The Influence of Program Format on the Professional Development of Science Teachers: Teacher Perceptions of AP and Honors Science Courses

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INTRODUCTION

In recent years there has been a shortage of well-prepared science teachers in the United States (Cooper & Hummel-Rossi, 1986; Harrison, 1984; Olsted & Beal, 1984; Guthrie & Zusman, 1982). In the early 1980s, it was reported that science teachers were leaving the teaching profession at four to five times the rate at which they were being replaced (Gifford, 1983). While the exodus may not be as great as it was a decade ago, turnover is still a serious problem and leaves the science programs of many schools in a state of disarray.

Researchers have attempted to identify the main reasons why teachers abandon the profession, and have determined that the insufficiency of opportunities for professional development is a key factor (Dworkin, 1985; McEnany, 1986). In addition, the lack of communication between high school professionals and their collegiate counterparts, due in part to a perceived academic "caste" system (Clark, 1985), may isolate those high school teachers who teach college preparatory or college-level courses. Knowing that professional communication and development are key ingredients to job satisfaction, it is important to understand the role that program format may play in encouraging growth in these areas.

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The purpose of this investigation was to determine which of the formats for advanced science instruction, Advanced Placement (P) or "honors," is more effective at fostering communication between educators and stimulating their professional development. Within this paper, professional development is defined as the process of acquiring further skills, knowledge, training, or professional contacts that may be helpful to the teaching of science. The influence of program format upon instruction and curriculum are the topics of other papers (Herr, 1991a, 1991b).

Although the College Entrance Examination Board's Advanced Placement Program and traditional "honors" programs are designed to serve similar students, they are organized differently (College Board, 1990; Herr, 1991c). Advanced Placement classes are intended to provide a curriculum that prepares students for a national examination by which they may earn college credit and/or advanced standing. By contrast, honors classes provide curricula that are designed on the local level to meet special criteria as established by districts, departments, or individual teachers. We hypothesized that the high standards and accountability of the Advanced Placement Program would help stimulate the professional development of AP teachers and would necessitate a greater degree of communication between teachers and professors than would comparable honors programs.

By investigating such variables as involvement in professional organizations, attendance at professional meetings, the reading of professional journals, and others, we were able to investigate teachers' perceptions of the influence that program format has upon their professional development.

METHODS AND MATERIALS

Instruments

Interviews were conducted to gather information regarding teachers' perspectives of the influence of program format upon their professional development. The hour-long interviews made use of semistructured questions and followed format recommendations outlined by Babbie (1973) and McMillan and Schumacher (1984). In addition, items under consideration for use in the subsequent questionnaire were field-tested for clarity and content.

Following the interviews, questionnaires were constructed to provide detailed information regarding the perceived influence of the program format upon curriculum (Herr, 1991a), instruction (Herr, 1991b), and the professional development of teachers. The questionnaires included Likert scale items (to assess teacher perceptions of the influence of class format upon professional communication, professional development, and teacher learning) and free-response questions (to determine the main reasons individuals teach AP and/or honors science classes). By phrasing questions in a causal rather than correlational fashion, it was possible to demonstrate cases in which program format was perceived as a stimulus for professional development, rather than a reward given to teachers who had already taken advantage of opportunities for professional development.

The questionnaire asked teachers to compare various aspects of instruction in their AP and honors classes with respect to their college preparatory classes. College preparatory classes were defined as those which fulfill basic admission requirements

for laboratory science coursework as specified by the University of California (University of California, 1988) or meet the New York State Regents requirements. These classes were used as an independent point of comparison in order to minimize personal biases that might accompany direct comparisons between AP and honors. Although the definition of "college preparatory" biology, chemistry, and physics varied slightly from school to school, such variation was not a problem since relative values, rather than specific ones, were used in the analysis.

Although the questionnaire was lengthy, virtually all respondents completed it and gave detailed written responses, suggesting that there was significant interest in the topic. Copies of the interview form, transcripts of sample interviews, and the questionnaire have been published previously (Herr, 1990).

Population

Interviews were conducted in the Spring of 1988 with nineteen Southern California teachers experienced in teaching advanced biology courses. The nonrandom sample of teachers was chosen so that there were representatives from private, public, urban, suburban, and rural high schools, as well as from schools representing the range of socioeconomic and ethnic diversity characteristic of the state. All of these teachers were experienced in teaching AP biology, while two thirds were also experienced with honors biology.

In the Spring of 1989, questionnaires were sent to the teachers of AP and honors biology, chemistry, and physics at all 861 high schools in California with graduating classes in excess of 60 students. In order to increase the sample size and the population to which the findings could be generalized, additional questionnaires were mailed to the teachers of AP and honors science at 452 high schools in the state of New York that were considered likely to have advanced programs based upon unpublished information provided by the College Board. The results from the New York and California samples were indistinguishable for almost every variable analyzed, suggesting that sampling biases were minimal.

In order to investigate the perceived influence of program format upon the professional development of teachers, it was necessary to control for classroom composition and to analyze the perceptions of those teachers who said that they were experienced in teaching AP and honors to students of similar academic ability and background. In general, most of these teachers obtained such parallel experiences because their advanced course had been redesignated. For example, a school's most advanced chemistry class may have been originally designated as an honors class, and then redesignated as an AP class the subsequent year (or vice versa), providing the instructor with the experience of teaching AP and honors to similar populations of students.

A total of 847 teachers responded to the survey, including 358 biology, 257 chemistry, and 232 physics teachers. Of these, only 155 (66 biology, 47 chemistry, 42 physics) claimed to have had experience teaching both honors and AP to students of comparable ability and academic preparation, as well as experience teaching traditional college preparatory classes in the same subject. Unless otherwise stated, all results were obtained from this subgroup.

Prior to this research, there was no data base specifying the number and location of honors and AP programs, or of teachers who had taught AP and honors, which precluded the calculation of precise response rates. By dividing the total number of AP examinations in each discipline (College Board, 1989) by the average class size (Herr, 1991d), it was possible to approximate the total number of AP biology, chemistry, and physics teachers. Using this information and the number of surveys returned, it was determined that responses were received from approximately 65% of all AP chemistry teachers as well as 68% of all AP physics and AP biology teachers. With no similar data available regarding the extent of honors programs, it was not possible to calculate the percentage of honors or honors/AP teachers who participated, but there were no reasons to suggest that response rates for these groups were significantly different.

Data Reduction and Analysis

The interviews were recorded on audio tape and fully transcribed. Content analysis (Holsti, 1968) was employed to reduce the large quantity of verbal data into a numerical form that could be more easily interpreted. Content analysis depends upon the judgments of trained analysts who classify or code responses on the basis of explicitly stated rules, and is an objective, systematic, and quantitative technique of studying communication. The transcripts were coded by the researcher and a paid assistant. An analysis of a random sample representing approximately 25% of the coded material showed that inter-coder reliability was 85% (85% of all comments received identical codings by both individuals).

The questionnaires were mailed to a large number of schools in order to obtain a sufficiently large subsample (n = 155) of teachers who were experienced in teaching AP and honors to students of similar ability, academic preparation, and grade level. Differences in student and teacher populations were controlled for by performing within-subject analyses of data provided by these teachers. Such within-subject analyses substantially reduced the number of potentially confounding variables and made it easier to distinguish between cause and effect (Shavelson, 1981). Where possible, these analyses were cross-checked by performing inter-group comparisons to contrast the responses of those who had taught only honors with those who had taught only AP, but no significant differences were found. In addition, the responses of teachers from different regions, disciplines, and academic and professional backgrounds were compared, and again no significant differences were found. The fact that similar responses were obtained using these additional subgroups further substantiated the findings of this study. Tables 1–4 report mean Likert-scale values for AP and honors classes, as well as the differences between these means, and the two-tailed probability that these differences could have arisen by chance.

RESULTS

Professional Communication

Those teachers experienced with parallel honors and AP classes believed that AP was more effective in encouraging and facilitating professional communication

and development (Table 1). While only 1% suggested that teaching honors influenced them more than teaching AP to attend professional conferences, seminars, or workshops, 59% claimed the opposite (40% rated both equally). Part of this is probably due to the fact that the College Board offers workshops for those teaching or preparing to teach AP classes. In addition, numerous colleges offer one- or two-week AP summer workshops in which teachers can obtain subject-specific training to assist them in teaching AP courses. By contrast, there are no major programs designed specifically to train honors teachers.

Instructors reported that teaching AP classes necessitated a greater degree of curricular coordination with instructors of prerequisite classes than did honors or regular college preparatory classes, and stimulated more professional interaction among high school science faculty (Table 1). Teachers were asked to rate the influence of AP and honors formats in terms of the degree to which they promoted or facilitated contact with college instructors (Table 1). By a ratio of 36 to 1, teachers rated the AP Program more highly in this area. Content analysis of interviews with AP/honors biology teachers showed that two thirds had some contact with college professionals in their area. Consider, for example, the following quotes: "AP necessitated contact with biologists at UCLA. . ."; "I was involved in Project RISE. The idea of the program was to get high school teachers in contact not only with each other, but also with college teachers. . . . I thought that it would help me develop the AP Program." AP biology teachers also described their need to establish such contacts in order to carry out the newly required laboratory exercises. They often mentioned that they contacted professors at local colleges in order to borrow materials or use facilities necessary for these experiments.

In summary, teachers perceived that AP facilitated or necessitated more contacts with other professionals than teaching honors did. Such a finding is significant in

TABLE 1
Mean Likert-Scale Values of Teacher Perceptions of the Influence of Class Format upon Professional Communication[a]

	Honors	AP	Difference	Two-Tail Probability
Stimulates me to attend professional conferences, seminars, or workshops	6.29	7.51	1.22	0.000
Promotes discussion and interaction with other high school science faculty	5.88	6.78	0.90	0.000
Promotes contact with college biology (chemistry, physics) instructors	5.66	6.69	1.03	0.000
Necessitates curricular coordination with instructors of prerequisite classes	5.60	6.13	0.53	0.000

[a]1 = "much less than college preparatory (CP)"; 5 = "equal to CP"; 9 = "much more than CP." N = 155 teachers who taught honors and AP science classes to comparable student populations. Two-tailed probability values were derived from the t-test and indicate the likelihood that the differences in the means could have arisen by chance.

light of the articulation and communication problems that exist in American science education today.

Professional Development

It is clear from the data in Table 2 that teachers believed that the AP Program was more effective in stimulating professional development. Of particular note was the fact that teachers believed the AP environment to be substantially more intellectually stimulating, even after controlling for students. (65% claimed that their AP experience had been more stimulating, while only 2% claimed that honors had been, and 33% rated them equally.)

Using a free-response format teachers were asked to explain why they were teaching honors or AP science classes. Content analysis of their written responses showed that the reasons given were quite similar with the exception that 7% more AP teachers cited the need for intellectual stimulation, while 7% more honors teachers cited their desire to have the "best" students. Sixty-three percent of all AP teachers stated that their primary reason for teaching AP science class was related to their need for intellectual or professional growth ("I need the intellectual stimulation," "Stimulates professional growth," "It's a stepping stone to a college job") while only 55% of honors teachers gave such reasons. Teachers were asked: "If you were given total freedom to determine the format in which you would teach advanced biology [chemistry or physics] at your school, which would you select

TABLE 2
Mean Likert-Scale Values for Teacher Perceptions of the Influence of Class Format upon Professional Development[a]

	Honors	AP	Difference	Two-Tailed Probability
Stimulates me intellectually	6.84	8.19	1.35	0.000
Motivates me to read academic and/or professional journals	6.48	7.26	0.78	0.000
The number of *new* biological concepts I have learned by teaching such a course	6.39	7.54	1.16	0.000
The amount of time I must spend studying biology to teach such a class	6.36	7.65	1.29	0.000
Workload associated with teaching such a class	6.64	8.07	1.43	0.000
"Knowledge overflow": the amount that I learn here that I then use in other classes	6.44	7.05	0.61	0.000
"Methodological overflow": *new* techniques learned here used in other classes	5.98	6.29	0.31	0.000

[a]1 = "much less than college preparatory (CP)"; 5 = "equal to CP"; 9 = "much more than CP." N = 155 teachers who taught honors and AP science classes to comparable student populations. Two-tailed probability values were derived from the t-test and indicate the likelihood that the differences in the means could have arisen by chance.

and why?" Content analysis of the results showed that there were many different reasons given for why teachers preferred one program or the other. While 17% of the entire sample mentioned that they would select AP because they felt that it provided a greater intellectual challenge than honors, not one honors teacher said that they would select honors because it provided a greater intellectual challenge than AP. In addition, 20% said that they would select AP because it validated their performance as a teacher. Again, not one honors teacher gave such a response.

A relatively objective measure of intellectual stimulation is the degree to which an individual is motivated to read academic and/or professional journals. Once again, teachers stated that AP was more effective in promoting this. Table 2 shows a relatively large difference existed between the workload associated with teaching AP and honors. Fifty-nine percent of all AP/honors teachers claimed to have spent more time studying their discipline in order to teach AP than honors, whereas only 1% claimed the reverse (39% claimed to have seen no difference). It is clear that AP provided a greater incentive for content-based studying, a key to the intellectual development of teachers.

With respect to the number of hours of preparation required, honors classes more closely resembled college preparatory classes than AP classes. Both during their first year of teaching AP or honors, and during the year of the survey (1989), teachers reported spending an average of two and a half hours per week longer preparing for their AP classes than for their honors classes. This difference was quite large (equivalent to about 6% of a 40 hour work week) and suggested that AP stimulated teachers to prepare more fully for class. A quote from an AP biology teacher expressed this:

> The bulk of my time outside of the classroom is spent preparing for AP. Going over the subject matter myself . . . making sure that I know what I have learned in *Scientific American* just a couple of weeks ago . . . going over my notes. I don't know who would be able to manage it by just turning on the tape recorder from last year, it is just a tremendous amount of work!

Teachers reported that they learned significantly more as a result of teaching AP classes than parallel honors classes (Table 2). To determine the specific influence of program format in this area, we asked teachers to identify how much they had learned in ten different areas. Each questionnaire (biology, chemistry, physics) specified five traditional "high school topics" as well as five "college topics." We hypothesized that teachers would learn the high school topics in greater depth by teaching honors classes, but would learn the college topics in much greater depth by teaching AP as they prepared their students for the national AP examination. The questions were arranged randomly on the questionnaire so as to give no hint of our classification scheme.

Table 3 reports the amount of instructor learning resulting from teaching honors, AP, and college preparatory biology. The first five items were descriptive topics frequently emphasized in high school biology textbooks while the second five were much more physiological and molecular in approach, and were more characteristic of college curricula and current research trends. In all ten fields, instructors reported that they learned more from teaching AP than from teaching honors, and more

TABLE 3
Mean Likert-Scale Values of How Much Teachers Reported Learning about Specific Topics by Teaching AP and Honors Biology[a]

	Honors	AP	Difference	Two-Tailed Probability
High school topics				
Classification of organisms	5.38	6.11	0.73	0.000
Heredity; Mendel's laws	5.84	6.65	0.81	0.000
Biome characteristics	5.40	6.07	0.67	0.001
Cellular structure	6.36	7.45	1.09	0.000
Structure of tissues	5.88	6.79	0.91	0.000
Mean values, high school topics	5.77	6.61	0.84	0.000
College topics				
Principles of speciation	6.11	7.23	1.12	0.000
Molecular genetics	6.45	7.97	1.52	0.000
Ecosystem dynamics	5.56	6.52	0.96	0.000
Cellular metabolism	6.61	8.14	1.53	0.000
Hormonal regulation	6.44	7.66	1.22	0.000
Mean values, college topics	6.34	7.50	1.16	0.000

[a]1 = "much less than college preparatory (CP)"; 5 = "equal to CP"; 9 = "much more than CP." N = 67 teachers who taught AP and honors biology classes to students of similar ability and grade level. Two-tailed probability values were derived from the t-test and indicate the likelihood that the differences in the means could have arisen by chance.

from teaching honors than from teaching college preparatory biology. The absolute and relative increases in instructor learning, however, were far greater for college level topics than for high school topics.

We performed a similar analysis in the field of chemistry and found virtually identical results (Table 4). In all ten fields, teachers reported that they learned more from teaching honors than from teaching college preparatory biology, and more from AP than from honors. Here, however, the influence of program format was seen more clearly in that the increase in learning associated with AP (as compared with honors) among "college topics" was more than double that among the "high school topics."

It was not possible to perform a similar analysis among the physics teachers for a variety of reasons. First of all, AP physics teachers may teach either Physics-B (non–calculus-based) or Physics-C (calculus-based). In addition, Physics-C teachers may cover the entire Physics-C curriculum, or they may prepare their students only for the first (mechanics) or second (electricity and magnetism) exam. Thus, there are four different curricular forms of AP physics: B, C, C1, and C2. After limiting our attention to just those who had taught honors and AP physics to comparable students, we no longer had a sufficient sample size to perform an analysis on each subgroup.

Finally, teachers were asked to respond to the following comment: "Teaching AP biology [chemistry or physics] has contributed more to my professional growth than any other classes have" (Figure 1). Fifty-three percent of the 570 teachers

TABLE 4
Mean Likert-Scale Values of How Much Teachers Reported Learning about Specific Topics by Teaching AP and Honors Chemistry[a]

	Honors	AP	Difference	Two-Tailed Probability
High school topics				
Nomenclature	5.52	5.78	0.26	0.175
Stoichiometry	5.69	6.45	0.76	0.003
Periodicity	5.64	6.07	0.43	0.016
Chemistry of metals	5.62	6.24	0.62	0.005
Gas laws	5.71	6.47	0.76	0.001
Mean values, high school topics	5.64	6.20	0.56	
College topics				
Nuclear chemistry	5.56	6.29	0.73	0.000
Electrochemistry	6.00	7.12	1.12	0.001
Kinetics	6.10	7.79	1.69	0.000
Thermodynamics	6.00	7.76	1.76	0.000
Electron behavior	5.80	6.85	1.05	0.000
Mean values, college topics	5.89	7.16	1.27	

[a]1 = "much less than college preparatory (CP)"; 5 = "equal to CP"; 9 = "much more than CP." N = 42 teachers who taught AP and honors chemistry classes to students of similar ability and grade level. Two-tailed probability values were derived from the t-test and indicate the likelihood that the differences in the means could have arisen by chance.

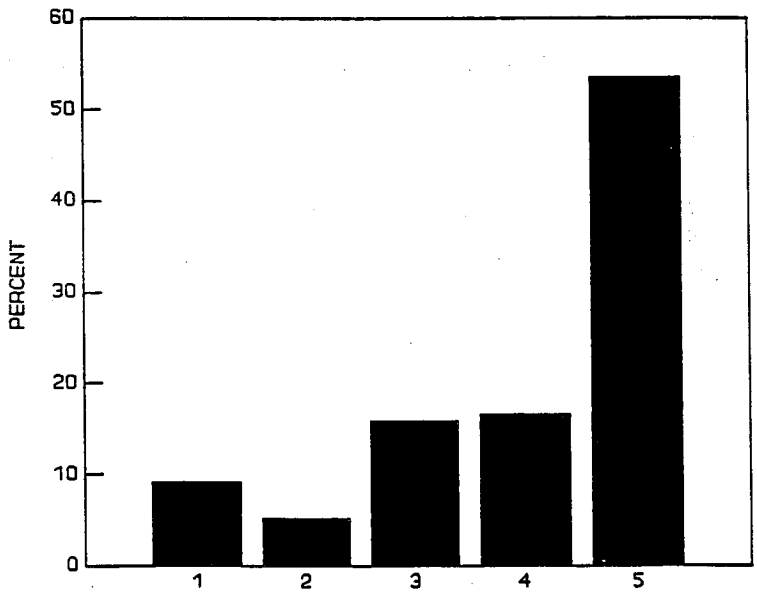

Figure 1. Response of AP science teachers to the statement: "Teaching AP biology [chemistry or physics] has contributed more to my professional growth than any other class has." (N = 570; 1 = strongly disagree, 3 = no opinion, 5 = strongly agree.) Results were virtually identical for the 155 teachers who had taught AP and honors classes to comparable students.

responding said that they "strongly agreed" with the statement, while an additional 17% indicated moderate agreement. Those agreeing outnumbered those disagreeing by a margin of 5 to 1 (mean value = 4.00 for all 570 teachers; 3.98 for the 155 teachers who had taught AP and honors to comparable students). The fact that this margin was so great showed that the teachers believed AP had a powerful influence on their professional development.

SUMMARY AND DISCUSSION

By peforming a within-subjects analysis of teachers who were experienced in teaching AP and honors to students of similar academic ability and background, it was possible to minimize the influence of potentially confounding variables, and thereby make it easier to distinguish between cause and effect. Rather than contrasting the professional development of AP teachers with honors teachers, it was possible to study the perceived influence of AP and honors on the same group of teachers. Differences in professional growth could therefore not have been due to inherent differences in AP and honors teachers, because all were experienced teaching both.

As hypothesized, the data suggest that the AP Program necessitates a greater degree of communication between teachers and professors than do comparable honors programs. Teachers are much more likely to attend professional conferences, seminars, or workshops in order to prepare for teaching AP classes than parallel honors classes. In addition, teachers reported that AP necessitated more contact with college professors as well as more curricular coordination with other members of their own faculty.

We hypothesized that the high standards and accountability of the AP Program would help stimulate the professional development of AP teachers. Our data show that those teachers who are experienced in teaching AP and honors to comparable students clearly believe this to be the case. Teachers report that AP is much more effective than honors in prompting them to read journals, participate in professional organizations, seek further training, and keep current in their disciplines. Teachers reported that they spend two and one half hours per week more preparing for their AP classes than comparable honors classes. Much of this preparation time is personal study, as reflected by the fact that teachers report spending more time studying their discipline in order to teach AP than to teach honors by a ratio of 59 to 1. This additional studying broadens their knowledge base, as evidenced by the fact that teachers reported learning significantly more of their disciplines by teaching AP than by teaching honors in 100% of the specialties in question.

The greatest gains in teacher knowledge were in the more advanced fields typically not taught in high school, indicating that AP not only encourages teachers to obtain greater depth in their fields, but also greater breadth. When asked why they chose to teach AP, teachers most commonly stated that they needed the intellectual stimulation that it provides, or they needed the assessment of the AP examination to validate their performance as a teacher. The majority of those who have taught AP and honors claim that teaching AP has contributed more to their professional growth than any other classes have. Although the AP Program is apparently quite effective in stimulating the professional development of teachers,

its influence on pedagogy is equivocal (Herr, 1991b), and little is yet known about how participation in this program affects one's teaching of non-AP courses.

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