The Influence of *Bio2010:* Results from a Survey

In 2003, the National Research Council (NRC) published *Bio2010: Transforming Undergraduate Education for Future Research Biologists*,[1] which outlines a strategy to improve the quantitative skills and math, chemistry, and physics comprehension of undergraduate biology students preparing for biomedical careers. The report also encourages faculty to implement teaching strategies that prepare future research biologists to become more engaged in their own learning and that promote the skills required for problem solving in an interdisciplinary world. *Bio2010* advises academic institutions to evaluate and revise courses and programs, providing eight major recommendations along with case studies, pedagogical resources, and model curricula for undergraduate biology.

There has been considerable reaction to the publication in the biology education community. Many of those seeking to reform undergraduate science education welcomed the report and felt that the pedagogical recommendations in *Bio2010* are positive and need to be implemented. However, a number of the report's content-specific recommendations have generated debate within the community.

The report was originally commissioned by Howard Hughes Medical Institute (HHMI) and the National Institutes of Health to make recommendations for the undergraduate education of future biomedical researchers,[2] but the final title of the report indicates that it is for "future research biologists." In summer 2003, concerns were raised about the report's proposed "new biology curriculum" and how this curriculum neglects fields of biology above the molecular and cell level.[3,4] These concerns were also discussed during sessions at national meetings of the Council on Undergraduate Research and the Ecological Society of America. Bruce Alberts, President of the National Academy of Sciences, recognized there was a misunderstanding about the intent of the report's recommendations and wrote a letter to the community.[5]

The *Bio2010* Survey

To gather information about the influence of the *Bio2010* report, education staff from the American Institute of Biological Sciences (AIBS) and Ecological Society of America (ESA), along with representatives from the AIBS, ESA, and Botanical Society of America (BSA) education committees, conducted a survey. The societies wanted to learn how *Bio2010* was influencing pedagogy and content in undergraduate biology curricula and whether recommendations from the report were on target to transform undergraduate education for future research biologists.

The survey contained 12 questions. The first 4 questions collected demographic information about the respondents:

1. What is your position title (e.g., professor, associate professor, assistant professor, lecturer, graduate teaching assistant, dean, administrator)?
2. What is the name of the department(s) in which you teach?
3. Choose your institution type (from the Carnegie Classification[6]).

4. List the courses you teach by name and level. Please place an asterisk (*) by any courses that are general education courses.

The next 6 questions asked for Yes/No responses to a series of questions about the influence of the *Bio2010* report and provided text boxes for additional explanations:

5. Prior to reading the introductory paragraph, had you heard about the NRC's report "*Bio2010: Transforming Undergraduate Education for Future Research Biologists*"? If your answer is No, you may stop here.
6. To date, has the *Bio2010* report influenced the way that courses are taught by you or by others in your department or at your institution? Please explain.
7. If your answer to Question 6 is No, do you or does your department or institution plan to implement changes to your teaching as recommended by this report sometime in the future? Please explain. (If your answer to Question 6 is Yes, please go to the next question.)
8. Are the report's pedagogical recommendations being implemented? Please explain.
9. To date, has the *Bio2010* report influenced course curricula, the structure or content of required courses for majors, or course offerings in general in your general department or institution? Please explain.
10. If your answer to Question 9 is No, does your department or institution plan to implement changes to your teaching as recommended by this report sometime in the future? Please explain. (If your answer to Question 9 is Yes, please go to the next question.)

The final 2 questions were:

11. Do you have any other comments about the *Bio2010* report?
12. If you are willing to allow us to contact you for additional information, please provide your name, e-mail address, and telephone number. This information will NOT be included in any reports about this survey.

The survey went online on the AIBS website in September 2004, two years after the release of *Bio2010*. It was publicized to the following groups and organizations via email: AIBS Education Committee, AIBS Education Report, ESA, BSA, Council for Undergraduate Research, Disciplinary Society and Education Association Alliance, Don Kennedy at *Science*, National Science Foundation, HHMI Summer Institute 2003 and 2004 participants, National Association of Biology Teachers' 2-year and 4-year college sections, Society for Integrative and Comparative Biology, American Society for Microbiology, National Association of Research in Science Teaching, Association of College Undergraduate Biology Educators, and Faculty Institutes for Reforming Science Teaching. All were encouraged to forward information about the survey to other relevant groups and individuals.

Analysis

The demographic responses were read through and quantified, and the statistics for the Yes/No questions regarding the influence of the report were calculated. The open-ended responses were analyzed by Susan Musante at AIBS, Jason Taylor of ESA, and Ian Ramjohn at University of Oklahoma.

Responses were analyzed to test the following hypothesis: *The Bio2010 report has influenced both the pedagogy and content of undergraduate biology. Its recommendations are on target to transform undergraduate education for future research biologists.*

The following questions were used to focus the analysis:

1. Has the *Bio2010* report been implemented at institutions across the country? If it has, at what types of institutions and what has the impact been?
2. Are there significant concerns about the lack of attention towards other biology disciplines (ecology, organismal biology, etc.)? How was the biomedical content focus of the report viewed within the community?
3. What have been the pedagogical results?

Because individuals responded to questions 5 through 9 in different text boxes, often either repeating themselves, responding to all questions in one text box, or referring to a previous open-ended response, each individual's text comments were treated as a single response (i.e., open-ended text responses from questions 5 through 9 were read as a single response from that individual). First, each individual's text responses were read to identify words or phrases describing the ways *Bio2010* had influenced them, their department or institution, or their thoughts about the report. This initial content analysis revealed (1) ways in which the report influenced individuals/institutions and (2) comments/thoughts about the report. From this information the most common themes were identified.

Results

By the time the online survey was closed at the end of October, 25 months after the original release of the report, 344 individuals responded to the survey and 342 completed all of the required questions. Thirty-one respondents are administrators, 135 teach an introductory biology course, and 157 teach general education courses. Ninety-eight respondents provided an e-mail address and/or phone number indicating they are willing to be contacted in the future for additional information.

The respondents are from a variety of institutions:

Institution	Count	Percent
1. Doctoral/Research University--Extensive (> 50 doctoral degrees per year across at least 15 disciplines)	111	32.46
2. Doctoral/Research University--Intensive (10-20 doctoral degrees per year)	35	10.23
3. Master's Colleges and Universities I (> 40 master's degrees per year across > three disciplines)	58	16.96
4. Master's Colleges and Universities II (20 master's degrees	35	10.23

per year)		
5. Baccalaureate Colleges--Liberal Arts (half of baccalaureate degrees are in the liberal arts)	73	21.35
6. Baccalaureate Colleges--General (< half in liberal arts)	14	4.09
7. Baccalaureate/Associate's Colleges (majority of degrees are below the baccalaureate, 10% bachelor's degrees)	3	0.88
8. Associate's Colleges--Community, Junior, and Technical Colleges	12	3.51
9. Other	1	0.29
Total	342	100.00

Approximately one-half of those responding to the survey heard of the report prior to receiving the survey.

Question 5	**Count**	**Percent**
1. Yes	169	49.42
2. No	173	50.58
Total	342	100.00

Eighty-three, or 24% of all respondents (*n* = 342), reported that *Bio2010* has influenced the way that courses are taught by themselves or by others in their department or institution.

Question 6	**Count**	**Percent**
1. Yes	83	37.39
2. No	139	62.61
Total	222	100.00

Of those who said the report has not influenced teaching at their institution, 42 said that there are future plans to implement changes based upon recommendations in the report.

Question 7	**Count**	**Percent**
1. Yes	42	31.34
2. No	92	68.66
Total	134	100.00

When asked whether the report’s pedagogical recommendations were being implemented, 91 said that they are.

Question 8	**Count**	**Percent**
1. Yes	91	48.15
2. No	98	51.85
Total	189	100.00

Sixty-four, or 18.7% of all respondents (*n* = 342), reported that *Bio2010* has influenced course curricula, the structure or content of required courses for majors, or course offerings in general in their general department or institution.

Question 9	Count	Percent
1. Yes	64	31.53
2. No	139	68.47
Total	203	100.00

An additional 38 respondents stated that their department or institution plans to implement changes to teaching as recommended by the report sometime in the future.

Question 10	Count	Percent
1. Yes	38	27.94
2. No	98	72.06
Total	136	100.00

Although most respondents reported that their institutions have not implemented curriculum change, 65 individuals said that changes had been implemented. Ramjohn's analysis provided a breakdown of both influence on teaching and curricular changes prompted by the report by institution type.

Institution (Category)	Yes (report had influenced teaching)	No (report had not influenced teaching)	Totals
1. Doctoral--Extensive	30	21	51
2. Doctoral--Intensive	10	7	17
3. Masters I	12	25	37
4. Masters II	8	9	17
5. Bacc.--Liberal Arts	18	19	37
6. Bacc.--General	3	2	5
7. Bacc./Assoc.	1	1	2
8. Assoc.	1	1	2
9. Other	0	1	1
Total	83	86	169

Institution (Category)	Yes (curriculum changes implemented)	No (curriculum changes not implemented)	Totals
1. Doctoral – extensive	26	36	62
2. Doctoral – intensive	8	16	24
3. Masters I	10	31	41
4. Masters II	7	10	17
5. Liberal Arts	12	28	40
6. Bacc. Gen.	2	7	9
7. Bacc./Assoc.	0	2	2
8. Assoc.	0	5	5
9. Other	0	1	1
Total	65	136	201

A content analysis was conducted to identify words and/or phrases that describe the ways in which *Bio2010* had influenced individuals or institutions. The number of individuals who shared this viewpoint or experience is in the right-hand column.

Influence/Comment	**Number of individuals**
Adding/increasing assessment/evaluation	3
Hiring new faculty / reorganized dept	4
Change to a molecular focus	4
Recommends addendum/change of title/misleading title	4
Too focused on training research scientists	9
Need funding and/or time	9
Wrote grant proposal / received funding	9
Not revising curriculum due to narrow focus	10
Adding/increasing student research projects/requirements	10
Catalyst for discussion/change	10
Revising curriculum independent of report	11
Institutional barriers to change	13
Adding student-active learning strategies	16
Report is one of many	16
Provided administrative support/guidelines for change	18
Revising curriculum based upon *Bio2010*	18
New program/course/requirement	23
Missing organismal bio./evolution/ecology/physiology	24
Adding inquiry/experiential/problem-based/investigative labs	29
Increasing quantitative focus/courses	30
Increasing interdisciplinary focus/courses (integrating generally, adding physics or chemistry specifically)	31
Too narrow/biased biomedical/molecular	41
Already doing recommendations	49

Common themes of the open-ended responses were identified, and these common themes can be categorized as follows:

1. Individuals and institutions are implementing *Bio2010* recommendations with
    - New hires and/or reorganization of departments
    - New courses/requirements
    - Increase of interdisciplinary courses
    - Integration of quantitative skills
    - Increase in student research

2. The report is being used as a standard or guideline to
    - Secure support from administration
    - Secure grant funding

3. Many were revising or had already revised curriculum and teaching strategies prior to the report
    - Innovative active-learning strategies already implemented
    - Interdisciplinary courses are standard
    - Report is nothing new, it is one of many with such recommendations
    - Curriculum revision is independent of *Bio2010*

4. Individuals are concerned about the narrow focus of the report for its
    - Lack of an organismal or higher level perspective
    - Overemphasis on biomedical sciences
    - Focus on only training future research scientists rather than biologists

5. The barriers to change are
    - Lack of institutional support
    - Need for funding and time
    - Departmental makeup
    - Major changes take time
    - Negative aspects to creating interdisciplinary courses/curriculum
    - Faculty has not yet read/discussed report

Discussion

The pedagogical and curricular recommendations of the *Bio2010* report are being implemented at a number of institutions, both in individual classrooms and on a broader departmental or inter-departmental level. There are, however, mixed reactions to the significance and direction of these changes.

Approximately 20% of the individuals responding to the survey reported that they were incorporating more quantitative skills, increasing the interdisciplinary focus of their biology courses, or implementing some type of inquiry or experimental approach. These, along with a reduced focus on teaching towards the MCAT exam, were three of the more enthusiastically supported of the *Bio2010* recommendations. Two areas--bioinformatics and mathematical biology--are already headed in this direction, and those involved in these efforts are pleased that the report supports their efforts.

A smaller percentage mentioned incorporating active-learning strategies, student research, or student assessment. There was a general feeling among respondents that it is easier to implement changes within biology courses (inquiry-based methods, research-linked labs) than to build interdisciplinary programs. Some suggested that faculty in other science, technology, engineering, and math (STEM) disciplines, such as chemistry, physics, or mathematics, should share responsibility for building an interdisciplinary undergraduate education program and that an effort should be made to include biology in those courses.

A few departments are reorganizing or hiring new faculty to reflect the recommendations in the report. Some individuals used the report to back up their initiatives and gain support from their institutions. They indicated that this type of “national support” for

reform of teaching is extremely valuable. Therefore, while some responses indicated that *Bio2010* served as a catalyst for change at some institutions, others simply commented on its role in securing support, or even the potential for change in the future.

Not all of the individuals responding to the survey were impressed with the recommendations in *Bio2010*. Physiologists seemed to be put off by the suggestion that they build interdisciplinary links, because physiology is highly interdisciplinary by nature. Not everyone felt the report was significant. Twenty-six percent of those who had heard of the report have no plans to implement recommendations. Nine percent felt it was just one of many reports making recommendations, and 29% said that they had already been implementing these ideas before the report came out. Within these responses, there was a general sense that the report's pedagogical recommendations were nothing new and did nothing to further the reform efforts in the biology education community.

The survey responses revealed that there are concerns within the community about the lack of attention towards other biology disciplines (ecology, organismal biology, etc.) and about the report's biomedical content focus. Approximately 30% of those who knew about the report expressed concern about its narrow content focus. About 5% of those who had heard of the report expressed concern that it was focused on training researchers, graduate students, or workers in industry and ignored the needs of liberal arts, nonmajors, high school teachers, and the importance of biological literacy for an "informed citizenry." Another 5% said that they had no plans to implement the recommendations of the report specifically because it was too narrow in focus.

There were some comments that the report was being used to support the gradual phasing out of organismal biology. Others criticized the model curricula presented in the report, stating that significant content was missing and/or not presented in the right order; for example, plant biology is missing, and evolution is proposed as a single semester course in the junior year. Those who did not express concern included a few who actively praised the biomedical slant and many who simply did not address that aspect or said that the report did not apply to them.

Regardless of their opinions, some faculty reported that *Bio2010*'s recommendations were not taking place and probably would not any time soon because of institutional barriers. Lack of funding and lack of time were cited as two of the reasons faculty were unable to implement new pedagogical strategies or curricular changes in courses or programs. Others reported that they have colleagues who seem to have little interest in working towards reforming biology education in general.

Conclusion

The survey results indicate that *Bio2010* has influenced both the pedagogy and content of undergraduate biology. The *Bio2010* recommendations, however, do not appear to be on target to transform undergraduate education for future research biologists. There are limitations to the analysis of these results because the survey was based on self-selected responses and the sample size was small.

Perhaps the greatest impact of *Bio2010* is the discussion it has generated among biologists. AIBS and ESA plan to use this survey as a springboard for dialogue within the broader biological community, with the hope that this dialogue serves as a catalyst for decisions regarding what every biology student in the 21st century should know and understand.

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