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AUTHOR Barry, Roger D.; Carter, Robert A.
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ABSTRACT

This document presents an evaluation of an instructional system to assist students in the general chemistry course. These materials include a series of 16mm sound motion picture films that outline the required laboratory experiments, slide/tape programs for individual student use designed to teach the student how to analyze and draw conclusions from the laboratory data for each experiment, similar slide/tape programs covering many of the lecture topics, and an instructional booklet that contains sets of problems and learning exercises related to lecture topics and an outline of each laboratory experiment. Four major points can be cited as a result of the evaluation study: (1) the achievement of students who used the slide/tape programs was superior to the achievement of those who chose not to use them; (2) for those students who used the materials, achievement tended to increase slightly as the amount of time devoted to the slide/tape programs increased; (3) a slightly higher proportion of low than high ability students chose to use the slide/tape materials; and (4) lower ability students who chose to use the materials tended to spend slightly more time on them than did high ability students. (HS)

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EVALUATION OF GENERAL CHEMISTRY SLIDE/AUDIO - TAPE PROGRAMS

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Roger D. Barry, Professor
Department of Chemistry
Robert A. Carter, Academic Media Coordinator
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OFFICE OF INSTITUTIONAL RESEARCH
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FOREWORD

The staff of the Office of Institutional Research is pleased to have been of assistance in the evaluation study reported herein. Assistance included consultation on evaluation design, statistical analysis of data, and editorial services.

Kalmer Stordahl, Director
Institutional Research

INTRODUCTION

During the past five years the Chemistry Department and the Learning Resources Division have cooperatively developed an instructional system to assist students in the general chemistry course. These materials include a series of 16mm sound motion picture films which outline the required laboratory experiments, slide/tape programs for individual student use designed to teach the student how to analyze and draw conclusions from the laboratory data for each experiment, similar slide/tape programs covering many of the lecture topics, and an instructional booklet which contains sets of problems and learning exercises related to lecture topics and an outline of each laboratory experiment.

As a first attempt to evaluate the instructional materials, the slide/tape programs were scrutenized. Each program consists of a sequence of 2" x 2" color slides (40 to 80) with the instructor's comments for each slide recorded on audio tape. At the time of the study, 22 slide/tape programs were available for student use; a list of titles is included in the Appendix.

The general format for teaching the course in which the slide/tape programs were evaluated was lecture, discussion, and laboratory supplemented by out-of-class use of the slide/tape materials. Lecture sections with approximately 100 students per section met two hours each week throughout the semester; discussion and laboratory sections met one hour per week with approximately 20 students in each section. The slide/tape programs were used at the Learning Resources Center in study carrels equipped with a slide projector and a cassette audio tape playback unit (See Figure 1). The audio tape provided verbal instructions for changing slides, for computation pauses, for work sheet drill, and other relevant activities.

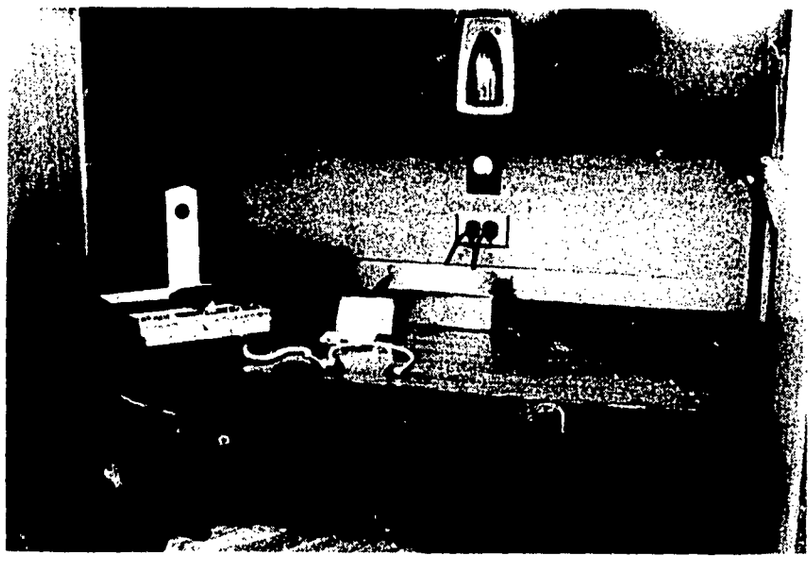

Figure 1. Typical arrangement of study carrels used by Chemistry students.

Each student who used the slide/tape materials was provided with a brief printed outline for use with each program. The outline contained problems and charts discussed in the program and provided the student with a work sheet which he retained for future study. Although most of the topics covered by the slide/tape programs were also covered in the lecture section of the course, some were not. Topics taught only through the slide/tape programs were logarithms, dimensional analysis, scientific notation, and significant figures. The students were told that competence in these topics was necessary and that they should use the prepared programs in learning or reviewing these subjects. Sets of problems assigned for each of these topics enabled the student to test his comprehension of the topic.

Even though some slide/tape programs were assigned by the Instructor, the majority of the programs were available on the students' initiative and time schedule. The Instructor distributed to all his students the program titles, the laboratory work schedule, and lecture topics covered by each of the three quizzes administered so that each student would have knowledge of all the opportunities available for the study of Freshman Chemistry. Thus, students were informed of the availability of the slide/tape programs and were encouraged, but not required to use them. A record of the amount of time (in minutes) that each student spent on each program was maintained and this time record constituted the independent variable for the study reported here. In this study the following questions were posed:

(1) Was the achievement of students who used the slide/tape materials superior to those who did not?

(2) Was the achievement of those students who used the materials related to the length of time they devoted to them?

(3) Was utilization of the materials related to the student's academic ability?

STUDENT SAMPLE

The sample consisted of students enrolled in General Chemistry 101 in the Fall Semester of 1970. Only those students who completed the course and for whom entrance test (ACT) scores were available were included; the total number of students meeting these criteria was 161. Most but not all of the students were first-semester freshmen.

ACHIEVEMENT CRITERIA

The following measures of achievement were used as criteria:

1. Laboratory Grade. The laboratory grade for the semester was the sum of "points earned" in laboratory experiments.

2. Quiz Grades. Three quizzes were given at intervals during the semester. Each quiz was intended to measure achievement in the immediately preceding segment of the course; that is, during the time interval since the preceding quiz.

3. Final Grade. Final course grade was expressed in terms of grade points earned using a numerical value of 4.0 for an A, 3.0 for a B, etc.

STATISTICAL ANALYSIS AND RESULTS

To answer the question of whether the achievement of students who used the slide/tape materials was superior to those who did not, students were classified as users or non-users with respect to the materials related to each of the criteria. For example, the students who used one or more of the slide/tape programs designed to teach terminology, principles, and concepts tested in Quiz 1 were considered users with respect to that criterion, whereas those who did not use the materials were classified as non-users. This same general procedure was applied to each achievement criterion. As would be expected, only a small number of students were classified as non-users with respect to the criterion of Final Grade as only those who used none of the materials were thus classified. In the case of the Laboratory Grade, however, more than 40 percent of the students had not used any of the related slide/tape materials.

Each criterion was analyzed by analysis of variance and covariance to ascertain whether there was any significant difference in the achievement of users and non-users. Composite ACT scores were used as a covariate to take into account (and to adjust criterion scores for) differences in general academic aptitude between the user and non-user groups, since the groups were self-selected rather than randomly assigned.

Mean achievement scores on each criterion for user and non-user groups are given in Table 1. As can be seen from the table, students who used the slide/tape materials earned higher scores on all achievement criteria even though they tended to have lower average ACT scores. On three of the five criteria the difference was statistically significant at the .01 level.

Table 1. Adjusted Mean Achievement Scores and ACT Composite Means for Students Who Used and Did Not Use Related Instructional Media.

	User			Non-User			
Achievement Criterion	N	Criterion Mean	ACT Mean	N	Criterion Mean	ACT Mean	F for Criterion
Laboratory Grade	91	230.7	23.05	70	197.3	23.55	23.66*
Quiz 1 Grade	104	58.8	23.19	56	54.1	23.57	1.66
Quiz 2 Grade	98	65.7	23.01	61	48.3	23.72	47.77*
Quiz 3 Grade	71	66.5	23.03	88	61.4	23.53	2.77
Final Grade	135	1.95	23.13	26	1.27	24.04	6.71*

*Significant at .01 level

To answer the second question posed for this study, namely, whether the amount of time devoted to the slide/tape materials by the users was related to achievement, the correlation between each criterion score and the number of minutes spent on related slide/tape programs was ascertained. Coefficients were calculated for students with ACT composite scores designated as "high" (26 and above), "average" (22 - 25) and "low" (21 or below), as well as for the entire group to determine whether the relationship might vary with academic aptitude. In addition, the correlation between ACT composite scores and time devoted to using the slide/tape materials was obtained. As previously noted, this aspect of the analysis was based only upon those students who had used the slide/tape materials relevant to a given criterion score.

As shown in Table 2 there tended to be a low positive relationship between the number of minutes devoted to the slide/tape materials and related achievement criteria; that is, the greater the amount of time spent in using the materials, the higher a student's achievement tended to be. It should be noted, however, that most of the coefficients reported in Table 2 are not statistically significant, although they are quite consistently positive.

Table 2. Correlation Coefficients Obtained Between Achievement Scores and Time Spent on Related Instructional Materials - User Group Only.

	All Students		ACT 26 & Above		ACT 22 - 25		ACT 21 or Less	
Criterion[1].	N	r	N	r	N	r	N	r
Laboratory Grade	91	-.01	27	.25	31	-.02	33	.01
Quiz 1 Grade	104	-.01	30	.17	39	.06	35	.11
Quiz 2 Grade	98	.16	27	.23	36	.34*	35	.22
Quiz 3 Grade	72	.16	17	.23	31	.26	24	.00
Final Grade	135	.18*	39	.14	49	.20	47	.31*

*P<.05

1. Independent variable was number of minutes spent on related material.

Academic aptitude as measured by ACT composite scores was found to have a low negative relationship to the number of minutes students spent on the slide/tape programs, except in the case of the programs associated with Quiz 3 where the relationship was positive but not statistically significant (See Table 3). In other words, students with low ACT scores tended to use the materials a slightly greater length of time than those with higher scores. Also, a slightly larger proportion of the lower than upper ability students used the slide/tape programs. As can be seen from Table 4, about 87 percent of the students with ACT scores of 21 or less used some of the slide/tape programs, whereas slightly smaller proportions of the middle (84%) and upper (80%) ACT groups used them. It should be emphasized, however, that these differences were very small and not statistically significant.

Table 3. Correlation Coefficients Obtained Between ACT Composite Scores and Number of Minutes Spent on Slide/Tape Programs.

Slide/Tape Programs	N	r
Laboratory	91	-.11
Quiz 1	105	-.21*
Quiz 2	99	-.11
Quiz 3	72	+.11
All Programs	135	-.03

*P<.05

Table 4. Percent of Students Who Used The Slide/Tape Programs by ACT Score Group.

Slide/Tape Programs	ACT 26 & Above	ACT 22 - 25	ACT 21 or Less	All Students
Laboratory	55	53	61	57
Quiz 1	61	67	67	65
Quiz 2	55	62	67	61
Quiz 3	35	53	43	44
Used Some Programs	80	84	87	84

Note: Chi-square was used to test for association between ACT classification and use or none-use of the slide/tape programs. None of the chi-square values were significant at the .05 level.

CONCLUSIONS

On the basis of this study the following conclusions seem warranted:

1. The achievement of students who used the slide/tape programs was superior to the achievement of those who chose not to use them.

2. For those students who used the materials, achievement tended to increase slightly as the amount of time devoted to the slide/tape programs increased.

3. A slightly higher proportion of low than high ability students chose to use the slide /tape materials.

4. Lower ability students who chose to use the materials tended to spend slightly more time on them than did high ability students.

Although this study has demonstrated the practical value of slide/tape materials which are planned and utilized as an integral component of course work, many questions relating to presentation and pacing remain to be answered. These include not only such technical questions as how to achieve optimum redundancy over time as a student acquires competence in the subject matter field, becomes more familiar with the study carrel procedures, and learns to study more effectively; the most effective ratio of pictures to words; the length and difficulty of the material, etc., but also such practical questions as how does a student evaluate the importance of using all the materials available while studying for a course and do carrels provide an environment conducive to effective study.

APPENDIX

Slide/tape sets designed to guide students through the assigned Laboratory Computations.

TITLE	No. Slides	Tape Duration Min.	Sec.
Density	19	12 :	15
Thermometer - Melting Points	31	16 :	00
Determine the Formula of a Compound	34	16 :	45
Emission Spectra	36	20 :	10
Determination of Avogadro's Number	48	20 :	00
Calculation of Avogadro's Number	39	16 :	30
Analysis of a Mixture ($KC10_3$)	45	16 :	45
Determination of Molecular Mass of $C0_2$	79	25 :	00
Slide/tape sets designed to present foundation information to students who need it.			
Significant Figures	34	19 :	00
Dimensional Analysis	32	16 :	05
Scientific Notation: Exponents	19	17 :	30
Writing Formulas from Names	85	24 :	00
Stoichiometry: Part I	60	18 :	55
Stoichiometry: Part II	42	25 :	30
Naming Inorganic Compounds	53	31 :	30
Balancing Chemical Equations: Molecular	27	13 :	15
Balancing Chemical Equations: Ionic	58	25 :	00
Balancing Oxidation-Reduction Reactions: Line	54	22 :	10
Balancing Oxidation-Reduction Reactions: Ion-Electron	58	21 :	00
Logarithms	44	21 :	25
Hybridization - I	79	35 :	00
Hybridization - II	79	35 :	00