ADVANCED PLACEMENT IN BIOLOGY:

ITS EFFECT ON THE COLLEGE-BOUND STUDENT

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF GENERAL BIOLOGY

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

1 9 8 0

STATEMENT BY AUTHOR

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In loving memory of

Sarah Alix Maxfield and Caroline Martin Maxfield

who so loved education

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to my major professor, Dr. Newell A. Younggren, for his enthusiastic and unfailing support. I would also like to thank Dr. Ivan M. Lytle for his inspiration and incentive which helped to make this thesis possible. An especial thanks goes to Donald B. Sayner who directed my studies in Scientific Illustration and shared his love of the Sea of Cortez and all things marine.

I want to especially thank my friends Curtis Lively who assisted with data analysis and Linda Halley who typed the final copy of this paper.

I acknowledge the faculty and staff of the Department of General Biology for their unfailing willingness to share ideas and offer assistance to the graduate students they treat as associates.

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ABSTRACT

There is a positive, significant correlation between grades on the Advanced Placement biology exam and students' subsequent performance in college biology as well as non-science curricula. The predictive value of the specific biology test for broader subject matter indicates student aptitude and motivation are the weighting factors. Changes in student selection procedures also seem to play a significant role. Requirements for entering Advanced Placement programs are not as stringent. Further, closer scrutiny of college performances versus Advanced Placement performances remains hampered unless discrepancies in awarding placement or credit by member colleges are not resolved.

INTRODUCTION

Students at the University of Arizona who had participated in an Advanced Placement program ("APP") in biology at their high schools were evaluated with respect to their subsequent college academic performances. The participants in the biology program were selected because of the desire of the University's Department of General Biology to have a basis for evaluating future participants and placing them in appropriate curricula. This study is also a response to the suggestions presented by some educators (Keller, 1958; Kieffer, 1959; Menacker, 1969; and Marland, 1975) that the APP provides academic enrichment and stimulation to the point that it is reflected in a student's future college performance regardless of whether advanced placement or credit was awarded as a consequence of a student's evaluation via the Advanced Placement biology exam. The results of this study appear to be contrary to this widely-held premise, at least under certain circumstances. College academic "success" does seem to parallel more closely those who received high scores on their Advanced Placement biology exams as opposed to those who received low scores. This seems to hold true not only for further biology or related curricula (zoology, botany, physiology, microbiology, etc.) but in overall academic performance as well.

HISTORICAL BACKGROUND

Advanced Placement programs were developed to provide the capable and motivated student with a means of breaking the traditional "lock-step" progression (Dudley, 1959) of education established in the mid-1800's (Brown, 1961). The APP was also designed to provide a smoother articulation between grades 12 and 13 with respect to monetary, academic, and even social and psychological considerations (Putnam, 1959; Menacker, 1969).

Early attempts to coordinate the transition from high school to college were: The Committee of Ten, 1893; Committee on College Entrance Requirements, 1899; and the Eight-Year Study, 1934 (Franklin, 1965). Also in the early 1930's the University of Buffalo actually tested and gave college credit to students who had done extra, advanced work while still in high school (Franklin, 1965).

One solution for dealing with the bright student was to allow early entrance into the university. During 1950-51, the Ford Foundation was supporting this early admission with a full scholarship program (Putnam, 1959). The high school junior could skip his senior year and enter college as a freshman. This particular solution, however, did not always take into account the social and psychological preparedness of the student in question. Also under this plan a meaningful coordination between the high schools and colleges was not yet realized.

The final evolution of the APP can be accredited to two main studies: the Andover Study, also known as The School and College Study of General Education; and the Kenyon Plan, also known as the School and College of Admission with Advanced Standing (Franklin, 1965; Putnam, 1959; and Douglas, 1959). Both studies received financial support from the Ford Foundation's Fund for the Advancement of Education (Putnam, 1959).

The Andover Study was begun by the Headmaster of Philips Academy in Andover, Massachusetts. It involved two other prep schools, Exeter and Lawrenceville, and three universities, Harvard, Princeton, and Yale. The plan was to coordinate a program dealing with the last two years of high school and the first two years of college. Special attention was focused on:

> "1. waste of time
> 2. lack of stimulation
> 3. weakening of study habits that result when able, well-taught students repeat (during the college freshman year) courses that were thoroughly studied in preparatory schools." (Putnam, 1959)

Under this plan, acceleration in the university setting depended upon the student doing sufficiently advanced work in secondary school to anticipate much of the freshman program he would encounter at college.

Gordon Chalmers (the late President of Kenyon College) began the Kenyon Plan on the basis of the following concepts:

> "1. For the bright student who is well taught the American system wastes time.
> 2. The best place for school boys is in school.
> 3. The best teachers of 17-year-olds are as likely to be found in schools as universities.
> 4. The increase of professions depending on graduate work and the necessary extension of graduate training for doctors, engineers, scholars, scientists, lawyers, ministers, and businessmen puts increasing emphasis on efficient use of the years available for study. Added to these opinions about American education and American students is an assumption about mobilization; that for many years to come young men will have to devote at least two years to military service." (Putnam, 1959)

In essence, this plan required that the colleges involved outline what they would consider a good freshman-level course. These course descriptions were combined and syllabi for eleven most commonly taught subjects were produced and distributed to the participating schools. In 1953, the college-level courses were taught to qualified students in their own high schools. The first tests, written by subject specialists from the participating colleges, were administered in 1954 by the Educational Testing Service. These tests were designed to bring a control and validation to the program that the member colleges insisted upon (Cameron, 1962). The tests were given to the high school students in the APP as well as to college freshmen who had undertaken a comparable college course. The high school students appeared to perform as well as any of the college students on some tests (Douglas, 1959).

In 1955 the College Board took responsibility for the program and formally changed the name to the Advanced Placement program (Putnam, 1959). The Ford Foundation withdrew major support in favor of a self-supporting organization. The Foundation did, however, supply funds to some of those high schools and colleges who wished to begin an Advanced Placement program of their own (McCormick, 1961).

BASIS FOR HYPOTHESES

Program participants have been evaluated statistically by a number of authors. Most of the studies deal with comparisons between APP students and non-APP students. Two such studies by Bergeson (1962, 1967) were designed to evaluate the effect of advanced placement in college curricula. In both situations "regular progress" students were compared to a group of APP students. The latter were permitted to enter upper division courses in which they had received Advanced Placement high school training. The regular progress students had received training in preliminary freshman courses. When the freshmen APP students were compared to the regular progress sophomores, no significant difference was found between final grade point averages. This led Bergeson to believe that high school Advanced Placement preparation is commensurate in most instances to preparation received in beginning college freshman courses.

Similar studies by Ruch (1968) and Evans (1962) also indicate that advanced college placement for APP participants is not scholastically detrimental. Further evaluation by Bergeson (1962, 1967, and 1968) and Ruch (1968) also revealed similar non-statistically significant results with respect to final overall grade point averages between test groups of APP students and non-APP students.

An interesting contrast to the preceeding studies is the one presented by the science-technical schools or colleges. According to Fackler (1969), these schools take almost no APP students for credit. They claim that in preliminary studies,

> "students placed out of freshman chemistry rarely do well in sophomore courses, despite high intellectual abilities. They further found that perhaps over 50% of the students who received advanced placement who are potentially 'A' students end their college careers with overall averages near 'C'." (Fackler, 1969)

Wagner (et al, 1967) studied the college performance of a group of APP students as compared to the grades these students received on their Advanced Placement Exams (APE or APEs). The tests were evaluated on an integer scale of 1 to 5 with "5" being a top score. Grades "1" and "2" are generally regarded as failing grades while students making grades "3" through "5" are usually awarded some kind of credit or placement (Frankel, 1959). The study showed that 73.5% of the group that failed the test ("1's" and "2's") received a "B" or better in their first topic-related course. None of these students received below a "C." A study by Bergeson (1968) also seems to support the proposal that so-called "failing" grades on the APE do not necessarily imply disappointing grades in advanced college courses.

These last two studies imply that perhaps it is the APP "experience" and not just the grade on the test that is important. This concept could have very important implications on the awarding of credit or placement. For purposes of analyzing this concept the following hypothesis was generated:

$1H_o$: There is no correlation between performance on the APE in biology and subsequent performance in college biology curricula.

Should $1H_o$ be rejected one should expect that the APE score in biology could be used to perhaps predict performances in college biology more so than in a course, such as English, that was not studied on the APP level. To test this possibility the following hypothesis was generated:

$2H_o$: The correlation of APE biology scores with the first course in college biology and the correlation of the APE biology score with the first course in college English should be equal.

To test the effect on the academic performance of students waiving introductory courses as a result of their high APE biology scores, an additional hypothesis was generated:

$3H_o$: There is no correlation in performance between students who took APP biology in high school and because of test scores could not waive introductory college biology courses as opposed to those who did waive introductory courses and proceeded to upper-division course work, likewise, as a result of their APE biology scores.

MATERIALS AND METHODS

A list of students who had participated in an APP biology class in high school was obtained from the Registrar's Office (University of Arizona). All of these students had submitted the results of their APE biology scores to the university for consideration of academic credit and/or placement. The administration released those students' college records for analysis with the understanding that only numerical and course curricula data were to be used. Students attending the university from 1970 through 1977 were studied. Information for consecutive years prior to 1970 was unavailable.

College performance was evaluated on a quantitative basis using grade point averages on the 4.0 scale ("4.0" being the highest grade). APP performance was evaluated on the basis of standardized test scores that are assigned after completion of the APE in biology. The exam is scored on an integer scale, as mentioned earlier, of 1 to 5, with "5" being the top score attainable. Correlation coefficients were determined with the University of Arizona CYBER computer, utilizing the SPSS statistical library for the APE biology scores with each of the following variables:

1. cumulative college grade point averages (GPAC)
2. cumulative college grade point averages in biology (GPAB)
3. grade in first college biology course (FCIB)
4. grade in first college English course (FCIE)

All variables were transformed to natural logs to meet assumptions of normality and homogeneity of variances of parametric tests.

A correlation coefficient was considered significant if its probability was less than 0.01 (Schefler, 1969; Dinham, 1976). Standard error for each correlation coefficient was also determined (Zar, 1974). The difference between the correlation coefficients for the first college biology course with APE biology scores and the first college English course with the APE biology score was determined utilizing the method presented in Zar (1974).

The data for correlation (upon preliminary inspection of raw data) was divided into three samples with all samples having the following criteria:

1. All students attended the University of Arizona for at least one freshman semester.
2. All students had APP biology courses in high school and were subsequently evaluated by taking the APE in biology.

Further division of samples was as follows:

1. Sample 1
    a. Size: N=100 students
    b. Variables common to all students in the sample:
        (1) APE biology score
        (2) Cumulative college grade point average
2. Sample 2
    a. Size: N=56 students
    b. Further criterion: took at least one course in biology

at the University of Arizona.

c. Variables common to all students in the sample:

(1) APE biology score

(2) Cumulative college grade point average

(3) Cumulative college grade point average in biology

(4) Grade in first college biology course

(5) Grade in first college English course

3. Sample 3

a. Size: N=26 students

b. Further criterion: took ten or more units in college biology (went beyond liberal arts requirements of eight units of laboratory science at the University of Arizona)

c. Variables common to all students in the sample are the same as in Sample 2.

In an attempt to understand the numerous qualitative parameters associated with academic performance, a survey of the students' high schools was conducted via a questionnaire sent to school authorities. The following topics were considered:

1. Current student population
2. Geographic location
3. Total enrollment during the years APP courses were offered
4. Number or percentage of students participating in APP
5. Number of APP courses offered
6. Number of years APP courses have been offered

7. Reasons for offering APP courses, especially in biology
8. APE performance of students
9. College credit awarded or placement received
10. Selection process of APP students
11. Selection process of APP teachers
12. APP course curricula in biology

RESULTS

The students in Sample 1 shared only two variables of our criteria, an APE biology score and a cumulative grade point average. The correlation coefficient for these two variables is shown in Table 1. The coefficient (plus or minus the standard error), 0.43 ± 0.091, indicates a positive correlation between the variables with significance at less than 0.01. Thus, an increase in APE biology scores is accompanied by an increase in grade point averages.

Table 1

Correlation coefficients (r) ± standard error (S_r) for entire group of students (Sample 1: N=100) submitting APE biology scores at the University of Arizona. Abbreviations are as on page nine of text. Significance (p) is determined at a probability of less than 0.01.

Variable I	Variable II	$r \pm S_r$	p
APE	GPAC	0.4259 ± 0.091	0.00001

The students in Sample 2 were selected from the first sample with the further criterion of having taken at least one biology or related course at the university. The correlation coefficients for three pairs of shared variables are shown in Table 2.

The correlation coefficient for the APEs and the cumulative grade point averages is slightly greater than in Sample 1. Significance is still at the level of 0.01. The correlation coefficient for the APE score and the first college biology course is 0.36 with a standard error of ± 0.127. This is a lower correlation than the preceeding one but is still significant under our criteria.

Table 2

Correlation coefficients (r) ± standard error (S_r) for the group of students (Sample 2: N=56) taking at least one course in college biology at the University of Arizona. Abbreviations are as on page nine of text. Significance (p) is determined at a probability of less than 0.01.

Variable I	Variable II	$r \pm S_r$	p
APE	GPAC	0.4829 ± 0.119	0.00004
APE	FCIB	0.3603 ± 0.127	0.00319
APE	GPAB	0.3014 ± 0.130	0.01199

APE biology scores and cumulative college grade point averages in biology (and related curricula) were also correlated for this group. This correlation was not significant at the 0.01 level. This result is not totally unexpected when one considers that for thirty students in this group the cumulative biology average may only be represented by one or two courses. This correlation, then, is highly intercorrelated

with the one involving the first course in college biology. Further, for those accepting a less rigorous test, one can see that this correlation would be significant at the 0.05 level.

Sample 3 was designed to alleviate the problem of the first biology course being the weighting factor on the cumulative biology grade. The students were included in the sample if they had taken ten or more hours of biology or related work. The results of the correlations can be seen in Table 3. All the correlation coefficients for this sample were quite positive (approaching the maximum of +1.0) with significance at the 0.01 level.

Table 3

Correlation coefficients (r) ± standard error (S_r) for the group of students (Sample 3: N=26) taking at least ten units in college biology at the University of Arizona. Abbreviations are as on page nine of text. Significance (p) is determined at a probability of less than 0.01.

Variable I	Variable II	$r \pm S_r$	p
APE	GPAC	0.6463 ± 0.156	0.00018
APE	FCIB	0.6361 ± 0.158	0.00024
APE	GPAB	0.7901 ± 0.125	0.00001

The test results for the second hypothesis are somewhat surprising. The test was designed to further evaluate the predictive value of the APE biology scores in regard to future performance in the

biology field. The difference between correlations (Sample 2) of two sets of variables, one correlation being in biology and the other in English, was not significant with a probability of greater than 0.50. This means that over 50% of the time one could expect a student to perform just as well in college English (no Advanced Placement preparation) as he did in college biology (Advanced Placement preparation). For Sample 3 the difference between correlations, likewise, proved not significant with a probability between 0.10 and 0.20.

The third hypothesis ($3H_0$) was designed to determine the effect of waiving introductory freshman college courses and proceeding into upper division work. Unfortunately this hypothesis was untestable due to insufficient data.

DISCUSSION

The correlations in the majority of cases in this study are positive and significant to the level of 0.01. In other words, as the value of one variable increases the value of the correlated variable also increases. This correlation data merely describes quantitatively the relationship between pairs of variables. One must be cautious to note, then, that causation or prediction from one variable to another is only implied and not proven. It is practical, however, to draw inferences utilizing a combination of quantitative and qualitative information.

The quantitative evidence implies that scores on the APE in biology can be used as a relatively fair standard for assigning credit or placement at this university. The earlier studies (Bergeson, 1962, 1967; Evans, 1962; Ruch, 1968) showing equal if not superior college performances by low scoring students appears to be directly related to the college biology curricula encountered after the Advanced Placement preparation. In at least one study (Wagner, et al, 1967), the students with low exam scores enrolled in a university course that to all purposes appeared identical to their APP course. The fact that they made good grades is not surprising.

Beginning biology curricula at the University of Arizona vary greatly from the suggested APP studies in the sciences (Frankel, 1959; Lightner, 1961). There are separate beginning courses for majors and

non-majors. Former APP biology students who enroll in these classes, especially the one for non-majors, will find themselves exposed to quite a different science philosophy. Therefore, it is unlikely that an incoming student will be enrolled in a replica of his Advanced Placement course.

Test results also imply that APP-prepared students who do well on the APE can probably be expected to do as well on non-APP related courses in college. This supports recent findings by Chamberlain, Pugh, and Schellhammer (1978) that APP students excel in most of their college work. Their study, however, did not delineate between APP students who received advanced placement and those who began with regular progress courses. Our study seems to imply that as exam scores become higher, their predictive value for specified subjects becomes broader. This would not seem to be the result of the APP "experience." Student aptitude and motivation appear to be a deciding point in these results. This would be a rather mundane consideration were it not for the fact that supposedly all of the APP participants are selected from among the superior students.

There is little doubt that the selection process for APP students on the high school level has changed. In the beginning of the program, selection standards were very stringent (Putnam, 1959; Gerich, 1960). Ralston (1961) in his questionnaire concerning participation policy found that 22 of 46 answering APP schools relied heavily on scholastic aptitude tests as well as teacher recommendations. Seventeen schools indicated that no one criteria was given weight over

any other. As late as 1973, Simpson (1973), states that in some schools only students with a "C" average or above are accepted. In most cases students are also evaluated on their motivation and work and study habits.

Could a change in this acceptance policy be a deciding factor in the positive correlations that were seen for this study? One could say "yes" in view of the small high school survey conducted during this study. The result of this survey indicates that student interest alone is sufficient to place a student in an APP. Thus, students of unequal motivation and intellectual as well as working ability are now perhaps being placed together in the traditional manner of the typical high school class. It seems this would present a feasible contributing factor to our test results. Those who make low grades on the APEs generally can be expected to make low grades in subsequent college work even though they were tested only for biology.

As was mentioned earlier, there was insufficient data to test the third hypothesis ($3H_o$). In several cases this was due to inconsistancies in awarding credit or placement at this university. As late as 1976 students who did very well on the APE in biology were given credit for courses that only are reserved for non-majors in biology. If the student decided to major in the sciences he could not even use these particular courses to count toward graduation.

CONCLUSIONS

Based on examination of correlation coefficients it is possible to reject the first hypothesis. There does seem to be adequate quantitative proof with a high level of significance suggesting that those who do well on their APE in biology will also do well in their college biology courses. In addition, the results of the exam do not appear to be an exclusive predictor of biology performance. Evaluating differences between the correlations for biology and English performances indicate the second hypothesis cannot be rejected. Therefore, students doing well on their APE in biology can be expected to do well in most of their other college work. This is also based on analysis of their cumulative college grade point averages.

Even though the APP "experience" is not the weighting factor in subsequent college performance, the author does realize that for motivated students with good study habits the opportunity to participate in such a program would greatly enrich their academic awareness. The problem seems to be in getting such students once again into the program. This is not meant as a rejection to those who are seeking admittance to the program simply out of subject interest. It is important to reevaluate the ultimate motives of the program and take a hard look at why the selection has changed, however. It cannot be doubted that economic pressure and collegiate competition are among the foremost reasons in changes in selection procedures.

There is also concern that awarding of credit or placement is obviously up to the member college. Gross discrepancies are seen when one considers the very special case of a student receiving a "5" on an exam in physics and subsequently receiving no credit or advanced placement from a member college! Our study certainly seems to indicate that students who score a three or better on the APE in biology can be awarded credit or placement without disappointing results in subsequent college performance. The old assumptions of inadequacy on the part of the high school curricula is no longer acceptable. This is especially ironic when one considers that it is the colleges themselves who contribute heavily to the subject matter presented in the APP courses.

Students from over thirty states and four foreign countries submitted scores from the APE in biology and were subsequently included in this investigation. It is reasonable, then, to assume that the students at the University of Arizona who were selected for this study represent a wide variety of Advanced Placement preparation backgrounds. Based upon this observation and the statistical results, the use of the Advanced Placement program exams as national and international indicators or predictors of future college performance appears to be justified.

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