Preparing Undergraduates for Research Careers: Using Astrobites in the Classroom

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Abstract

Because undergraduate participation in research is a longstanding and increasingly important aspect of the career path for future scientists, students can benefit from additional resources to introduce them to the culture and process of research. We suggest the adoption of the web resource Astrobites as a classroom tool to increase the preparation of undergraduate physics and astronomy students for careers in research. We describe the content and development of the website, discuss previous university courses that have made use of Astrobites, and suggest additional strategies for using Astrobites in the classroom.

Keywords: College majors, Graduate study, General, Teaching Approaches, Web-based Learning

1. Introduction

Research experience is a vital aspect of undergraduate education in the physical sciences, as well as an increasingly-critical qualification for graduate admissions (Crowe and Brakke 2008, Russell et al. 2007, DeHaan 2005, Wilkerson 2007). However, many developmental barriers stand in the way of undergraduate students’ successful participation in research, even for those with strong conceptual and technical backgrounds from coursework. Comprehension of the specialized jargon and idioms of the field, understanding of research practices and technical methods, and familiarity with the technical literature are useful knowledge that students new to research lack. The challenge of obtaining this background can be particularly intimidating to undergraduates working with more senior researchers who acquired a more complete command of these faculties through a decade or more of undergraduate, graduate, and post-doctoral study.

Immersion in scientific discourse through activities such as seminar attendance and interaction with senior researchers has been a leading pathway for undergraduates to attain literacy in research, similar to the widely-applied philosophy for education in foreign language (Johnson and Swain 1997). However, the time available for such direct interaction is necessarily limited, and can vary substantially depending on the size and structure of the host department at the student’s institution. To supplement these important real-world interactions, virtual tools can be used to increase student immersion (Price 2007, Chang et al. 2012).

In this commentary, we suggest the use of the web resource Astrobites as a learning tool for undergraduate astronomy courses. We describe the content and goals of the Astrobites website and its authorship, discuss previous uses of Astrobites in formal academic settings, and suggest novel applications of its content to prepare undergraduates for careers in research.
2. Describing Astrobites

The Astrobites website (http://astrobites.com), founded in December 2010, is an online “reader’s digest” for the astrophysics preprint server astro-ph.1 As illustrated in Figure 1, the website publishes succinct (~4–7 paragraph) summaries of the methods, results, conclusions, and context of new research papers in astrophysics posted to astro-ph. The summaries are designed for undergraduates who have taken coursework in the physical sciences. Knowledge of basic physical concepts (e.g. energy conservation or blackbody radiation) is assumed, but relevant terminology and research methods are defined and links are provided to detailed references. Astrobites articles incorporate figures from the original sources, guiding readers through the visual presentation of key results from the paper. About 400 of these summaries have been posted to date, with a current publication rate of one per day. Astrobites also publishes pieces with career advice for young researchers, notices of professional opportunities available to undergraduate students (such as Research Experiences for Undergraduates, REU, programs), and other supplementary content at a rate of twice per week.

Astrobites was created and is developed and maintained by graduate students in astrophysical sciences from the United States and Europe (including the authors of this commentary). A regular “rotation” of about 30 authors each year ensures that the articles are fresh and contemporary. All Astrobites authors contribute on an unpaid basis and the website is presented without advertising and entirely as a not-for-profit enterprise.

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1 astro-ph is the Astrophysics section of the arXiv, http://arxiv.org/archive/astro-ph
2 The full Astrobites authorship is listed at http://astrobites.com/meet-the-authors/
summaries, but are also aware of the level of familiarity to expect from the undergraduate target audience, and 2) the graduate students benefit from the pedagogical exercise of summarizing research papers into an accessible format.

*Astrobites* currently receives about 300 regular readers per day, as measured by returning visitors tracked by Google Analytics. In addition, an informal September 2011 reader survey (for which there were 125 respondents) indicated that 2/3 of our readers do not visit our website, but instead subscribe to our RSS feed. The survey also showed that 20% of the respondents were undergraduate students. The remainder of the readership is approximately evenly divided between graduate students in astronomy, researchers who have already earned the PhD, and non-professional astronomy “enthusiasts.” We therefore estimate that *Astrobites*’ daily readership already includes >150 students in our target demographic of undergraduates in a physical science field. In the same reader survey, >80% of undergraduate respondents listed their career goal as “researcher” in astrophysics or a related field.

### 3. Astrobites in the Classroom

#### 3.1 Past uses of Astrobites

To assess the usage of *Astrobites* in undergraduate classrooms to date, we performed a survey targeted at both students and educators in our readership that have used *Astrobites* in the classroom. We received responses from 4 students and 6 educators indicating that they had used *Astrobites* in a class. From among these responses, we present two anecdotes regarding the use of Astrobites in undergraduate classrooms:

1. **Astronomy 20, “Basic Astronomy & the Galaxy”**
   California Institute of Technology, Fall 2012, Prof. John Johnson

   In this inquiry-based introductory astronomy course, students were instructed to maintain their own blogs. Students used the blogs to record problem-solving techniques learned in the class, as well as to produce original content including interviews with astronomers and summaries of modern research topics. *Astrobites* was presented to the students as a model for a blog of this type.

2. **Astronomy 61, “Current Problems in Astronomy and Astrophysics”**
   Swarthmore College, Spring 2012, Prof. Eric Jensen

   In this journal-club-style discussion course for advanced undergraduates, students were responsible for selecting and summarizing research papers for the week’s seminar on a rotating basis. *Astrobites* was offered to students as a resource for selecting interesting papers and as a source for background information and context.

These anecdotes illustrate a subset of the possibilities for incorporating Astrobites into formal educational settings to increase student engagement outside the classroom.

#### 3.2 Suggested uses of Astrobites

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To supplement the existing examples of *Astrobites* usage in the classroom described in
the previous section, here we present suggestions for novel applications of *Astrobites* in
undergraduate curricula.

1. **Reading assignments:** Students are asked to read *Astrobites* throughout the semester,
to increase immersion in astronomy outside the classroom and to reinforce concepts
learned in lectures. *Astrobites* would therefore be used in a manner similar to web-
based multimedia learning modules as pre-lecture assignments to supplement
textbook materials (Stelzer et al. 2009, Sadaghiani 2012). Student participation could
be evaluated during in-class discussions of current research, or by asking students
to formulate follow-up questions based on the reading. These questions could be
submitted for class discussion, or could be posted directly on the *Astrobites* website (see
4 below).

2. **Written summaries:** Students are asked to write their own summaries of research
papers in astronomy, modeled on the format of *Astrobites*. These research summaries
could be assigned periodically throughout the semester, or as a single term project
where the students are asked to review several topical papers. The *Astrobites* website
provides a convenient archive of brief, informative, and accessible summaries of
recent research in astrophysics and can therefore serve as a resource to help students
identify specific studies or topics that have methodology and results that interest
them. This obviates the need for students to become sufficiently expert in the full
range of astrophysics research to select a recent paper from a general bibliography of
publications. If student writing is posted online, in a blog format, it may facilitate peer
discussion and encourage students to make high-order connections between scientific
topics discussed in the classroom and research methods (Daniels 2010).

3. **In-class presentations:** Students are asked to describe a research paper in
astrophysics to their peers via an in-class presentation. As in #2 above, the *Astrobites*
website provides an archive of summaries which students can use to select interesting
papers or topics. Moreover, if students plan to present on a paper that was already
discussed on *Astrobites*, their classmates can read the *Astrobites* summary to rapidly
familiarize themselves with the subject matter so they may come prepared to start a
discussion. In this way, students can engage in a collaborative argumentation learning
environment where they can debate the merits of the scientific ideas presented in the
papers, as well as the assumptions that the ideas rely on (Bell and Linn 2000).

4. **Discussion forum:** Students are asked to use the commenting feature of the *Astrobites*
website to hold a discussion forum on a given research topic. By holding this discussion
on the website rather than in the classroom, students have the opportunity to formulate
their responses after doing background research into the topics as necessary and to
cite relevant materials. Furthermore, because *Astrobites* authors and researchers from
throughout the world (including, often, the authors of the paper in discussion) read
*Astrobites*, the discussion may broaden to include a wide range of perspectives and
expertise. Comments from readers at all levels of instruction would be welcome on the
*Astrobites* website.

4. **Conclusions**

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5 Examples of *Astrobites* articles with reader discussions can be found at the following links:

 http://astrobites.com/2011/07/13/cold-flows-and-the-first-quasars/
 http://astrobites.com/2011/04/24/inelastic-dark-matter-ruled-out/
In this commentary, we have presented Astrobites as a web resource that can be integrated into formal classroom education to improve undergraduate preparation for careers in research. We have described previous applications of Astrobites to the undergraduate curriculum and suggested novel uses for the website in future curricula.

In the sense that Astrobites is written by and for students in astronomy, and because many of the strategies we have suggested involve classroom discussions and peer-teaching, the usage of Astrobites in the classroom is a form of peer-assisted learning (see e.g. Parkinson 2009). If the adoption of Astrobites as a mechanism for this type of instruction becomes more widespread, it could facilitate the use of statistically-validated studies on the educational impact of Astrobites or other web-based pedagogy tools in the classroom.

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