

4-1940

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Palmer O. Johnson  
*University of Minnesota*

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### Recommended Citation

Johnson, P. O. (1940). The Measurement Of The Effectiveness Of Laboratory Procedures Upon The Achievement Of Students In Zoology With Particular Reference To The Use And Value Of Detailed Drawings. *Journal of the Minnesota Academy of Science*, Vol. 8 No.1, 70-72.  
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## Science Education

### THE MEASUREMENT OF THE EFFECTIVENESS OF LABORATORY PROCEDURES UPON THE ACHIEVEMENT OF STUDENTS IN ZOOLOGY WITH PARTICULAR REFERENCE TO THE USE AND VALUE OF DETAILED DRAWINGS

PALMER O. JOHNSON  
*University of Minnesota*

#### ABSTRACT

In the biological sciences it is customary to require carefully prepared, detailed drawings by students in the laboratory under the assumption that this activity is fundamental to an understanding of plant and animal structures and functions and that the character of the drawings is an index of laboratory accomplishment. The time spent by students in making acceptable drawings and by the instructors in grading drawing plates constitutes a very considerable proportion of the total time and energy of student and instructor.

The Department of Zoology had long felt the need for a revision of the laboratory procedures in general zoology. Detailed drawings were required from the students and these drawings formed the basis upon which the laboratory grades of the students were determined. It was recognized that drawings can serve only as extremely unreliable and subjective means of determining laboratory outcomes. Only to the extent that drawing ability and outcomes of laboratory instruction and experiences are highly positively correlated could laboratory drawings serve as a valid means for estimating student achievement. It was decided, therefore, to set up other procedures and to subject them to systematic observation and evaluation. Accordingly in 1937-38, the practice described in the following statement to students was inaugurated:

"Hereafter drawings will not be collected at the end of each laboratory period. They must be turned in, however, on October 25, 26, or 27 for checking by your laboratory instructor and again on December 2, 3, or 4.

"Your laboratory grade will be determined by a series of short unannounced written or practical examinations which will cover all the laboratory work. Your drawings will affect your grade only in the event that they are missing or uniformly incorrect.

"You should, then, spend the greater portion of each laboratory period studying the material and a minimum of time in drawing. You may find it advantageous, however, to make quick sketches throughout the period of various aspects of your own material, the

best features of your neighbors' and of the demonstration material. The final product may be a rapidly constructed composite picture drawn from these various sources. It will not be necessary for you to strive for beauty of lines or perfection in printing. . . . Your instructor will attempt to correct any misconceptions which you might have concerning your work during the laboratory hour. Nevertheless, you should make it a point to check your own work against your lecture notes, textbook, manual, or any other source during the laboratory period or between successive laboratory periods."

Practical examinations on the laboratory outcomes supplanted the drawings as a basis for determining student accomplishment. Much care and ingenuity were expended in developing these examinations and in working out efficient methods of administration.

TABLE I. COMPARISON OF ACHIEVEMENT OF THE 1936-37 AND THE 1937-38 GROUPS ON COMPREHENSIVE EXAMINATIONS OVER THREE QUARTERS

Statistic	1936-37 (N = 456)	1937-38 (N = 433)	Differ- ence	t	F	P
Lecture Comprehensive						
Mean . . . . .	159.94	163.64	3.70	{ 1.44*	. . .	.16
				{ 1.82	. . .	.09
Standard deviation . . .	30.41	30.15	-0.26		1.02	>.05
Laboratory Comprehensive						
Mean . . . . .	136.35	147.66	11.31	{ 6.93*	. . .	<.001
				{ 7.01	. . .	<.001
Standard deviation . . .	25.34	22.54	-2.80		1.26	<.01

\* Corrected for group inequalities in High School Rank and College Aptitude Test Rating.

While several subsidiary problems were studied including the validity and reliability of laboratory grades based chiefly on laboratory drawings over a five year period, only the comparisons on lecture and laboratory outcomes as measured by a separate comprehensive examination over each, between the groups of students under the old plan of procedure in 1936-37 and the group of students following the innovating practice in 1937-38 described above can be presented here. The comprehensive examination over the lectures was one of a number that had been prepared during a previous three year period, 1933-36, devoted to the construction of examinations in zoology. The laboratory comprehensive was one developed through the initiative and resourcefulness of Professor Wodsedalek.

The main findings from the comparison are presented in Table I. It is noted that the average (arithmetical mean) of the 1936-37 group of students on the lecture-comprehensive examination was 159.94 as compared with an average of 163.64 for the 1937-38 group, a difference of 3.7, which difference, however, is not to be regarded as statistically significant. The mean of the 1936-37 group of stu-

dent on the laboratory comprehensive was 136.35 as compared with a mean of 147.66 for the 1937-38 group, a difference of 11.31, which is statistically significant. In Table II summary statistics are given on College Aptitude and High School ratings which permit a comparison of the two groups of students on two characters providing a basis for determining the relative capacity for achievement. This information was necessary to enable a more precise estimate of the

TABLE II. COMPARISON OF 1936-37 AND 1937-38 GROUPS ON SPECIFIED BASIC CHARACTERS

Statistic	1936-37 (N = 456)	1937-38 (N = 433)	Differ- ence	t	F	P
College Aptitude						
Mean .....	5.1759	5.1042	-.0717	1.04	...	.32
Standard deviation ...	.9476	1.0969	.1493	...	1.34	<.01
High School Rank						
Mean .....	5.9408	6.0949	.1541	2.22	...	.03
Standard deviation ...	1.0302	1.0311	.0009	...	1.00	>.05

differences in achievement of the two groups as recorded in Table I.

From this investigation it may be inferred that students pursuing zoology under the new plan, in so far as they may be representative of the groups constituting the subjects of this investigation, may be expected to do at least equally well if not better in achieving the outcomes as measured by the lecture-examination and that with respect to the achievement of the laboratory outcomes as measured by the laboratory examination, they may be expected to do better than under the old plan where emphasis was placed on detailed laboratory drawings. Furthermore, the reactions of students as well as of instructors indicate a preference for the new procedure. The students have more time to study their materials and good students with little drawing ability are no longer penalized by their inability to make polished drawings in a course where this outcome does not loom large as an important outcome of instruction. The considerable burden of grading and correcting drawing plates has been lifted from the instructors thereby saving time for their more significant functions.

Additional values may be expected to accrue to students from the use of a new laboratory manual completed by Professor Wodse-dalek and introduced this year, 1938-39, in which he includes numerous accurate and detailed drawings for all of the major exercises.