professional scientific peer review. For students, BioTAP promotes the development of writing and critical-thinking skills by clearly communicating the expectations for the thesis, and by teaching students how to respond to and solicit useful feedback on their writing to guide the revision process. For faculty, BioTAP offers guidelines for more efficient and effective methods of giving feedback on drafts. And for departments, BioTAP helps to promote high-quality student work by outlining departmental standards and expectations, by facilitating meaningful communication between faculty and students, and by making evaluations of student work more consistent and less dependent on the preferences and pet peeves of particular advisers.

BioTAP's rubric. The BioTAP rubric, which is divided into four parts, addresses the various writing, thinking, and research skills needed to produce a successful thesis (box 1; full details available at *www.science-writing.org/biotap.html*). The first section, higher-order writing issues, addresses fundamental elements of academic writing, such as targeting the intended audience, contextualizing the research within the scientific literature, and communicating research aims. Like many writing issues, these also reflect critical-thinking skills (as described in Bloom 1984) such as synthesizing information from multiple sources, analyzing data, and evaluating competing hypotheses. The second section, mid- and lower-order writing issues, addresses thesis organization, mechanistic issues (e.g., spelling, grammar, and punctuation), citations, and presentation of figures and tables. The third section, quality of scientific work, addresses the accuracy and appropriateness of the research. Finally, the rubric outlines the qualifications for the awards of honors and high honors.

Since BioTAP's rubric is designed for both formative and summative assessment, we provide students and faculty with detailed explanations of each question, as well as descriptions of the department's minimum acceptable standards and standards for excellence. For example, BioTAP question 1 asks if the writing is appropriate for the target audience. We define the target audience as "readers who are not necessarily specialists in the particular area of the student's research but who have a solid understanding of basic biology—specifically, any faculty member in the biology department regardless of subdiscipline." Since many students are unsure about what they can assume their audience does and does not know, we explain that although faculty members are experts within their specific field of research, they are unlikely to be familiar with the jargon and conceptual nuances of other highly specialized fields of study. Therefore, we suggest to students that they assume their readers understand basic biological processes (e.g., cell signaling), but they cannot assume their readers will readily remember all the details (such as the proteins involved in a particular signaling pathway). The minimum acceptable standards for this issue require that the thesis include useful definitions or explanations of specialized terms and uncommon concepts so that nonspecialist readers are able to follow the main themes. In comparison, the standards of excellence require that the thesis makes the research not only accessible but also engaging for nonspecialist readers. We provide such detailed explanations for all the writing issues in our rubric to facilitate effective teaching and learning and to ensure reliable assessment.

The BioTAP writing process. The publication process for most academic research scientists follows a fairly standard template: drafting a manuscript, submitting the manuscript for review, incorporating reviewer comments in revisions, and writing a cover letter explaining how the revised manuscript responds to reviewer feedback. Because this process is so familiar to STEM faculty, we chose it as a model for guiding student writing. BioTAP facilitates a similar process by encouraging students to begin drafting early, supporting faculty in giving timely and effective feedback, and expecting students to explain how they revised their drafts in response to that feedback.

Guidelines for students: Soliciting and responding to feedback. Students often take a passive approach to revising their writing. Given the typical roles of faculty as expert and student as novice, many students assume that their faculty mentor will identify all needed changes in their writing, and that they must accept suggested changes without question. In the most unproductive version of this interaction, the instructor inserts editorial suggestions in an electronic copy of the draft, and the student then merely clicks "accept all changes" to get the "corrected" paper.

Box 1. BioTAP's rubric.

BioTAP's rubric assesses higher-order writing issues (questions 1–5), mid- and lower-order writing issues (questions 6–9), and the accuracy and appropriateness of students' research projects (questions 10–13). For each question, a "no" answer indicates that the thesis does not meet the department's minimum acceptable standards; a "somewhat" rating indicates that the thesis meets the department's minimum standards but not the standards of excellence; a "yes" response reflects the department's standards of excellence. A holistic rubric outlines the qualifications for the awards of honors and high honors. Descriptions of each element of the rubric, as well as departmental standards, can be found at *www.science-writing.org/biotap.html.*

Higher-order writing issues

1. Is the writing appropriate for the target audience?

2. Does the thesis make a compelling argument for the significance of the student's research within the context of the current literature?

3. Does the thesis clearly articulate the student's research goals?

4a. [For theses with conclusive and complete results] Does the thesis skillfully interpret the results?

4b. [For theses with inconclusive or incomplete results] Does the thesis provides an insightful explanation of the reasons underlying the lack of clear results?

5a. [For theses with conclusive and complete results] Is there a compelling discussion of the implications of findings?

5b. [For theses with inconclusive or incomplete results] Does the thesis provides a thoughtful and thorough discussion of possible future studies or alternative approaches?

Mid- and lower-order writing issues

6. Is the thesis clearly organized?

7. Is the thesis free of writing errors?

8. Are the citations presented consistently and professionally throughout the text and in the list of works cited?

9. Are the tables and figures clear, effective, and informative?

Quality of scientific work

10. Does the thesis represent the student's significant scientific research?

11. Is the literature review accurate and complete?

12. Are the methods appropriate, given the student's research question?

13. Is the data analysis appropriate, accurate, and unbiased?

Criteria for honors

To be considered for the award of honors, students must show proficiency in scientific research, as demonstrated by an original, independent, and substantive research question, as well as care in data collection and analysis. The student must also produce a written thesis that achieves the following:

- It is written for a broad audience of biologists, not just experts in the field of research.
- It makes a compelling argument for the significance of the student's research within the context of current scientific literature.
- It explicitly interprets results in relation to a hypothesis.
- It discusses inconsistencies, uncertainties, or limitations of the results.
- It is coherent, reasonably free of errors, and professionally presented.

Criteria for high honors

To be considered for the award of high honors, a student must have met all the criteria for the honors award and demonstrated an exceptional ability to conduct scientific research, as demonstrated by scientific innovation, sophistication, insight, creativity, or exceptional care in data collection or analysis. Moreover, a student must have produced a thesis that is exceptionally well written.

Students assuming such a passive role will be especially frustrated if they have multiple readers for their thesis because they will have to contend with the inevitable conflicting comments and suggestions. Unless students are encouraged to take ownership of their writing, they may believe that their task is merely to choose between the preferences of competing authoritative voices, rather than to thoughtfully consider conflicting comments and then decide what makes the most sense for their writing. Since students working on faculty-mentored research are usually highly invested in their projects, writing a thesis is a great opportunity for students to transition from the role of passive student to that of engaged writer.

To help students take responsibility for getting useful feedback, BioTAP asks students to write a cover letter for each draft that they submit to their faculty readers for review; in each cover letter, they should identify specific issues that they most want feedback on at that point. The following questions guide students in writing their cover letters:

1. Thinking about each of the items in the BioTAP rubric, what are your top concerns about this draft? Are you concerned, for example, with your research statement, making an argument for the significance of your research, your data analysis, organization, use of sources, style, or something else? Be as specific as possible.

2. What else would you like your reviewers to know about your draft or yourself as a writer (such as particular strengths or weaknesses)?

BioTAP also encourages students to take responsibility for making their own writing choices by having them provide a detailed explanation of how they revised their paper in response to all readers' comments, including comments they felt were not applicable or suggestions they felt were not the best choice. This format mirrors the process for responding to a revise-and-resubmit request for many scientific journals: Students must respond to each substantial comment made by reviewers, describe the particular concern, explain the way that concern was addressed, and identify where in the manuscript the change occurs (provided a change is made). This approach not only helps students clarify their thinking but also addresses the unequal power relationship between student-writers and faculty-readers by giving students a voice in this relationship. By providing detailed explanations of how they revised their papers in response to all readers' comments, students are making the writing choices visible to faculty, who can then better guide students' development as writers.

Guidelines for faculty: Responding to student writing. Since STEM faculty often have little experience with writing pedagogy, BioTAP offers advice about how to give efficient and effective feedback on students' drafts. The guiding principle is that faculty can best help their students improve as writers by adopting practices that keep the writing choices in students' hands (Brannon and Knoblauch 1982). Students' development as writers is greatly enhanced when they have a chance to rethink their writing in response to reader feedback (Straub 1996).

BioTAP's rubrics help faculty focus and categorize their comments in a manner that is coherent to students, who tend to read marginal comments as if all were equally problematic. Faculty members are encouraged to avoid large-scale editing or rewriting of students' drafts, as these practices are usually pedagogically inefficient. When faculty rewrite large parts of a student's text, the end result is usually a better draft, but this time-consuming practice often does little to help students learn to edit their own writing (Neman 1995). Editing by faculty implies that changes are necessary, but makes it difficult for students to consider alternatives, especially if the student doesn't understand what those changes accomplished.

BioTAP also encourages faculty to give "reader-based" feedback, that is, make comments on drafts from the perspective of a member of the target audience rather than as an editor or grader (Elbow 1998). Such feedback might include asking questions ("What do you mean by...," "Did you consider...," "Why do you think your results showed...?"), or making reader-based comments ("I don't know why you are raising this point," "I thought you were explaining X, but it seems you're doing something else now," "I'd like more details about..."). Additional guidelines can be downloaded from our Web site.

Additionally, BioTAP recommends that on final drafts, faculty write only as much as needed to justify the final grade or honors determination, with no more than an additional paragraph or two giving their overall sense of the work. The bulk of faculty comments should already have been made on earlier drafts, where such comments can be effective. Even if students take the time to seriously consider marginal comments on final drafts—and there is some evidence that they do not (Ziv 1984, Neman 1995)—the amount of learning that usually occurs is so minimal that it does not warrant the time that faculty spend writing them. Students can be encouraged to make appointments with faculty if they would like more detailed feedback.

Ideally, students will have more than one reader for their theses. Having multiple readers helps to avoid the unproductive dynamic of students tailoring their writing to their advisers' particular preferences, and creates a situation in which students must make choices between competing comments and suggestions. It is not always practical to have multiple reviewers, however, which is all the more reason faculty should explain needed revisions on a conceptual or rhetorical level rather than simply rewrite texts for students.

Timeline for drafting and revision. Given the relatively unstructured environment of faculty-mentored research, an explicit timeline for drafting, feedback, and revision offers a number of benefits. First, because procrastination is one of the greatest impediments to high-quality writing, BioTAP directs students to meet with faculty advisers early in the process to discuss expectations for the writing and to work out the logistics for exchanging drafts, and to begin writing as soon as possible.

Second, students need regular guidance on their writing as part of their mentoring. BioTAP's timeline imposes periodic deadlines for both students and faculty; this ensures that faculty members have adequate time for commenting on drafts, and that students have sufficient time to undertake serious revisions. While students are not expected to have polished drafts at the early stages, they are expected to make their drafts coherent enough that faculty can respond effectively without wasting time trying to decipher sloppy prose. In turn, faculty are asked to return their comments on drafts within a specified time frame (usually one or two weeks) so that students will have time to consider their comments seriously while preparing the next draft. Giving students adequate time to respond to these comments makes the time spent giving feedback as pedagogically valuable as possible.

On our Web page, we offer a sample timeline for students writing their theses in one semester; this timeline can be adapted to year-long or quarter-based programs. When adapting this timeline, it is important to ensure that students begin writing early, that faculty give feedback at key points during the writing process rather than mainly near the end, and that students have sufficient time to thoughtfully reflect on those comments and revise.

Thesis-writing courses. One of the most reliable ways to ensure that students meet these deadlines is to offer a course that supports students who are writing their theses. Such courses can guide students through the issues raised by BioTAP, offer opportunities for discussions about various aspects of scientific writing, and facilitate feedback on rough drafts from peers before drafts are sent to faculty. Although thesis-writing courses are an effective way to maximize student learning and promote strong writing, some departments may not be able to offer such courses. Those that can may find it useful to design these courses in consultation with writing pedagogy experts who are familiar with scientific writing practices and conventions. For those departments that cannot, faculty mentors need to be vigilant about adhering to explicit timelines.

Determining the interrater reliability of BioTAP

Because we recognize the importance of ensuring any rubric's reliability, we calculated the interrater reliability (the agreement between scores independently assigned by two raters) of BioTAP's rubric by assessing a sample of undergraduate biology theses. Below we describe our methods and results, and discuss the implications of this study.

Methods. We hired 10 biology graduate students and postdocs to assess honors theses using BioTAP. Since our raters lacked the specialized expertise to assess the accuracy and appropriateness of the research (box 1, questions 10–13), we assessed only the quality of the writing (box 1, questions 1–9).

Each rater completed approximately 10 hours of training in the use of BioTAP prior to the actual assessment. This training included a one-and-a-half-day workshop during which the raters examined excerpts from student writing that illustrated unacceptable, acceptable, and excellent examples of each of the nine writing issues assessed. For the final part of the training, each rater read several sample theses that were not part of our assessment, and assessed them using BioTAP. After each individual assessment was completed, all raters discussed their responses and, as a group, calibrated their scores.

Our assessment consisted of an evaluation of 190 theses completed between 2005 and 2008 by Duke University biology majors. Each thesis was assessed by two independent raters. For each question, raters gave no points if the thesis failed to meet the minimum acceptable standards, one point if the thesis met the minimum standards but not the standards for excellence, and two points if the thesis met the standards of excellence for the item being assessed. Raters were able to add or subtract half a point if the thesis seemed to fit into more than one category. Since BioTAP questions 1–5 reflected higher-order writing issues, we weighted those questions more heavily (i.e., 0 = unacceptable, 2 = acceptable, 4 = excellent), and raters were able to add or subtract one point if the thesis seemed to fit into more than one category. The highest possible score, therefore, was 28.

We determined the overall level of interrater reliability, an indication of the consistency with which different raters assess the same thesis, by calculating Pearson's correlation coefficient (Salvia and Ysseldyke 1998). To determine how consistently our raters identified theses that achieved the department's standards of excellence, we computed the joint probability of agreement and the kappa coefficients to determine the statistical significance of these levels of agreement (Cohen 1960, Landis and Koch 1977).

Results and implications of the study. The Pearson's correlation coefficient for total scores was 0.72 ($p < 0.01$). The joint probability of agreement ranged from 76 percent to 90 percent with kappa values from 0.41 to 0.67 (all $p < 0.01$), indicating moderate to strong agreement between raters for all BioTAP questions that were assessed (table 1). Taken as a whole, these results indicate that BioTAP is sufficiently reliable to be effective not only as a teaching tool but also as an assessment tool.

A limitation of this study is that we were unable to assess the reliability of BioTAP questions 10–13. Given the wide range and high degree of specialization of student research projects, faculty mentors are best qualified to assess the quality of the science. But because it was impractical to ask faculty to participate in the training necessary for this pedagogical research, we did not have two independent raters qualified to address questions 10–13 for each thesis in our sample.

The next step in this research is to assess the effect of using BioTAP on student learning. Anecdotally, many students have reported that using BioTAP has helped them identify

Table 1. Levels of agreement between raters for BioTAP questions 1–9 (n = 190).

BioTAP question	Joint probability of agreement (percentage)	Kappa coefficient	Level of agreement
1. Is the writing appropriate for the target audience?	76	0.47	Moderate
2. Does the thesis make a compelling argument for the significance of the student's research within the context of the current literature?	78	0.47	Moderate
3. Does the thesis clearly articulate the student's research goals?	77	0.41	Moderate
4. Does the thesis skillfully interpret the results?	82	0.55	Moderate
5. Is there a compelling discussion of the implications of findings?	84	0.66	Substantial
6. Is the thesis clearly organized?	87	0.67	Substantial
7. Is the thesis free of writing errors?	90	0.55	Moderate
8. Are the citations presented consistently and professionally throughout the text and in the list of works cited?	82	0.56	Moderate
9. Are the tables and figures clear, effective, and informative?	81	0.61	Substantial

Note: Levels of agreement were determined in accordance with Landis and Koch (1977). All kappa coefficients were statistically significant ($p < 0.01$).

misunderstandings about their research. Others reported that the structured writing process has helped them develop both as scientists and as writers. One study currently under way tests the hypothesis that theses written by students who use BioTAP are more likely to meet departmental standards than those written by students who do not have access to BioTAP. A separate study investigates our assumption that BioTAP can serve as a powerful writing-to-learn tool by helping students sharpen their scientific reasoning skills. Finally, we are working with colleagues in other departments to assess how readily BioTAP can be adapted to other disciplines.

Building a faculty learning community

Because capstone research projects are of broad interest within science departments, adopting a protocol like BioTAP may have the additional benefit of strengthening faculty interest in writing pedagogy, and may help build faculty learning communities. BioTAP, in addition to serving its primary purpose as a guide for undergraduate thesis writers, has catalyzed ongoing conversations about student writing within Duke's biology department, and members of that department are considering the value of adapting BioTAP for courses throughout the major.

Building learning communities often takes time, however, and is typically the result of focused effort. Before creating BioTAP, we hosted a series of focus groups in which faculty could discuss their concerns and expectations regarding student writing. From these conversations we learned that faculty were generally pleased with the quality of scientific mentoring, but not with the quality of the written theses. The faculty also acknowledged that mentoring on writing was substantially unequal: Some faculty spent hours meticulously editing student writing, whereas others offered only perfunctory comments. As is common among scientists, most felt unqualified to teach writing per se, and recognized the need for additional writing support.

Once we understood the faculty's concerns and pedagogical practices, we began the process of helping them to articulate a set of standards and expectations. The first step was to have the eight faculty members who attended our focus groups read and rank several sample theses to see if there was consensus about which were best. Next, we asked faculty to articulate why certain theses were better than others. From these conversations, we wrote an initial set of standards which was then vetted by the whole faculty.

While many faculty members were eager for change, some were skeptical that BioTAP would be any more effective than their previous strategies for working with student writers, and others were concerned about the time it might take to learn a new system for assessing theses. Therefore, we carried out a pilot study from 2006 to 2007 in which faculty use of BioTAP was optional, as was attendance at a one-hour workshop on using BioTAP. At the end of that year, we surveyed students and faculty about their opinions of BioTAP, its usefulness, and its ease of use. We learned that some faculty initially viewed BioTAP primarily as an assessment tool and used it only to grade final drafts. We realized that we had to promote BioTAP as a powerful teaching tool as well, encouraging faculty to use BioTAP to provide feedback on early drafts so that students would have the opportunity to revise. Anecdotal evidence from conversations with students and faculty the following year indicated that faculty use of BioTAP on drafts increased, and that the feedback was helpful to students.

During the pilot study, we also learned that faculty readers tended to focus primarily on the accuracy of content, paying less attention to writing issues. To illustrate this point, 80 percent of theses assessed by faculty readers were given a perfect score on the writing issues (BioTAP questions 1–9), whereas only 14 percent of those theses were given perfect scores by trained raters. When we addressed this discrepancy at a faculty meeting, two problems were identified (after the knowing laughter died down). First, when faculty read only one or two theses a year, they have little frame of reference for evaluation. Second, when faculty felt unsure about their ability to assess writing issues, they tended to give students the benefit of the doubt. To address these concerns, we offered workshops on how to use BioTAP to work with student writers, and we created handouts that illustrate each writing issue in our rubric. The following year (2007–2008), only 23 percent of theses were given a perfect score by faculty readers, which was more in line with the scores by our trained raters. Although faculty can use BioTAP with no formal training, we found that a short workshop improved understanding about writing issues and best practices in working with student writers. Continued support has helped our faculty become more efficient and effective responders to student writing. Their interest in becoming better mentors for student writers is evidenced by the fact that our workshops attract, on average, a dozen participants each time it is offered, and 70 to 80 percent of faculty use BioTAP each year.

Adopting BioTAP in other departments

BioTAP is a tool that can be used in both formative and summative assessment, with benefits for students, faculty, and departments. BioTAP is carefully written to facilitate reliable assessment, and it is based on sound writing pedagogy. However, as the version of BioTAP presented here was tailored to the standards and expectations of one particular biology department, we anticipate that BioTAP will have to be modified to meet the specific needs of different departments. On the basis of our work with several departments that have adopted BioTAP, we have developed some suggestions to expedite this process.

Those who may want to use BioTAP should carefully consider the matter of validity, that is, whether BioTAP questions are applicable in contexts other than the one for which they were designed (Rafilson 1991). Since faculty in different departments or institutional contexts may have different priorities for student research products, any rubric should be tested to ensure a reasonable local fit. For example, some departments might prefer undergraduate theses to resemble short master's theses, whereas others might prefer theses to approximate a journal article. Such differences would need to be reflected in the rubric. That said, we believe that BioTAP can be effectively adapted to many STEM contexts, given both the wide range of issues it addresses and the detailed nature of each rubric element.

For faculty to buy into the practice of using BioTAP, it is essential for faculty within departments to identify the problems they perceive with their thesis writers, and to articulate the learning outcomes they value most. BioTAP can be used to facilitate these conversations. Departments considering adopting BioTAP should also recognize that change often occurs slowly, and that faculty may want to try BioTAP before committing to its use.

Finally, although BioTAP is flexible enough to be adapted to the needs of different departments, we urge caution when making changes. The categories and wording have been tested and refined, and for this reason we recommend that changes be carefully considered, perhaps in collaboration with institutional writing centers. Just as with any good piece of writing, the investment of time in the process produces a stronger end product.

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