

Feature From the National Science Foundation

Vision and Change in the Biology Community: Snapshots of Change

Helen L. Vasaly, Jason Feser,* Matthew D. Lettrich, Kevin Correa,[†] and Katherine J. Denniston

National Science Foundation, Arlington, VA 22230

INTRODUCTION

When we were first invited to write these columns, the editors felt it would be an interesting way to give the readers of *CBE—Life Sciences Education* an agency's-eye view of its concerns, workings, and accomplishments. This column is written with that charge in mind. It is intended to inform the community about our outreach efforts, some of the mechanisms used, and the effectiveness of these efforts.

In 2007, the National Science Foundation (NSF), the American Association for the Advancement of Science (AAAS), the Howard Hughes Medical Institute (HHMI), and the National Institutes of Health (NIH) launched an initiative called Vision and Change in Undergraduate Biology Education (V&C), designed to enable the biology community to address the challenges of preparing undergraduates for 21st-century biology using 21st-century findings about effective teaching strategies. Over the next 2 yr, with support from the partners listed above, the community engaged in “conversations” among faculty, administrators, students, and professional societies through a series of workshops (<http://visionandchange.org/files/2010/03/VC-Preliminary-Reports-from-Conversations1.pdf>).

Those conversations culminated in a working conference in 2009, in which more than 500 faculty, administrators, and students pooled their collective wisdom (visionandchange.org/about). The tangible result from all this effort, *Vision and Change in Undergraduate Biology Education: A Call to Action*

DOI: 10.1187/cbe.13-12-0234

Address correspondence to: Helen L. Vasaly (hvasaly@nsf.gov). Present addresses: *Office of Naval Research, Arlington, VA 22217; [†]University of California, Riverside, Riverside, CA 92521.

© 2014 H. L. Vasaly *et al.* *CBE—Life Sciences Education* © 2014 The American Society for Cell Biology. This article is distributed by The American Society for Cell Biology under license from the author(s). It is available to the public under an Attribution-Noncommercial-Share Alike 3.0 Unported Creative Commons License (<http://creativecommons.org/licenses/by-nc-sa/3.0/>).

“ASCB®” and “The American Society for Cell Biology®” are registered trademarks of The American Society for Cell Biology.

(<http://visionandchange.org/files/2011/03/Revised-Vision-and-Change-Final-Report.pdf>), is a document setting forth their vision of the approaches needed to ensure undergraduate biology education truly reflects the biology of the 21st century in both the content included and the competencies developed and the delivery reflects what is known about effective teaching practices. Its message is summarized in four action statements “aimed at ensuring that the vision of the conference becomes an agenda for change” (Vision and Change Final Report; <http://visionandchange.org/files/2011/03/Revised-Vision-and-Change-Final-Report.pdf>):

- Integrate core concepts and competencies throughout the curriculum
- Focus on student-centered learning
- Promote a campus-wide commitment to change
- Engage the biology community in the implementation of change

Since the release of the report, many organizations, including those listed above, the U.S. Department of Agriculture, the National Research Council, and a number of professional societies have led efforts to disseminate the document and engage the biology community in efforts to implement the actions outlined in it. These efforts have recently been enhanced by such initiatives as the Partnership for Undergraduate Life Sciences Education (PULSE; www.pulsecommunity.org) and CourseSource (<http://coursesourcejournal.wordpress.com>), both designed with the specific aim of disseminating the ideas presented in V&C and catalyzing their widespread implementation.^{1,2} In addition, a second V&C conference, *Vision and Change*:

¹PULSE is a joint effort by the NSF, NIH/National Institute of General Medical Sciences, and HHMI to stimulate systemic changes within biology departments at all types of postsecondary educational institutions.

²CourseSource is a journal of peer-reviewed biology education materials using evidence-based pedagogy.

Table 1. Analysis of the frequency of V&C citations in TUES biology-related proposals from 2009–2013^a

TUES date of proposal submission	Number of proposals submitted	Number of proposals citing V&C	Percent of proposals citing V&C
2009, May type 1	108	1	0.93
2010, May type 1	98	14	15.3
2011, May type 1	79	27	34.2
2012, May type 1	98	44	44.9
2010, January types 2 and 3	17	2	11.76
2011, January types 2 and 3	28	16	57.1
2012, January types 2 and 3	18	12	66.7
2013, January types 2 and 3	32	19	59.4

^aData from the NSF report server.

Chronicling the Change, was held in August 2013 to document and encourage adoption of the key ideas at the departmental and institutional levels.

How successful have these efforts been? Six years after those initial conversations, it is important to try to determine the extent of dissemination and implementation of V&C, not only to determine the challenges ahead and possible next steps, but also to begin to establish mechanisms for effective response when a science experiences the sort of rapid evolution in approach, resources, and focus that has occurred recently in biology.

Finding interesting and informative anecdotes concerning individual efforts is relatively easy; documenting adoption on a more universal scale within the discipline is a much more formidable challenge. This paper summarizes the results of efforts to systematically analyze the impact of V&C by examining the references and ideas presented in proposals submitted to various programs within the NSF, documenting use of V&C in the community through Web data analytics, and investigating the presentation and discussion of V&C at professional society events. It also includes initial findings reported at the August 2013 conference. We hope both to inform the reader and to inspire reflection within the readership about effective means of determining the outcomes of efforts such as V&C that aim to meet the broad general needs of a science, technology, engineering, and mathematics (STEM) community.

For example, preliminary evidence, gleaned from analysis of biology education-related proposals submitted to a number of NSF programs, indicates that although there is good evidence of use by some segments of the biology community, there is less use of V&C principles or even acknowledgment of its existence within other segments (see tables and figures). This suggests the need to develop dissemination efforts that resonate well with these communities.

EVIDENCE WITHIN NSF

The Transforming Undergraduate Education in STEM (TUES) Program, a program offered from 2010 to 2013, sought to improve the quality of STEM education for all undergraduate students (www.nsf.gov/pubs/2010/nsf10544/nsf10544.pdf). TUES included both pilot projects (TUES type 1) and those with a more global reach at the departmental, institutional, or national level (TUES types 2 and 3). This program was a natural home for those seeking support for V&C-

related projects. Therefore, biology-related TUES proposals from 2009 (the year of the first V&C meeting) to 2013 were examined with two goals in mind: 1) to ascertain the growth of community awareness of the V&C initiative and 2) to determine the number of proposals whose project design and implementation reflected the recommendations of V&C.

To determine the growth of community awareness of V&C, we examined proposals and documented the number that cited V&C at least once within the proposal (Table 1). The data in Table 1 show that < 1% of the proposals submitted to the TUES type 1 track in 2009 included a reference to V&C. In each subsequent year, the percentage of proposals including a reference to V&C increased dramatically, indicating increasing knowledge of the existence of V&C by TUES submitters (faculty in a variety of fields of biology and from a variety of institutions). The trend is similar for all types of TUES proposals, ranging from pilot project submissions (type 1) to proposals with a wider range of influence (types 2 and 3).

The increasing frequency of citations in TUES proposals over time suggests that V&C is recognized as a significant report to be cited as part of the required literature base for proposals to the program, but it does not reveal the extent to which the recommendations of V&C were drivers of project design. To study the influence of V&C on the design of the TUES projects, we examined the language used in the proposals. It was determined that the terms *core competencies*, *student-centered*, and *core concept* correlated with the use of the recommendations of V&C in the design of the project. Any proposal that used two or more of these terms was scored as having a V&C-influenced design (Figure 1).

The data in Figure 1 suggest that the V&C report is not only an important element of the literature base for proposals seeking to improve undergraduate biology education, it is increasingly the foundation for the design of those projects. While this is a preliminary analysis, it is encouraging that V&C is having an increasing impact among the community of biology educators who seek external funding from NSF to improve undergraduate biology education at their home institutions.

We next examined the impact of V&C on other NSF programs that receive biology-specific proposals for education projects. The data show that not all undergraduate education programs see the same integration of V&C principles and suggest that action is needed to disseminate the recommendations more effectively. For instance, in the Advanced Technological Education Program biology proposals, the percentage of references to V&C increased from 0 to ~9% between

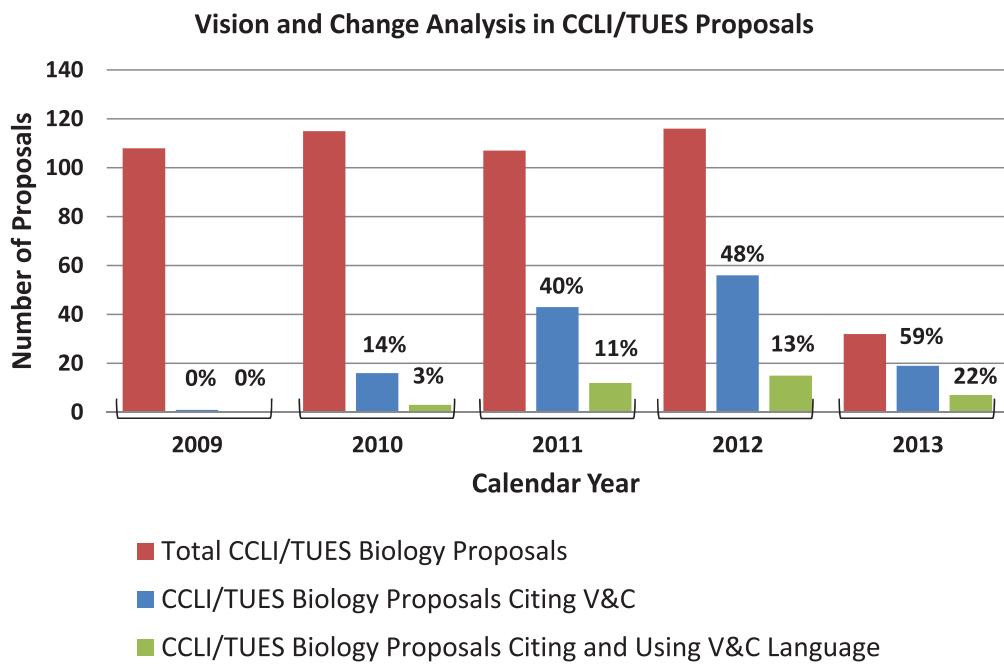


Figure 1. Biology-specific proposals submitted to the Course, Curriculum, and Laboratory Improvement/TUES Program in the years 2009–2013, using only those submitted post–February 2009 (the date of the V&C meeting), were analyzed for V&C citations and for evidence that the design of the program reflected principles within V&C. The proposal numbers are aggregates of type 1 and type 2/3 submissions and are grouped according to the calendar year in which they were submitted. The percentages listed above the bars reflect percentage of the total number of proposals analyzed in that year. The low proposal number in 2013 reflects the fact there was no TUES 1 competition in that year. Data from the NSF report server.

2009 and 2012 (Table 2). This program is primarily focused on training technicians in community colleges. It suggests that the V&C initiative has not been as successful in engaging faculty in the 2-yr schools as it has been in other institutions of higher education. Among the biology proposals submitted to

the Tribal Colleges and Universities Program (T-CUP) and the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), there is only one proposal that references V&C. T-CUP and HBCU-UP programs are designed to improve STEM education and preparation of undergraduate

Table 2. Analysis of the frequency of V&C citations from 2008–2012 in proposals submitted to several NSF programs^a

Date of proposal submission	Number of proposals sampled	Number of proposals citing V&C	Percent of proposals citing V&C
ATE, biology-identified proposals^b			
2009	23	0	0.0
2010	36	1	2.8
2011	22	2	9.1
T-CUP			
2009	7	0	0.0
2010	15	0	0.0
2011	15	0	0.0
HBCU-UP			
2009	3	0	0.0
2010	26	1	3.8
2011	45	0	0.0
CAREER biology awards			
2008	83	0	0.0
2009	55	1	1.8
2010	46	0	0.0
2011	66	4	6.1
2012	44	3	6.8

^aData from the NSF report server.

^bBiology-focused proposals that have been submitted to the ATE program.

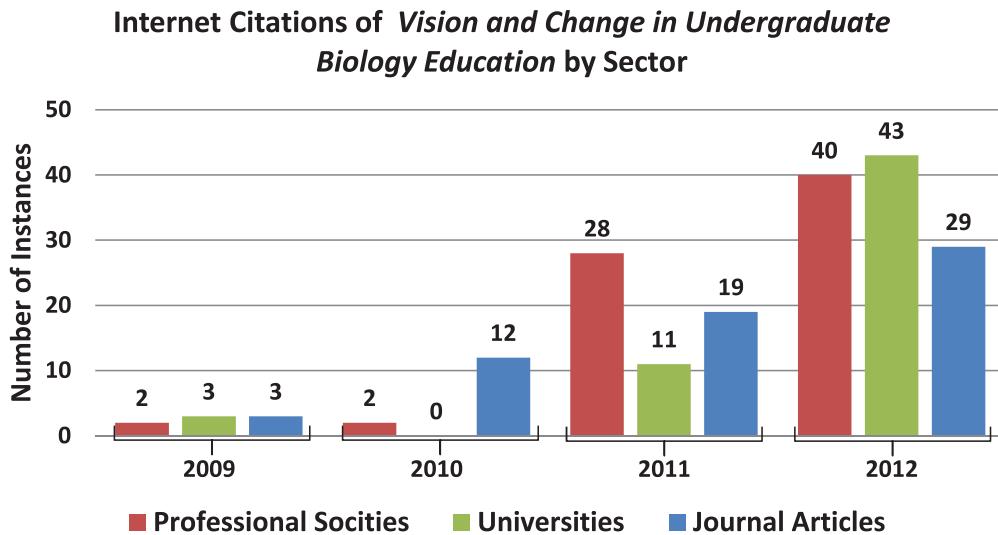


Figure 2. Analysis of the frequency of V&C citations from 2009 to 2012 on the Internet.

students in these minority-serving institutions, suggesting that V&C outreach to faculty in these institutions needs to be more vigorous.

The increase in V&C citations in the biology proposals to the Faculty Early Career Development (CAREER) Program has been modest, rising from ~2% in 2009 to nearly 7% in 2012 (Table 2). Because this program supports junior faculty who “exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations,” greater awareness of V&C would have been expected (CAREER Solicitation; www.nsf.gov/pubs/2014/nsf14532/nsf14532.htm).

EVIDENCE IN THE COMMUNITY

Looking beyond NSF, changes in biology community awareness of V&C were examined by analyzing Web data referencing V&C. From October 2011 to September 2012, each instance of “Vision and Change in Undergraduate Biology Education” on the Web was catalogued through the use of Web search engines. Data regarding the host of the material, the date posted, and the type of data were recorded to develop a broader understanding of V&C in the academic community as manifested online.

While generating a snapshot over time, the heterogeneity of the data, while intriguing, made it difficult to assess in a comprehensible way. Consequently, we chose to examine the instances of V&C that occurred in journal articles, in postings by universities and colleges, and in postings by professional societies, as for faculty these have clear associations and meaning for the discipline. The data were restricted to instances in which clear identification of the date posted and the identity of the host were possible, greatly reducing the sample sizes (Figure 2).

The data show increasing numbers of Internet citations in the period 2009–2012 (Figure 2). This trend mirrors the observations from the proposal investigations and further suggests there is increasing awareness and penetration of the

V&C report within the academic community. Furthermore, as professional societies have integral roles in the discipline, detailed agendas of recent and future annual meetings were analyzed. Of the 40 societies examined, 23 provided information regarding V&C, while 11 had V&C-related talks at their annual meeting.

The AAAS was excluded from the collection of professional society data, because it hosts the official V&C website (www.visionandchange.org). However, the increased usage of that site is also an indicator of the community’s responsiveness to the V&C initiative. Since its inception in July 2010, the site has had 36,302 visitors, with average visitors per month increasing each year from 334 visits per month in 2010 to 1338 visits per month in 2013. Of these, 65% were new visitors and 35% were repeat visitors. It is interesting to note that 80% of the visits were from individuals typing “vision and change” into the Web browser or searching with a search engine. This suggests that these visitors were familiar with the report and were seeking additional information. Ten percent of the visits were referred by other websites, including AAAS, the American Society for Microbiology, the American Institute of Biological Sciences, *CBE—Life Sciences Education*, and the American Society of Plant Biologists.

CHRONICLING THE CHANGE

In August 2013, AAAS hosted Vision and Change in Undergraduate Biology: Chronicling the Change, Inspiring the Future (<http://visionandchange.org/about-v-c-chronicling-the-changes>), a working meeting that drew more than 350 faculty members and administrators, as well as professional society representatives. Like the first meeting in 2009, this meeting had specific goals, including sharing innovative strategies, identifying common challenges, understanding the role of leadership in driving change in undergraduate biology education, and strengthening collaborative networks. The posters submitted included a range of actions from

individual classroom efforts to department-wide initiatives. Evidence of university and community college system-wide collaborative change and of the development of communities of practice through professional societies suggests that V&C is having a significant impact on undergraduate biology education. A report synthesizing what has been learned, strategies found to be successful, and needed next steps will be released in Spring of 2014.

Additional evidence of the penetration of V&C is the establishment of a variety of resources by the supporting agencies. Organizations such as PULSE, *CourseSource*, and many biology professional societies are providing a wealth of resources, communities of practice, and professional development opportunities to support faculty in their efforts to implement the curricular changes recommended in V&C. Notable among these initiatives is the PULSE community website, which currently serves nearly 1200 members. The community continues to expand the variety of resources available to faculty, departments, and institutions striving to implement the V&C recommendations.

Supporting V&C has been an interesting effort for the agencies involved as we try to help the community respond to what they and we see as both a unique opportunity and an interesting challenge—the need to respond to the changes in a science that is constantly finding new directions and resources—while at the same time learning to utilize the resources provided by current knowledge about how people learn. It is rather amazing that we have worked together

on these issues for almost 8 yr, and you, the community of biology educators, have kept us going. We have been informed, inspired, and energized by the community response to our calls for action.

Our efforts to catalogue changes made are just beginning, but seem to have made progress. We depend on you for suggestions for mechanisms we can use to get a sense of community actions. Information about individual faculty, institutions, or professional societies is not always easy to catalogue, but this information is simple compared with getting a sense of the community as a whole. We hope this article triggers ideas from the community as to how to capture the larger picture. Armed with this accumulated knowledge, each segment of the community can move forward with a clearer understanding of the next steps necessary and the mechanisms to use to transform undergraduate biology education and prepare students for the 21st century. We hope that this article will spark ideas we can use to further chronicle the changes. Send your reactions and ideas to us at kdennist@nsf.gov or hvasaly@nsf.gov. Thank you!

ACKNOWLEDGMENTS

We thank Terry Woodin and Cynthia Bauerle for assistance and for comments on the manuscript. We thank Sarah Elgin for her insightful and quick editing.