

Evaluation of the Amgen Biotech Experience Program

2013-2017

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Executive Summary of Evaluation Findings

The Amgen Biotech Experience (ABE) provides high school biology teachers with the opportunity to offer highcaliber biotechnology labs in their classrooms, ensuring that all students within their class have the chance to participate in the real-world science that is offered by the program. The program lets students experience the same hands-on investigations that scientists do in their labs. Led by the ABE Program Office, local ABE program sites train teachers on the ABE curriculum, provide supplies, and loan lab-grade equipment for teachers to do the

ABE curriculum in classrooms with their students. The ultimate goals are to increase students' STEM interest and learning of biotech and science (see **Figure 1**). During the 2016-17 school year, the ABE program reached nearly 1,000 teachers and 80,000 students in select U.S. and European Amgen communities, all free of charge to schools, teachers, and students through the support of the Amgen Foundation.

From 2013 to 2017 WestEd conducted a comprehensive evaluation for U.S. ABE sites, and when possible the international sites in the United Kingdom and Ireland. The evaluation focused on evaluating:

ABE Program Activities & Outcomes





student learning gains and changes in STEM interest; teacher training at professional development institutes (PDIs); teacher implementation and attrition; and demographic analysis of participating schools.

A program-wide evaluation during the 2016-17 school year found that high school students experiencing ABE have (1) significant and substantial learning in biotechnology and (2) increased interest and confidence in doing science and biotechnology (see *ABE's Impact on Student Learning and Attitudes* below for more details). The validated assessment measured students' knowledge and skills related to biotechnology. Students averaged a statistically significant (p < 0.001) increase of 20 percentage points between the pre- and post-tests. Students show the largest gains on items related to their ability to interpret experimental results and knowledge of biotechnology skills.

Students exposed to ABE also have increased interest and confidence in doing science. Through ABE students gain new ideas about what happens in science laboratories, gain new ideas about what science is, become more interested in learning about science research, and want to know more about science careers. Similar to the learning gains, students in Honors Biology and AP Biology show higher gains on STEM interest than students in Biology or Biotechnology courses but all students showed statistically significant increases.

To evaluate the delivery of the ABE curriculum to students, WestEd surveyed teachers after all trainings and developed an implementation survey (see *ABE's Impact on Teacher Training* and *Teacher's Implementation of ABE and Attrition from ABE* below for more details). Overall, teachers thought very highly of their training – over 90% of US respondents gave high approval ratings for the design and implementation of their workshop, and a high majority of teachers reported enhancement of their interest, knowledge, and skills. The majority of teachers, across all program sites, implement ABE as intended by the program. The majority of teachers taught ABE for 2-3 weeks which they considered an appropriate amount of time, though a small portion said they would like more time. Almost all teachers said their kit came with all the necessary equipment and consumables, and that they had contact with their ABE site during implementation.

Lastly, WestEd analyzed the demographic data for U.S. schools where ABE was taught annually. The program serves students in schools having diverse student race/ethnicity and socio-economic status. During the 2016-2017 school year, almost two-thirds of students in ABE schools were non-White, with almost half being under-represented minorities in STEM. Over two-fifths of students in ABE schools were eligible for free or reduced lunch, and on average, over two-fifths of ABE schools were Title I schools.

Visit www.amgenbiotechexperience.com or email ABEInfo@edc.org for more information about the ABE program.



Overview of the ABE Program Evaluation

For the first 20 years of ABE, escalating teacher demand and high satisfaction with ABE drove the expansion of the program within Amgen communities and to additional Amgen communities. The evidence to support this expansion came from program sites, which adjusted the program based on their individual evaluation efforts. From 2009 to 2011, limited external evaluation work by SmartStart used early surveys, observations, and interviews to obtain students' views of ABE. Beginning in 2013, the Amgen Foundation established the ABE Program Office to support the ABE program sites in making strategic decisions based on evaluative data. To support this effort, the Foundation and Program Office commissioned evaluators in WestEd's STEM program to conduct a professional external evaluation of ABE. The ABE evaluation was directed by Dr. Andrew Grillo-Hill, a biologist experienced with teacher professional development for biotechnology content and skills, and Dr. Ted Britton, the Managing Associate Director of the STEM program. From 2013 to 2017 WestEd conducted a comprehensive evaluation for U.S. ABE sites and when possible, the international sites in the United Kingdom and Ireland. The evaluation plan focused on evaluating multiple levels of the ABE program: student learning gains and changes in STEM interest; teacher training at professional development institutes (PDIs); teacher implementation and attrition; and demographic analysis of participating schools.

Overview of the ABE Program from 2013-2017

ABE is a hands-on laboratory-based program developed by Amgen scientists and educators – and supported by the Amgen Foundation – which allows teachers to teach classes of their students (primarily high school students) about genetics, molecular biology, and biotechnology. As part of this program, eleven sites across the United States, as well as in the United Kingdom, Ireland, and Puerto Rico, offer training workshops to teachers interested in utilizing the ABE curriculum, provide supplies, and loan equipment for teachers to do the curriculum in classrooms with their students. The ABE program currently reaches nearly 1,000 teachers and 80,000 students each year in select U.S. and European Amgen communities. Since 2017, ABE has expanded into several additional countries, including within Asia; however, this expansion is not included in WestEd's evaluation.

The ABE curriculum allows classes of students to learn about core technologies used by scientists in the discovery of human therapeutics, so that they will better understand the role of biotechnology and the potential impact of this industry on our future. If students participate in the complete sequence of ABE labs, they will produce a recombinant DNA molecule and then use it to transform *E. coli* followed by a protein purification of the recombinant protein. The different sequences allow the ABE curriculum to be adapted to a variety of schools, course subjects, classrooms, and teacher contexts. It also allows teachers to start teaching less complex ABE lessons then increase to teaching more in-depth lessons as their confidence increases.

The program is supported by the ABE Program Office at Education Development Center (EDC), which provides leadership and management for the program sites, offers technical assistance to the program sites and ABE teachers, and serves as the hub to support program implementation and facilitate its continued development. The Program Office serves as an intermediary between the Amgen Foundation and the ABE program, seeking ways to both strengthen the program and elevate the program's profile as an effective, hands-on educational program.



ABE's Impact on Student Learning and Attitudes

A study during the 2016-2017 school year demonstrates that U.S. high school students exposed to ABE have significant and substantial (1) learning in biotechnology and (2) increased interest and confidence in doing science and biotechnology. These statistically significant increases in student learning and view of science are particularly remarkable since ABE is only a one- to three-week experience.

Student knowledge and skills

Overall, students exposed to ABE lessons showed a statistically significant increase (p < 0.001) and with large effect size (d = 1.03) on a 25-question, validated assessment which measured students' knowledge and skills related to biotechnology. Students averaged an increase of 20% between the pre- and post-tests. Students averaged 36% correct items on the pre-test and 56% correct on the post-test. **Figure 2** shows the distribution of pre- and post-test scores for all students and **Table 1** summarizes the data overall and by item topic.



Figure 2. Distribution of student scores for items 1-25.

Table 1. Pre-test and post-test results, overall and by sub-topics,for approximately 3000 students.

	Mean Pre-Test	Mean Post-Test	Difference	Effect Size
All	36% +/- 3%	56% +/- 4%	20%	1.03
General	41% +/- 5%	57% +/- 5%	17%	0.63
Process	36% +/- 4%	54% +/- 5%	17%	0.72
Results	29% +/- 4%	54% +/- 5%	25%	1.02
Skills	42% +/- 4%	63% +/- 5%	21%	0.86

Students showed the largest gains for questions related to their ability to interpret experimental results (25% increase) and knowledge of biotechnology skills (21% increase). Students showed more moderate gains for questions related to their understanding of experimental processes in biotechnology and general biotechnology knowledge (17% increases for each).

Girls and boys showed almost identical scores and gains on the pre- and post-tests (36% pre and 56% post for both genders); any differences were not significant. Subgroup analysis by course subjects showed differences in how students performed on the assessment. Students in Honors Biology and AP Biology showed larger gains following exposure to ABE than students in Biology or Biotechnology courses. Honors Biology students showed an increase of 27 percentage points while students in AP Biology courses had a 24-percentage point increase. Biology and Biotechnology students had more moderate increases on their assessment scores, with an average increase of 15 and 13 percentage points, respectively. Subgroups by ABE lab sequence showed that students who were taught the Abridged sequence with the protein purification lab (lab 6) had the biggest increase from pre- to post-assessments scores, an average increase of 26 percentage points. Students who were taught the Abridged or Complete lab sequences without lab 6 showed the next highest increases of 23 and 21 percentage points, respectively. Interestingly, students who were taught the Complete lab sequence with lab 6 showed the smallest assessment gains, with an increase of 14 percentage points.

Student interest and confidence

Students were asked a series of seven questions about what they got out of doing ABE (see **Table 2**). Results indicate that ABE was most impactful on students by giving them new ideas about what happens in science laboratories (82% agreed), followed closely by giving them new ideas about what science is (72% agreed). More than half agreed that ABE made them more interested in learning about science research and made them want



to know more about what science careers there are (53% for each). Forty-five percent (45%) agreed that they are better at doing science than they thought they were from doing ABE, while 43% were neutral in response to this question.

Subgroup analysis of student interest questions showed that students in Honors Biology and AP Biology had higher levels of agreement that ABE gave them new ideas about what happens in science laboratories, gave them new ideas about what science is, want to know more about what science careers there are, and are more interested in learning about science research. Students in Biology and Biotechnology classes had lower levels of agreement with these topics. Subgroups by ABE lab sequence showed that students who were taught the Abridged sequence with lab 6 had the highest level of agreement on these questions compared to students taught the Complete lab sequences (with or without lab 6). Students taught the Abridged sequence without lab 6 had the lowest levels of agreement to these questions. Table 2. Student responses to what they got out of doing ABE (n=2485 to 3150).

	Mean
From doing ABE	response
I got some new ideas about what happens in science laboratories.	4.08
I got some new ideas about what science is.	3.81
I am more interested in learning about science research.	3.52
I want to know more about what science careers there are.	3.49
I am better at doing science than I thought I was.	3.41
I am thinking harder about taking more science courses in high school. *	3.34
I am thinking about taking different high school science courses than I had planned. *	2.90

Note: students responded on a five-point scale: strongly disagree (1), disagree (2), neutral (3), agree (4), strongly agree (5). *Seniors, 12th grade students, were omitted from the analysis of these two items.

Students were also asked eight questions about how ABE changed their interest in education, science, and jobs after high school (see **Table 3**). All questions showed a significant increase in students' agreement from before to after the experience but of varying magnitudes. Students showed an increased interest in learning about

Table 3. Retrospective survey responses to how ABE may havechanged student interest.

	Before	After	Difference
I am interested in taking more biotechnology after high school.	3.74	4.11	0.37
I would be comfortable with a job/ career that requires using science.	4.61	4.88	0.27
I am interested in becoming a laboratory technician.	2.99	3.21	0.22
I am interested in taking more science after high school.	4.62	4.83	0.21
I am interested in becoming a scientist.	3.73	3.91	0.18
I am interested in majoring in science at college.	4.41	4.55	0.14
I am interested in going to a community college.	3.07	3.09	0.02
I am interested in going to a four- year college or university.	6.07	6.08	0.01

Note: students responded on a seven-point scale: strongly disagree (1), disagree (2), slightly disagree (3), neutral (4), slightly agree (5), agree (6), strongly agree (7).

biotechnology and science. Before doing ABE, 28% of students agreed they were interested in taking more biotechnology after high school compared to 43% of students after doing ABE. Similarly, results show an eight percent gain in students' interest in taking more science after high school (52% before and 60% after) and a six percent gain in interest in majoring in science at college (46% before and 52% after).

Results indicate students' interest in science careers increased after doing ABE. Over half (53%) said they would be comfortable with a job or career that requires using science before ABE, compared to 61% of students after. Likewise, 31% of students said they were interested in becoming a scientist before doing ABE, compared to 38% who said they were interested after. Students showed almost no increase in their interest to go to a community college or four-year university due to exposure to ABE.

About this study

A large sample of sixty (60) high school teachers from across U.S. ABE sites and their classrooms (n = 3507 students) were required to participate in the study during the 2016-17 academic year. The study-created assessment shows high reliability (Coefficient Alpha = 0.9084) and good discrimination (mean discrimination = 0.5068) for all but one item. The full report is available upon request to the ABE Program Office by emailing ABEInfo@edc.org.



ABE's Impact on Teacher Training

To measure the impact of ABE professional development institutes (PDIs), WestEd surveyed all teachers who attended the dozens of PDIs from January 2016 through August 2017. Overall, PDI participants were experienced teachers, mostly female, teaching at the high school level, and mainly teaching biology courses. About two-thirds

had never implemented ABE before. Those who had used it before had varying years of experience, ranging from those with over five years' experience to those who were using it in their classroom for the first time that year.

Over 90% of teachers gave high approval ratings for the design and implementation of their ABE PDI.

A majority of teachers (77% to 93%) reported enhancement of their interest, knowledge, and skills from their ABE PDI.

Participants thought very highly of the PDI workshops – over 90% of US respondents gave high approval ratings for the design and implementation of their workshop. This included questions about the PDI's quality, organization, pacing, interactions (exchange of feedback and answering questions), and preparation for teaching the ABE curriculum (laboratory practice and classroom management). When asked to check items for improvement, more participants wanted more rather than less content and a more challenging rather than a less challenging PDI. The most frequently suggested changes were to "provide more information on how to differentiate instruction for students at different levels," and "provide more information on how to differentiate instruction for students with different needs and abilities." These findings show that the PDI workshops meet the needs of participating teachers.

PDI workshop participants were asked to self-report their prior interest, knowledge, and skills related to ABE prior to attending their workshop and if their workshop enhanced these items (see **Figure 3**). Teachers rated their prior interest, knowledge, and skills fairly high with the lowest items being questions about their knowledge,



Figure 3. ABE PDI participants self-rated enhancement of their interest, knowledge, and skills related to ABE from attending the PDI workshop.

confidence, and understanding specific to ABE. As may have been expected, teachers with more prior ABE experience rated themselves higher on many of the interest, knowledge, and skills questions. From the PDI workshops, a high majority of participants (77% to 93%) reported enhancement of their interest, knowledge, and skills with the highest gains being reported for questions specific to ABE. Participants with less prior ABE training reported a larger gain on their understanding of the ABE curriculum. However, for all other questions about how the PDI enhanced their interest, knowledge, and skills, there was no correlation with how much prior ABE training participants had received. This finding supports the program model to include PDI trainings for both new and experienced ABE teachers.

About this study

This was the first program-wide effort to summarize the participants and impacts PDIs had on participating teachers. From January 2016 through August 2017 ABE sites were asked to have participants complete an anonymous online survey at the conclusion of the PDI. The survey consisted of 19 multiple response and open-ended questions to probe program-wide: 1) what PDIs were offered, 2) the characteristics of PDI participants, 3) what participants gained from the PDI, 4) what participants thought of the PDI, and 5) their intention to implement the ABE curriculum. The full report is available upon request to the ABE Program Office by emailing ABEInfo@edc.org.



Teacher's Implementation of ABE and Attrition from ABE

To evaluate teacher's implementation of ABE and possible attrition from ABE, WestEd surveyed all prior and current teachers who had previously signed up to participate in an ABE program site's training session. The survey sought to gain insights into how teachers implement the ABE lessons, how teachers interact with ABE program sites during implementation, and why some teachers either stop teaching ABE or do not consistently teach ABE.

Overall findings show that the majority of teachers, across all program sites, implement ABE as intended by the program. The majority of teachers taught ABE for 2-3 weeks (69%) which most considered an appropriate amount of time, though a small portion said it was less than they needed.

Almost all teachers (over 90%) said their kit came with all the necessary equipment and consumables and had contact with their site during implementation (67%). The vast majority (96%) of teachers who did ABE said their ABE site was extremely or very available when they needed assistance. Most teachers said the amount of time they spent maintaining supplies and instruments was equal to or greater than the amount of time they would spend prepping for other laboratory activities (37%).

Almost all teachers (over 90%) said that ABE was aligned with their class curriculum, their district standards, and the Next Generation Science Standards (NGSS). About half said their school administrator and other teachers at their school were supportive of them teaching ABE; the rest said their administrators and fellow teachers were neutral (49% and 39%) or slightly resistant (1% and 4%).

96% of teachers said their site was extremely or very available when they needed assistance.

Over 90% of teachers said their kit came with all the necessary equipment and consumables materials.

Of the teachers who responded to the survey and used the ABE curriculum, 80% taught it for one or more years, including 36% that had taught it for five or more years. The course teachers most frequently used ABE in was Biology followed by AP Biology and Honors Biology. The majority of teachers were female

(75%) and White/Caucasian (67%). Most had taught science for eight or more years (76%). Most taught in suburban schools (61%) and schools that were not Title I (59%).

Teachers stopped doing ABE or did it inconsistently mainly for reasons outside of the ABE program's design or control. Only 86 of the survey respondents (19% of all teachers) had stopped doing ABE or did it inconsistently. The most common reason why teachers stopped or did ABE inconsistently was a change in their teaching assignments (n=42, 49%). About half the teachers who stopped doing ABE listed this as their reason. Only a fifth of the teachers who stopped or were inconsistent (n=18, 21%) reported it was due to an issue with the ABE program, such as it not meeting their needs or it being too complicated.

A comparison of those who consistently did ABE against those who stopped or who were inconsistent due to one or more issues with the ABE program (i.e. challenges with site, program did not meet needs, etc.) showed that the two groups were very similar with respect to how they implemented the ABE program. Three noteworthy differences emerge from these two groups in how they responded to questions of their ABE site checking in with them while teaching the ABE lessons, the amount of support they perceive from other teachers at their school, and if they checked in with their ABE site while teaching the ABE lessons. No causal claims can be made about the nature of these relationships, but the ABE program may benefit from ensuring that ABE sites and teachers check in with each other while they teach the ABE lessons and finding means to increase the supportiveness of other teachers at participants' schools.

About this study

In the fall of 2017, WestEd conducted a program-wide online survey of ABE teachers who had participated in the program during the past 5 years. The survey consisted of four main question topics; teacher demographics, how long and how consistently teachers did ABE, how teachers are implementing ABE, and why teachers stopped or were inconsistent in teaching ABE. The survey was sent to a total of 1,284 teachers and was completed by 444, for a response rate of 35%. The full report is available upon request to the ABE Program Office by emailing ABEInfo@edc.org.



Demographics of U.S. Schools Where ABE Is Taught

WestEd evaluators conducted a yearly analysis of the demographic data for schools where ABE was taught, characterizing the reach of ABE in schools and types of students that can be reached by the program. The following summarizes the demographic analysis of U.S. ABE schools during the 2016-17 school year.

As in prior years of this analysis, the program again served students in schools having diverse student race/ethnicity and socio-economic status (SES). Available indicators for SES were percentage of Title I schools served and percentage of students receiving free or reduced lunch. As shown in **Figure 4**, almost two-thirds of students (63%) in ABE schools were non-White, with almost half being under-represented minorities in STEM (42%, 6%, and 1% being Hispanic, African American, and Native American or Pacific Islanders, respectively). Across all but one ABE region, values for the proportion of Hispanic students ranged from 15% to 56%; in Puerto Rico, 99% of students in ABE schools were Hispanic. Values for African American students ranged from 2% to 7% in every region except for Massachusetts where they represented 11% of students and Washington D.C. where they represented 19%.



Figure 5. Number of Title I schools by ABE site in 2016-17.



Figure 4. Demographics of students reached by the U.S. ABE program in 2016-17.

Over two-fifths (45%) of students in ABE schools were eligible for free or reduced lunch. By ABE region, values ranged from 25% to 55%, with the exception of Puerto Rico where 90 percent of students were eligible. On average, over two-fifths (44%) of ABE schools were Title I schools (see **Figure 5**). However, the programwide average masks substantial differences: Puerto Rico with the most number of Title I schools at 94% of schools and Colorado with the fewest at 6% of schools.

Further analysis shows that during the 2016-17 school year, the students who were learning ABE were: primarily in high schools

(85% of ABE schools) and mostly in suburban or city schools (54% and 38% of schools, respectively). Additionally, 76% of ABE schools were ones continuing the program from the 2015-16 school year.

About this study

For each U.S. teacher providing the ABE program in a public school, WestEd's evaluators obtained demographic information about the 491 public ABE schools from federal databases such as the Common Core of Data (CCD). This data does not include demographic information about: the 78 private schools in the program in the same year, because such information is not publicly available, and the 21 postsecondary institutions who participate in the program. By ABE site, the public K-12 schools reached were between 67-97 percent of all schools served except for Puerto Rico, in which 58 percent of schools served were public and 26 percent were private.