MORE ABOUT COLLEGE RESEARCH

by

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One of my pleasant tasks these last three Septembers has been to assemble information on the research activities of the Midwestern Liberal Arts College Chemistry Departments. Every institutional member of the group has been most co-operative so it's not necessary to resort to blackmail to get the information and the collective information is in the expanding direction, and hence it is a pleasure to prepare the report. In a sense, the report this year is a report of your newly formed Research Advisory Committee, for the information it contains was gathered as the result of committee action taken at the Cincinnati A.C.S. meeting of last Spring.

This year's report will again cover both "productivity" and "creativity," the terms having the meaning set up for them at the Appleton meeting of MACTLAC--and I might add, having the same limitations. By "productivity" is meant the number of chemistry Ph.D.'s who receive their undergraduate training in the colleges in our (or some other) group. "Creativity" means, for the purpose of this report, the amount of money and the number of grants our schools have received for research, although in this report I'm going to spread out into the publication field for supporting evidence. May I again stress, as I have before, that a school may be extremely productive in training B.S. chemists (and I might add, this is the current greatest shortage according to industry) and rate low on the productivity scale. Another school may be quite independent in the matter of asking for support for its research or carry on a wonderful program of "research in teaching" and rate way down in its "creativity index." More power to both groups.

The latest report* from the National Research Council's Office on Scientific Personnel (just out at $2.00 per copy) gives us some additional data on productivity for the doctorates awarded in science from 1936-50, inclusive.

In general there seems to be a trend toward the increasing baccalaureate preparation of scientists in doctorate-granting institutions. The 1936-45 period covered in the first report from that office, commonly referred to as the Trytten report, had about 57% of the doctorates coming from undergraduate training in such institutions; the second period, 1946-50, inclusive, reports 67.3% in this category. It's not so for the combined fields of chemistry and biochemistry, for here there's very little difference between the two periods--the universities training somewhat under 63%, the colleges somewhat over 30%. The difference between the sum of these and 100 is made up of students from technical institutions and teachers colleges. Colleges, by definition, appear to be nondoctorate-granting institutions which are neither technical institutions nor teachers colleges, and this brings together as colleges strange bed fellows, but by and large the institutions in the college category are liberal arts colleges similar to those making up this organization. It may come as a surprise to some of you that the universities are giving undergraduate preparation to about two thirds of our chemical Ph.D.'s; as a matter of fact, universities during 1948-49 graduated twice as many men as did the colleges.

But to get back to productivity--of first interest is the fact that the rate of production of chemistry Ph.D.'s increased during

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the 1946-50 period by about one quarter. The increase for universities was 24.8%, for colleges 23%, but for MACTLAC colleges only 7%. Our colleges sent on 527 to the Ph.D. from 1936-45 and 282 in the 1946-50 period [note that these years are the years when the Ph.D.'s were conferred--not the baccalaureate degrees]. We might gain the impression from this that we're not keeping out end up, but actually the MACTLAC colleges during the 1936-45 period were more than twice as productive as all colleges and on a par with the productivity of all institutions, including universities with productivity measured not in per cents but in actual numbers. MACTLAC colleges averaged 7.7 Ph.D.'s in the ten-year period 1935-45, all colleges 3.5, all institutions (including universities) 7.1. On a comparable basis during 1946-50, MACTLAC colleges averaged 8.3, all colleges 4.3, all institutions 8.8. We are all progressing, but the other colleges are slowly catching up. Our standards are not falling, theirs are rising.

Another point of interest is the fact that a higher percentage of MACTLAC colleges participate in undergraduate training of chemical Ph.D.'s than do the colleges of the country. The 1936-45 chemistry Ph.D.'s had training in 332 of our 482 colleges, or 69% of the number; 85%, on the other hand, of the MACTLAC colleges sent students on to the Ph.D. during that period. To the 1945-50 group 57.8% of all colleges supplied Ph.D. material compared to 72% for the MACTLAC colleges. (The over-all fall-off from 69% to 57.8% should not cause alarm for the second period was just half as long as the first, and quite a number of the nonproductive schools might have shown some productivity in a second five-year period to bring up the over-all percentage.) MACTLAC colleges make up only 14.2% of all colleges, but 16.8% of the colleges giving

undergraduate training to the Ph.D. in the 1936-45 period, and 17.6% in the more recent period.

Another interesting statistic has to do with the relative number of colleges in the higher productivity range. During the first period there were 30 colleges listed as producing at the rate of better than one Ph.D. a year; they include Oberlin, DePauw, Wooster, Hope, Central (Mo.), Kalamazoo, Carleton, Antioch, Wheaton, Monmouth, Augustana, St. Thomas, St. Olaf, Grinnell, Wabash, Calvin, Knox, Lawrence, Beloit, Alma, Milliken, and Ohio Wesleyan; 16 of these were MACTLAC colleges, or 53%. From 1946-50 46 colleges are so listed, and 22 are MACTLAC colleges, or 48% of the total. We go up from 16 to 22, all colleges from 1930-46. There are 155 colleges and universities listed as producing more than one a year. MACTLAC makes up 14.2% of the number, although we make up only 8.7% of the total number of colleges and universities in the report.

As an aside, and for what it's worth, there is one trend in the National Research Council report which seems significant, and that is the fact that there seems to be a lessening interest in the field of biochemistry on the part of the college chemistry graduates. During the first ten-year period 208 students with undergraduate training in colleges got their Ph.D.'s in the field of biochemistry; in the second period only 60. The production rate in the second period was only 60% of that in the first period, while comparable figures for all institutions show that the over-all rate in the second period is about 80% of that in the first--hence the above statement of trend.

But enough of such statistics. They do show that the liberal arts colleges are maintaining their relative effectiveness in production of chemistry Ph.D.'s. They do not give MACTLAC colleges too much comfort, for they show that MACTLAC colleges are not increasing their productivity at as great a rate as are either all colleges in the country or all universities in the country. It is important to remember that even the latest of these statistics cover the period of undergraduate training running about up to 1946 or 1947. These do not tell us how productive we now are nor can we even guess what effect MACTLAC has had on our productivity. If the conference feels this to be a matter of interest, we might include leading questions on our own 1950-55 productivity in the next Fact Finder.

For the report on current creativity, I am drawing upon the returns to the recent questionnaire. These were sent out to the 68 colleges making up the MACTLAC membership list and to some nonmember interested colleges who have participated in earlier questionnaires. Sixty one of the 68 responded. These 61 colleges report 162 full-time teaching staff, or 2.6 members per college. Of the 162, 105 or 60% are engaged in research. These 105 faculty members are connected with 49 of the 61 colleges, so staff research is in progress in four fifths of our colleges which may be compared to an analagous figure of 25% for all colleges. In two thirds of the colleges or 47, student research is being done. Ninety of the 105 faculty carried on research work during the school year, 63 in the summer, some of course working in both periods. Of the 42 colleges reporting student research, 40 had 169 students working in the school year, 19 had 42 students in the summer. This compares well with the 1954 report which stated that 128 students

were researching in 36 colleges, and 64 faculty were researching in 43 colleges. We have gone up this year in the number of colleges reporting research, in the number of staff researching, and in the number of students researching. A revealing statistic in connection with this is that during the summer of 1955, $28,552 were used to pay faculty and a few student salaries in support of summer research in 15 colleges and for 31 researchers. This is a real advance. Our goal is financial support for all those who are able to carry on summer research in their own laboratories. There is quite a way still to go.

Another set of facts of interest has to do with financial support of research in MACTLAC colleges. In Table I I have tried to summarize the 1955 figures for comparison with the 1948-53 figures presented in Appleton and the 1954 figures presented in Grinnell. The actual amount of money reported in 1955 over 1954 shows a slight increase, the '54 figure being $138,083 in 43 colleges, the '55 figure being $143,790 in 48 colleges. Industry, government, and the Research Corporation furnished the backbone of the '55 grants. Twenty-nine grants were made by industry, 20 by the Research Corporation, and an indeterminate number under government and others. The contributions of the Research Corporation to college research are clearly shown, and the number of their grants has increased from 14 to 20. More industry grants have been made--21 in '54 and 29 in '55, although the total amount has gone down somewhat. During the earlier years the principal sources of industry income were Du Pont and Standard Oil of Indiana. This is no longer true. This year's list shows contributions from Dow, Du Pont, Standard Oil of Indiana, Standard Oil of

TABLE I

RESEARCH INCOME

	1953 Report 1948-53 Figures Averaged to 1 Year	No. Grants	1954 Report	No. Grants	1955 Repor
Industry	$11,760	21	$60,327	29	$42,700
Government and others	26,170		37,272		41,512
Research Corp.	13,596	14	17,765	20	41,252
National Science Foundation	0	4	9,524	5	12,826
College	5,810		13,195		5,500
Total	57,336		138,083		143,790
MACTLAC Colleges Researching			43		48

Ohio, Cyanamid, Upjohn, Johnson's Wax, Minnesota Mining, and Monsanto, as well as grants from the Petroleum Research Fund of the American Chemical Society. The category "Government and Others" includes Army Ordnance, the O.O.R., Office of Naval Research, Kettering Laboratory, the Illinois Academy of Science, American Heart Association, Wilson Fund, Sigma Xi, and gifts from alumni funds of various kinds. Actually I think it may be said that many of the colleges in a position to carry on research are probably now receiving financial support and, in many cases, about all they can use. This is never completely true, for we all think that more money would mean more research workers and equipment (and, I add, not more space in which to work).

The big problem now remaining to us is that of activating programs in the colleges needing help in starting research, in ideas, guidance, co-ordination, and ultimately money. I am optimistic about the possibilities along these lines during this coming year. I believe that we can show other colleges the way. In this connection the Research Corporation has indicated a very considerable interest in co-operating programs of this type, and I am pleased to quote the following from a recent letter from Mr. Charles H. Schauer of the Corporation:

> "We are very interested in helping to support science and better science teaching, most especially in the smaller colleges. ..... With you we are convinced that an effective teacher in the experimental sciences can be kept alive and alert to the new developments in his professional field only if he can maintain some active research interest. Accordingly, we try to stimulate wherever possible and are glad to find others who are working in that direction in fostering the pursuit of new knowledge at all academic institutions. In the specific case which you cite (a co-operative project between a college and The Institute of Paper Chemistry), as well as in the general idea of working with other small colleges, we would be favorably disposed. This assumes a sound proposal for reasonably independent work on the part of the applicant with guidance and co-ordination primarily coming from the major institution involved. We would be glad to expand on this in any way you might wish and/or to consider any concrete examples."

I should like to report on the proposal which led to this letter from the Research Corporation. Professor Grothaus of Olivet Nazarene College in Kankakee wrote last year to Dr. Haenisch asking whether it would be possible for his college to get some research going and how MACTLAC could help. The letter was referred to me as Chairman of the Research Advisory Committee. I asked our Institute faculty for suggested subjects for research. [This was easier at the time than going to a MACTLAC school.] Two subjects were suggested by one of our men, and either seemed to be the type which would fit into the facilities and time of Olivet Nazarene College. The college concurred in the idea of a joint program and has approached the Research Corporation for a grant to cover the purchase of equipment and the expenses of student assistants. It is in connection with this Olivet Nazarene proposal that Mr. Schauer's letter was written. A follow-up letter has come indicating that this type of a proposal will receive very serious consideration. This relates directly to the answers to the question asked of MACTLAC. Eleven colleges said they were willing to sponsor research, and eight colleges wished to carry on research and asked for help in getting started. If we can tie these two groups together in an effective program, I think we can feel that the MACTLAC colleges have found the formula which can be followed by other colleges in other parts of the country.

"Creativity" and research publication go together. We requested information on two periods--September 1951-September 1953, and September 1953-September 1955--with the latter period representing the period of MACTLAC activity. From 1951-53, 22 colleges reported 27

publications in various journals of the American Chemical Society and other professional societies, five papers were read before Academies of Science, one paper read before the American Chemical Society (either section, division, or national meeting), one scientific lecture, and three student papers. For the second period 25 colleges reported 30 papers in various A.C.S. and other professional journals, 23 papers read before A.C.S. and other professional society sections or national meetings, 28 papers read before Academies, seven read before other groups and five student papers, or 37 papers or speeches for the 1951-53 period and 93 papers or speeches for the 1953-55 period. These figures are qualitatively accurate, not quantitatively, for I rather suspect that some reporters may have had some difficulty in remembering their activities in this field five years ago, but still it does show that there is a very definite increase in research interest and in the reporting of this research interest. This is in line with the increase in grants during the first five years of the '50's and with the increase in the number of staff and students carrying on research. It's bound to be reflected ultimately in the productivity figures.

I had intended for the final section of this report to summarize suggestions telling how those without ideas might go about getting ideas. I have already mentioned one way--namely, to seek a co-operative arrangement with another college, the second college providing the ideas. Financing could follow. Dr. Thiessen of Monmouth has suggested a way for members of a college staff getting ideas themselves; this is by setting up a chemistry literature course in which research reports are studied.

At the Cincinnati meeting we had a general experience meeting on Liberal Arts College Research, and a number of people from different sections of the country participated. It seemed to be the general opinion that college staff and undergraduate research were extremely valuable. The College of Wooster program was described; it has already been covered before the MACTLAC colleges; this continues to be extremely fruitful with many undergraduates getting research experience, the juniors starting in the library, the seniors in the laboratory. The University of Redlands has an undergraduate program which is extremely productive and which has had financing. Creighton University in Omaha and North Dakota State College have programs. Sam Massie, now at Fisk University, was enthusiastic about the results of undergraduate research as a preliminary to graduate work. Centre College, Danville, Kentucky, has had such a program for a number of years, pointed in three directions--(1) research in teaching, (2) co-operation with the National Co-operative Undergraduate Research Program, and (3) staff member research with industrial support, part time in the college year, full time in the summer. Their industrial support has been steady and continuous and, as a matter of interest, on November 19 I am spending a full day at Centre College talking on research in the colleges with the faculties of the liberal arts colleges of Kentucky, using MACTLAC as a point of departure. Colgate University reported a program of research in their senior physical chemistry, also sponsorship from the ONR, the Research Corporation, and Du Pont. They have been very fortunate in getting the help of their graduates in getting equipment for their program. Antioch College has an inter-departmental approach

to a problem, and I can speak from having visited Antioch that this is extremely effective both in the production of money and results. This helps our science departments to get going--I can recommend it. DePaul University in Chicago uses their course in Qualitative Organic Chemistry as a research in teaching device. Dickinson College has an Honors Course which feeds into graduate school; they also carry on inter-departmental research.

In conclusion let me say that there are many ways of going about it. Interest is now developing from the state universities in university-college co-operative research projects. The National Science Foundation is definitely interested and has been considering ways and means. The summer conferences on teaching of chemistry put on by the Division of Chemical Education with the financial help of the National Science Foundation offer many opportunities for people who would like to start research programs to talk with those who are successful in their researches, getting ideas, inspiration, and help. The Division of Chemical Education has an increasing program of summer conferences and institutes planned for 1956; scholarships are available for those conferences. Any of you in MACTLAC who need stimulation should get in on some one of these conferences. I'll be happy to put you in touch with the authorities. Finally I might say that the opportunity of working in industry in the summertime occasionally should not be overlooked as a means for getting real education and understanding. Dr. Weaver at Wabash College believes that such an experience every five or six years is a wonderful thing for a teacher. As Dr. Van Zyl has said so often, the way to start researching is to take off your coat, roll up your sleeves, and start.