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AUTHOR	Leonard, William H.; Penick, John E.
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ABSTRACT

This paper describes a preparation program in which 16 high school biology teachers in widely diverse settings across the country have successfully implemented a new standards-based biology curriculum, "Biology: A Community Context" (BACC), written by W.H. Leonard and J.E. Penick. During the summer of 1997, these 16 teachers were given an intensive, 1-week training session on the methodology and contents of BACC. During the following school year, the same 16 high school biology teachers each taught at least 1 class using the Standards-Based Curriculum outlined in BACC and at least 1 class using their existing traditional curriculum and text. During the first and last weeks of school, teachers administered two different pretests: (1) a test of understanding biology concepts; and (2) a test of science process skills. Data were analyzed for differences in mean scores between BACC versus traditional classes. In addition, all 16 teachers were observed twice (August-October and March-June). A 7-item free response questionnaire was given at the end of the year to all students of the 16 teachers. Results reveal that students liked BACC, felt they had done well, and enjoyed the activities. The 16 teachers appeared to be persuaded that a standards-based approach is desirable, reasonable, and practical to implement. (CCM)

PREPARING HIGH SCHOOL BIOLOGY TEACHERS FOR STANDARDS-BASED CURRICULA

William H. Leonard, Clemson University
John E. Penick, North Carolina State University

This paper describes a preparation program in which sixteen high school biology teachers in widely diverse settings across the country have successfully implemented a new, standards-based biology curriculum.

Background

The concurrent development of the *National Science Education Standards* by the National Research Council and the *Benchmarks for Science Literacy* by the American Association for the Advancement of Science have been major funding efforts by the National Science Foundation. They are in response to what is widely perceived as very inappropriate teaching of science in elementary and secondary education. A large part of the problem is that secondary science has historically been taught primarily through lecture as a long list of rather trivial facts and vocabulary words which are to be memorized and that this practice is widely supported by traditional, encyclopedic science texts.

Both AAAS and the NRC have attempted to aid science curriculum developers in both content selection and pedagogical approach by identifying a smaller subset of the most important science concepts rather than a long set of facts which attempt to cover an entire subject, as is the case for many traditional science curricula. Also, very much unlike the dominant traditional curricula, AAAS and NRC strongly recommend that science curricula devote significantly more time to developing scientific thinking skills and understanding the nature of science thus promoting student learning by engaged investigation as opposed to passive listening.

Science curricula recently funded by the National Science Foundation have tried to align themselves to the Standards and Benchmarks by reducing concepts and topics and by trading off

treatment of more concepts and topics for activities which develop scientific thinking skills and understanding the nature of science. That is why these new curricula are highly activity-oriented and engage students extensively in scientific inquiry.

Biology: A Community Context (Leonard and Penick, South-Western Educational Publishing, 1998) was one such curriculum. This curriculum for introductory high school biology was developed under a $2.3 million NSF grant awarded to Clemson University. Part of the grant's requirements was a teacher preparation and evaluation component. There was much interest in knowing if teachers using standards-based curricula would result in any greater student learning of selected science concepts identified in the Standards and Benchmarks and any greater learning of scientific inquiry skills than do traditional curricula that dominate the schools today.

Procedures

During the summer of 1997, sixteen high school biology teachers representing very diverse educational settings in the United States were given an intensive, one-week training on the methodology and contents of *Biology: A Community Context* by the authors (Leonard and Penick) and Project Manager (Speziale) of the curriculum. They were immersed in all the components of the curriculum (student text, teacher guide, initial inquiry video, and assessment package). Activities from the student text were by the authors. These were then completed by the participating teachers, followed by a discussion with the authors of the relevant biology concepts, science process skills, and understandings of the nature of science. Specific discussions of the curriculum's instructional methodology, namely the nature of scientific inquiry, a constructivist view of learning, active learning, and the critical sequencing of the different kinds of classroom instruction were also emphasized.

During the 1997-98 school year the same sixteen high school biology teachers each taught at least one class using the Standards-based curriculum *Biology: A Community Context* and at least one class using their existing traditional curriculum and text. During the first week of school, teachers administered two different pretests: A Test of Understanding Biology Concepts and A Test of Science Process Skills. The tests were constructed by the authors, reviewed by biology

teachers and revised accordingly. The classes which used each curriculum were not chosen randomly, but were selected by the teacher as having a "typical" composition of students at their school for an introductory biology class. Specific attention was paid to assuring that the intact classes using the two different curricula were as equivalent in student ability as possible.

Teachers used the *Biology: A Community Context* and their existing traditional curriculum with the corresponding intact classes during the entire school year. They attempted to use classroom methodologies consistent with *Biology: A Community Context* (BACC) and their traditional curriculum respectively.

All students in the study repeated the same two tests as posttests during the last week of the school year. Data were analyzed for differences in mean scores between BACC versus traditional classes. Also during this school year, all sixteen teachers were visited for a full teaching day once early in the year (August to October) and once later in the year (March to June) by one of the developers of the BACC curriculum. Attempts were made to note the relative differences between student and teacher behaviors of BACC and the contrasting traditional classrooms. Further, a seven-item free response questionnaire was given at the end of the school year to all students of the sixteen teachers using the BACC curriculum.

Data and Results

The major differences observed between the implementation of the two curricula were:

- Biology content in BACC classes was more selective and focused on fewer biology concepts whereas there was an attempt to cover as much content of the traditional textbook as possible in the traditional classroom.
- Laboratory, field and group research activities on given concepts were done prior to reading, lecture and discussion in the BACC class, whereas laboratory, field and group activities were done after lecture and discussion in the traditional classes.
- All student activities were of an investigative and inquiry nature in the BACC classes, whereas activities were mostly prescriptive and verifying in the traditional classes.

• There was extensive emphasis on development of science process skills and in understanding the nature of science in the BACC classes and there was nearly a total emphasis on biology content in the traditional classes.

• Students spent approximately 75% of classroom time directly engaged in inquiry activities in the BACC classes and at least 75% of the time engaged in listening to teacher lecture and discussion in the traditional classes.

• The BACC curriculum was in a context of community applications of biology concepts whereas the traditional curriculum was primarily in the context of scientific concepts.

The results of pre- and posttests are shown in Table 1. There were no statistically significant differences between BACC and traditional classes on the pretest for understanding of key biology concepts. However, there were statistically significant differences on the pretest for science process skills. BACC classes scored significantly lower than traditional classes on this pretest.

Table 1
Student Pre- and Posttest Scores for Tests
for Biology Concepts and Science Process Skills

	Mean	N	SD	t	p
TEST ON BIOLOGY CONCEPTS (40 questions)					
Pretest - BACC Classes:	13.38	372	5.59	1.68	.90
Pretest - Traditional Classes:	14.06	368	5.45		
Posttest - BACC Classes:	18.50	365	8.03	3.43	.005
Posttest - Traditional Classes:	16.50	298	6.96		
TEST ON PROCESSES SKILLS (30 questions)					
Pretest - BACC Classes:	10.52	395	4.79	3.95	.005
Pretest - Traditional Classes:	11.97	379	5.39		
Posttest - BACC Classes:	14.06	376	5.65	3.07	.005
Posttest - Traditional Classes:	12.69	308	5.93		

There were statistically significant differences between the BACC and traditional classes on both posttests. BACC classes scored higher on both tests. It was notable that, although the BACC classes scored significantly lower on the science process skills pretest, they scored significantly higher on that posttest. Of particular interest were the differences between pre-and post-test gain scores for the two groups. BACC students gained 2.68 more points than the traditional classes on the biology concepts test and 3.83 more points than the traditional classes on the test for science process skills. These differences in gain scores represented approximately one-half standard deviation.

Student responses on the seven-item questionnaire are shown in Table 2. They revealed that students liked BACC, felt they had done well, and enjoyed the activities. Their comments were consistent with what we observed as we visited the classes. The comments (and percentage of students responding in this manner) were consistent with our observations.

Table 2
End-of-Year Questionnaire Responses by BACC Students

1. The activities in the text were: too difficult (6) about right (89) too easy (5)
2. I found the activities: interesting & helpful (77) uninteresting (23)
3. The readings were: too difficult (13) about right (81) too easy (6)
4. The amount of work for this course was: too much (23) about right (72) not enough (5)
5. Compared with other science programs, I performed: better (86) worse (8) same (6)
6. Compared with other science programs, I learned: more (80) less (16) same (4)
7. I enjoyed using this material: agree (76) disagree (23) sometimes (1)

Inferences

Experienced biology teachers can successfully implement a standards-based high school biology curriculum. They can also differentiate their behaviors to match the philosophy and methodology of the respective curriculum. Moreover, these teachers appeared to be persuaded that a standards-based approach is desirable, reasonable and practical to implement.

From the limited population used in this study, this standards-based biology curriculum appears to be more productive in teaching students understanding of key biology concepts and ability to carry out science process skills. This study may provide some evidence that NSF-funded curricula are accomplishing the goals of the *National Science Education Standards*.

References

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Signature: W H Leonard	Printed Name/Position/Title: W. H. Leonard	
Organization/Address: Clemson University	Telephone: 864 656 1398	Fax: 864 656 7243
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