DOCUMENT RESUME

ED 063 266 24 SP 005 738

AUTHOR Meinhold, Russell
TITLE Large Group Instruction Through Concept Development. Final Report.
INSTITUTION Rhode Island Coll., Providence.
SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO BR-8-A-042
PUB DATE Jul 70
GRANT OEG-1-9-080042-0004(010)
NOTE 22p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Concept Formation; *Concept Teaching; *Educational Development; *Group Instruction; *Instructional Innovation; *Physics Instruction

ABSTRACT

The intent of this project was to utilize in a unique way some of the recent thinking and research on the teaching learning process so that the lecture method might be replaced by a more effective instructional model. The area of instruction was physical science for the non-science college student. At each meeting a single concept was presented as follows: 1) As the students entered the lecture hall each received a set of mimeographed materials. The materials consisted of from 17-22 multiple choice questions dealing with concept development, data interpretation, and explanation and prediction. 2) A carefully planned demonstration, 20-30 minutes long, was supported by visual aids. 3) After the completion of the demonstration, students answered the questions. When at least 80 percent of the students had finished, answers were flashed on the screen. Forty-four concepts were presented for a 2-semester course with a 2-hour lab each week. The project was evaluated by a committee of five who had no other connection with the project. To determine the attitudes and preferences of the students, both personal interviews and a Likert scaled Inventory of Student Attitudes and Opinions were used. While the findings were multifaceted, with both positive and negative reactions, the important fact was that there was general agreement that this method makes a course more interesting than one taught by the lecture method. A 2-item bibliography, references and appendixes are included. (Author/MJM)

8-A-042
PA 24
NCERD

TITLE PAGE

FINAL REPORT
Project No. 8-A-042
Grant No. OEG-1-9-080042-0004(010)

LARGE GROUP INSTRUCTION THROUGH CONCEPT DEVELOPMENT

Russell Meinhold
Rhode Island College
600 Mt. Pleasant Ave.
Providence, R.I. 02908

July 1, 1970

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education

Bureau of Research

TABLE OF CONTENTS

SUMMARY

The intent of this project was to utilize in a unique way some of the recent thinking and research on the teaching-learning process, so that the lecture method could be replaced by a more effective instructional model.

The area of instruction was physical science for the non-science college student.

At each class meeting a single concept was presented as follows:

1. As the students entered the lecture hall each received a set of mimeographed materials. The materials consisted of from seventeen to twenty-two multiple-choice questions, organized into three categories: A. Concept Development, B. Data Interpretation, and C. Explanation and Prediction. The concept itself was succinctly stated at the end of the questions.

2. A carefully planned demonstration, supported by neccessary visuals was presented, with as little verbalization as possible. The demonstration lasted from ten to twenty minutes.

3. As soon as the demonstration was completed, the students were requested to answer the questions. When it was felt that at least 80% of the students had completed a given category, the answers were flashed on the screen.

Forty-four concepts were prepared and presented as the work for a two-semester course. A two-hour laboratory was given each week. The laboratory work was closely associated with the two concepts presented that week.

The same testing program was used as had been used in previous years when the straight lecture technique had been used.

The project was evaluated by a committee of five who had no other connection with the project.

To determine the attitudes and preferences of the students both personal interviews and Likert-Scale Inventories were used. While the findings were multifaceted, with both positive and negative reactions, the important fact was that there was general agreement that this method makes a course more interesting than one taught by the lecture method.

BACKGROUND FOR THE STUDY

As college enrollments have increased class sizes have increased, and with the increased size of classes the teaching style has tended to be limited to impersonalized lectures. Even the laboratory experiences have become routine, usually based upon "cook-book" type experiments with reports that can be corrected quickly and routinely.

Science courses have always been poorly received by the nonscience student. As the teaching deteriorated due to the increased class size the nonscience student became even more disenchanted with science courses.

Several years ago this investigator developed a general education course in physical science for the nonscience major.

For the first two years that the course was offered, conditions were such that it could be taught in sections of twenty-four students. This permitted considerable interaction and a developmental approach as opposed to lecturing. Also, the laboratory grouping was identical with the class grouping and this enabled the instructor to keep the class discussions and laboratory experiences closely related.

In the following four years the demands became such as to require a large group lecture. It was possible to keep the laboratory sections at twenty-four.

Within a period of two or three semesters it became quite evident that there was little learning taking place in the lectures; and what intellectual stimulation the students were receiving was coming from the laboratory experience. Attendance was very poor in the lecture sessions and laboratory instructors reported that there was no real carryover from the lecture to the laboratory.

The objective of this project was to develop an instructional model which would involve the individual student in his own learning process. Of all courses taught at the college level as general education, science is one which completely misses its objective if the student is not actively engaged in thinking through the concepts.

The model constructed is built upon some curricular and learning research carried on by Hilda Taba(1). Although Taba's research was carried out at the elementary level, and the subject matter area was social studies, this investigator felt that the model held promise for physical science at the college level, especially in the area of general education.

Taba's model consists essentially of four parts (1) The first part is a presentation in the form of a demonstration, a short story, a short film clip or a film strip. This presentation is then exploited by class interaction with three distinct procedural steps. These steps consist of (1) concept formation (2) data interpretation, and (3) extension or prediction of other phenomena on the basis of the concept developed. These

three steps are achieved through a specific form of questioning which is at once open-ended and yet developmental in that the teacher has the desired behavioral outcomes clearly in mind.

The model to be constructed for physical science could not be based upon verbal interaction with the class, inasmuch as the group were on occasion in excess of two hundred students.

The approach used is to develop sets of multiple-choice questions in a developmental format, somewhat according to Skinner (2), but using large-step questions; furthermore the questions are oriented toward the demonstration part of the presentation. This nature of the demonstration and its relationship to the questions is explained below.

Methods, materials and evaluative techniques:

Forty-four concepts of physical science were developed. These concepts were built around a basic theme and structure. The concepts dealt with the nature of matter and energy, moving from the simple to the complex, so that the closing concepts show the structure of matter. These concepts are listed in the appendix.

For each concept there is a detailed demonstration and a set of multiple-choice questions. The number of questions for each concept approximates twenty. These twenty questions are organized according to Taba's three steps: A. Concept Formation; B. Data Interpretation; and C. Extension and Prediction. The complete instructional unit for concept XXXIII is shown in the appendix. The unit consists of a detailed description of the demonstration and supporting visuals and verbalizations, and the set of questions.

The instructional process is as follows: As the students enter the lecture hall, each one is given a memiographed set of materials which includes the questions discussed above and a brief and succinct statement of the concept.

Punctuality is encouraged by beginning the demonstration at the exact minute that the class is scheduled to start. The demonstration, depending upon the concept, requires from ten to twenty minutes.

As soon as the demonstration is completed the group is instructed to begin answering the questions. While the students are working on the questions the instructor and an assistant moves about the lecture room. Students are encouraged to as questions of the instructors and to discuss the instructional questions with one another. When the instructors judge that about 80% have completed the five to eight questions in part A. Concept Development, the answers are flashed on the screen and students are instructed to indicate the correct answers on their papers, and to continue on to part B. Data Interpretation. A similar procedure is followed for the three sections. Whenever the process is completed the class is immediately dismissed, whether the formal "class hour" is over or not.

At the beginning of the semester, and on a number of occasions throughout

each semester, these suggestions are made: Follow the demonstration carefully. When instructed to answer the questions, do so by selecting two options from each item which you feel are definitely incorrect and cancel them out; select the option which you consider the correct answer from the three remaining options. Do not move to Section B of your questions until the answers to Section A have been given. Information discovered in Section A is usually needed to answer the questions in Section B; the same is true for Section C. The statement of the concept follows the questions of Section C. This should help you understand the items that you missed. This material is yours to keep, and should serve as the "notes" for the course. The instructors are available for assistance while you are engaged in answering the qustions in class, and at specified office hours. You are free to discuss the questions with your classmates throughout the presentation.

The testing procedure for the course was not changed from the one used in previous years. Two one-hour tests of fifty multipe-choice items and a two-hour final examination were given each semester.

Findings:

The project was evaluated not on the basis of test scores, but in terms of the attitude toward, and interest in the course. This evaluation was carried out by a committee; none of whose members had any other connection with either the course or the project. The committee was chaired by a psychologist whose specialty is research in learning. One member is a curriculum specialist; another is dean of the Division of Arts and Sciences. Of the other two members one is a professor of chemistry and the other is a professor of science education at a sister institution.

The final report of the committee is presented:

Report of the Evaluation Committee for Grant
No. OEG-1-9-080042-0004(010) Large Group
Instruction through Concept Development,
Dr. Russell Meinhold, Project Director
June, 1970

During the past year the Evaluation Committee has met several times, continued to observe lectures and laboratory periods, examined prepared materials, and met with students in class. In addition, a Likert-Scale Inventory of Student Attitudes and Opinions developed by the committee earlier was revised for greater reliability and validity.* A summary of the results of the above activities follows:

1. There does not seem to be a marked change in students' academic performance. Since there was no provision made for comparison of groups, it is difficult to make valid comparisons to performance levels.

2. Tests administered to the classes seem to have produced improved grades over the previous year. This improved performance may be attributed to the close relation between the items included on the work sheets distributed in class and the test items.

* A copy of this questionnaire together with percentage summaries item by item appears in the appendix.

3. According to the individuals interviewed, the feedback from students has indicated that a high value is placed on laboratory sessions. Attendance at laboratory sessions is very good as testing is frequent and students are required to make up sessions which have been missed.

4. Interviewees reported that the new course format has required that more teaching be included as a part of the lab session than was formerly required under the previous course organization. No marked difference was noted in the nature of students' questions and in their ability to deal with abstractions.

5. No change in the function of the laboratory sessions was reported.

6. No marked differences could be noted in the laboratory phase of the program as a result of the institution of the program.

7. The concepts being presented in the course are either too difficult for the students or they are presented at too rapid a pace.

8. There appears to be some question about which portion of the teaching method is most effective, the demonstration or the question-response, but there is agreement that the method is more interesting than the usual large group lecture method.

9. Although there may be no large amount of correlation between the class sessions and the lab sessions, the students agree that the lab sessions are interesting and meaningful.

10. The questions used to enhance the understanding of the demonstrations are effective study guides for the students.

In general, the committee's position is that the project has achieved most of its objectives.

CONCLUSIONS

There is no doubt that for large group instruction this method of presentation results in better attendance, better rapport, and increased interest. The key appears to be student participation.

There is little doubt that the specific materials and certain details of procedure, such as the relationship between the amount of time allotted to demonstration and time for responding to the instructional materials can be improved. However, there is no doubt that this form of instruction is superior to either TV lectures or live lectures.

One of the weaknesses of this instructional technique is that, as is the case with most instruction at the college level, individual differences are not cared for. The potential is present in the technique but it depends upon the initiative of the student, which, particularly on the part of the more able student appears to be entirely lacking. Less able, but motivated students exploited the materials and the instructors to take care of individual weaknesses and difficulties.

Although it was not intended to use academic achievement as a criterion for judging the success of the project there is no doubt that (1) a smaller percentage of students dropped the course, (2) a much smaller percentage failed the course, and (3) the average score of examinations was higher.

It is also true, however, there was no improvement in scores on laboratory reports, and laboratory instructors claimed that there was little or no carry-over from the "lecture" sessions to the laboratory sessions. There is some evidence that the program of laboratory experiences was not as well correlated with the instructional sessions as in previous years.

RECOMMENDATIONS

Certainly the basic recommendation is that other courses, especially for the non-specialist, be organized and taught in a similar method. It should be pointed out that hundreds of hours are required to organize a course into concepts and then write the multiple-choice questions sets, and prepare supporting visual aids and other teaching materials.

As this course was presented two one-hour sessions were allotted to instruction with the specially prepared materials and one two-hour laboratory session. It is the opinion of this investigator that the addition of one one-hour small group sessions for purposes of discussing the questions in depth would increase the success of this method two-fold at least. This might increase the likelihood of meeting the problem of individual differences.

This investigator would like to see this model used and evaluated on the basis of academic achievement. We can only infer that academic achievement is increased when interest and rapport are improved.

References:

1. Taba, Hilda, and others. Research Report: Thinking in Elementary School Children, San Francisco: San Francisco State College. p 30

2. Skinner, B.F. "Teaching Machines," Science, 128: 969 - 977. October 24, 1958.

Bibliography:

1. Bruner, Jerome. "Liberal Education for All Youth," Science Teacher, 32: 19 - 21, November, 1965.

2. ________, The Process of Education. Cambridge: Harvard University Press 1961. p 6

3. Novak, Joseph D. "Importance of Conceptual Schemes for Science Teaching."

4. Willey, Clarence F. "The Three-Decision Multiple-Choice Test: A Method of Increasing the Sensitivity of the Multiple-Choice Items," Psychological Reports, 7: 475 - 477, 1960.

APPENDICES

CONCEPTS

I	Laws of Motion - Speed
II	Laws of Motion - Acceleration
III	Newton's Second Law
IV	Mass and Weight
V	Newton's First Law
VI	Projectile Motion
VII	Newton's Third Law
BIII	Momentum
IX	Circular Motion
X	Rotary Motion
XI	Simple Harmonic Motion
XII	Work, Energy and Power
XIII	Waves
XIV	Properties of Waves
XV	Thermometry and Heat
XVI	Change of State
XVII	Air Pressure and Boyle's Law
XVIII	Charles Law; Pressure and Volume as Related to Temperature; Absolute Temperature
XIX	Law of Thermodynamics
XX	Kinetic Theory of Gases
XXI	Atoms, Molecules and Moles
XXII	Universal Gas Constant R
XXIII	Graham's Law
XXIV	Interaction Between a Moving Charge and a Magnetic Field, and Induction by Magnetic Fields
XXV	Electromagnetic Waves

CONCEPTS

XXVI	Electrostatics and Coulomb's Law
XXVII	Electrostatic Field and Potential Difference
XXVIII	Electric Current and Ohm's Law
XXIX	Magnetism and Magnetic Fields
XXX	Speed of Light, Electromagnetic Spectrum and Electromagnetic Radiation
XXXI	Diffraction and Interference of Light
XXXII	Particle Theory of Light
XXXIII	Electrolysis
XXXIV	Passage of electricity through gases
XXXV	Describing the Electron
XXXVI	Sources of Electrons
XXXVII	Positive Ions and Isotopes
XXXVIII	Bright Line Spectra and Thomson's Model of the Atom
XXXIX	Radioactivity and Rutherford's Model of the Atom
XL	The Bohr Atom I
XLI	The Bohr Atom II
XLII	Energy Levels
XLIII	Periodic Table
XLIV	Electron Cloud

XXXIII The Electron: Electrolysis

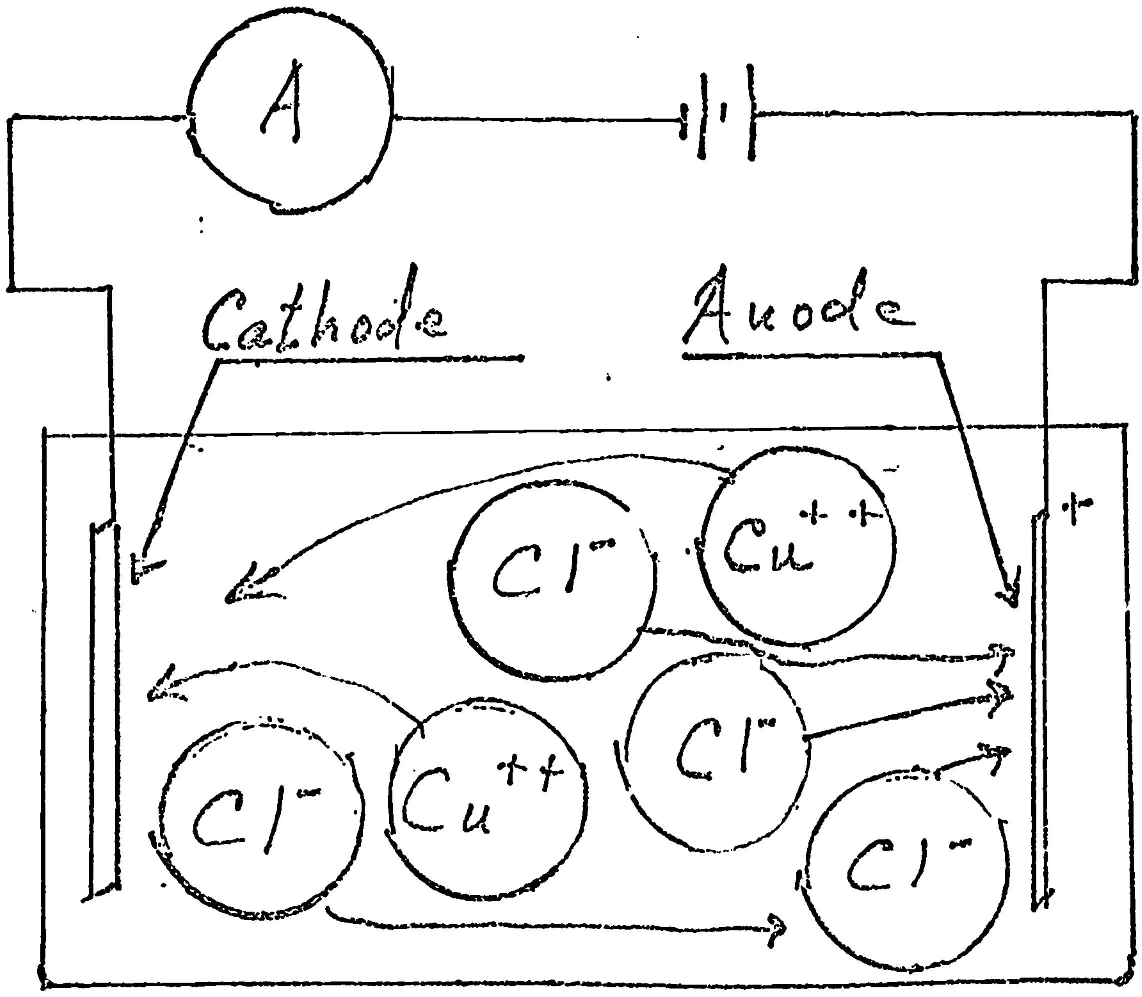
XXXIII Part A

Demonstration: Using TOPS projection equipment and electrolysis cell, and projection ammeter, carry out electrolysis of $Cu\ Cl_2$ solution.

The cell and the ammeter are projected on screen. The cathode shows increase in size, indicating that copper is being deposited on the cathode.

Verbal: Discuss the process.

Visual:



Visual:

Ions of Cu^{++} and cl^-

cu^{++} cathode Cu^o

2 cl^- anode Cl_2

Cu^{++} accepts 2 electrons

Each Cl^- gives up an electron

Questions from Section A

Questions from Section B'

Demonstrate:

1. Conduction of
   a. Sucrose
   b. Na Cl
   c. Alcohol

   Use dilute solutions of each with a conductivity apparatus

2. Demonstrate:

   $Ba\ (OH)_2 + H_2\ SO_4$

Make barium hydroxide solution by shaking excess of BaO in distilled water. Let stand for 24 hours and decant. Dilute $Ba(OH)_2$ solution by adding equal parts of distilled water. Make 800 ml. Place in a rectangular electrolysis tank with conductivity unit with clear bulb in series. Solution will conduct an electric current. Arrange buret tube so that 0.1 M H_2SO_4 can be added slowly. Continue until light goes out, and then goes on. Caution students to watch light closely.

Students do Section C.

XXXIII The Electron: Electrolysis

XXXIII

A Concept development:

1. The experiment supports the assumption that
   a. water conducts electrons.
   b. copper conducts electricity.
   c. ions serve to transfer electrons.
   d. electricity is really the motion of positive and negative changes.
   e. electrons can be created.

2. A basic assumption in an experiment is that
   a. the copper carries positive charges from the cathode to the anode.
   b. the chlorine carries negative charges from anode to the cathode.
   c. the chlorine changes from negative to positive.
   d. the copper ion carries negative charges from the cathode to the anode.
   e. the chlorine ion gives up an electron to the anode.

3. If a current of one ampere were flowing in the circuit, and then the current were increased to two amperes, we could assume that
   a. the resistance of the entire circuit would be increased,
   b. the amount of chlorine given off would be reduced.
   c. the amount of copper deposited would be increased,
   d. the number of electrons passing through the entire circuit would be reduced.
   e. there would be no change in the copper, copper ions, chlorine, or chlorine ions,

4. The copper ions
   a. loses two electrons
   b. loses one electron
   c. remains unchanged
   d. gains one electron
   e. gains two electrons

5. Each cupric ion, Cu^{++}, requires two electrons to change from an ion to an atom. The gram atomic mass of copper is 63.54 grams. In order to change 63.54 grams of copper from a solution of copper chloride it requires
   a. 63.54 electrons
   b. 6.06×10^{23} electrons
   c. $1/2 \times 6.06 \times 10^{23}$ electrons
   d. $2 \times 6.06 \times 10^{23}$ electrons
   e. 2×63.54 electrons

6. Each chloride ion, Cl^-, gives up one electron as it changes from an ion to an atom. The gram atomic mass of chloride is 35.46. If 31.77 grams of copper are released at the cathode, the number of grams of chlorine that will be released at the anode is:
   a. 35.46
   b. 2×35.46
   c. $1/2 \times 35.46$
   d. 6.06×10^{23}
   e. $1/2 \times 6.06 \times 10^{23}$

7. If the copper chloride were replaced by lead nitrate, one could predict that
   a. No current would flow in the circuit.
   b. metallic lead would be formed on the cathode.
   c. metallic lead would be formed on the anode.
   d. chlorine would be formed at the anode.
   e. nitrogen would be given off at the cathode.

X XIII
B Interpretation of data:

An experiment similar to the one we have just seen was performed under the following conditions:

1. At the beginning of the experiment the copper cathode had a mass of 14.742 grams and the anode had a mass of 26.401 grams.
2. The readings on the ammeter averaged .710 over a period of 8 minutes and 20 seconds.

Recall that:

1. coulomb is equivalent to 6.24×10^{18} electrons
1 coulomb equals one ampere/second
1 gram atomic mass of copper equals 63.54 grams
1 cupric ion Cu^{++} requires two electrons to change to an atom of copper.

1. The number of coulombs of electricity that passed through the solution was
   a. 500
   b. 5.68
   c. 6.24×10^{18}
   d. 355.
   e. 11.659

2. The number of electrons that passed through the entire circuit was approximately
   a. 500
   b. 355
   c. 2.2×10^{21}
   d. 4.4×10^{18}
   e. $2 \times 6.24 \times 10^{18}$

3. At the end of the experiment (8 min. and 20 seconds) the number of cupric ions that have changed to copper atoms will be
   a. 1.1×10^{21}
   b. 2.2×10^{21}
   c. 4.4×10^{18}
   d. 6.024×10^{23}
   e. 3.012×10^{23}

4. At the end of the experiment the mass of copper that has undergone a change from ions to atoms will be

a. $\dfrac{1.1 \times 10^{21} \times 63.54}{6.024 \times 10^{23}}$ g

b. $\dfrac{2.2 \times 10^{21} \times 63.54}{6.024 \times 10^{23}}$ g

c. $\dfrac{4.4 \times 10^{18} \times 63.54}{6.024 \times 10^{23}}$ g

d. $\dfrac{6.023 \times 10^{23} \times 31.77}{2.2 \times 10^{21}}$ g

e. $\dfrac{3.012 \times 10^{23} \times 31.77}{2.2 \times 10^{21}}$ g

5. At the end of the experiment
   a. the anode will have increased in mass.
   b. the cathode will have decreased in mass.
   c. the anode and cathode will be the same weight as in the beginning.
   d. the cathode will have increased in mass.
   e. both the cathode and anode will have increased in mass.

XXIII
C Explanation and prediction:

1. The reason that the alcohol solution did not conduct an electric current is that
   a. the atoms that make up the alcohol molecule have no electrons
   b. the molecule contains carbon atoms
   c. there is no chlorine in alcohol
   d. there are no ions in a solution of alcohol and water
   e. alcohol is not really soluble in water

2. A solution of sugar and water does not conduct an electric current
   a. for the same reason that a solution of alcohol and water does not conduct an electric current
   b. because of the large amount of oxygen in the sugar molecule
   c. because it contains no sodium
   d. because it contains no copper
   e. because the solution was too dilute

3. Of the solutions listed below the one which will not conduct an electric current is
   a. ferrous chloride; $Fe\ Cl_2$
   b. zinc sulfate; $Zn\ SO_4$
   c. glycerine; $C_3H_5(OH)_3$
   d. sodium nitrate; $NaNO_3$
   e. ammonium acetate, $NH_4C_2H_2O_2$

4. In the demonstration with borium hydroxide and sulfuric acid, the reason the current ceased to flow was due to
   a. the presence of sulfuric acid
   b. the presence of a white precipitate
   c. the presence of sulfate ions
   d. the absence of ions in the solution
   e. the absence of electrons in the solution

5. The reason the light went on as additional sulfuric acid was added was due to the fact that
   a. the borium ions returned to solution
   b. the sulfuric acid supplied ions to the solution
   c. the sulfuric acid reacted with the borium sulfate
   d. the additional time permitted the borium sulfate to dissolve
   e. a new compound was formed that supplied the ions.

Concept XXIII

Ions in a solution serve to transfer electrons from the negative electrode to the positive electrode; negatively charged ions, called anions transfer their electrons to the anode, or positively charged electrode; while positively charged ions, called cations accept electrons from the cathode, or negatively charged electrode.

One gram atomic mass of a given substance (6.06×10^{23} atoms) requires a specific number of electrons for the process of electrolysis; and is a multiple of Avogadro's number, depending upon the element.

STUDENT EVALUATION FORMS FOR PHYSICAL SCIENCE 101-102

PLEASE FILL IN: College Class ____________
Present Grade Point Average ____________
Sex ____________
Major ____________
Minor ____________

We are interested in your opinion regarding the new experimental format of Physical Science 101. Please circle the most appropriate response to each of the below questions.

1 STRONGLY AGREE	2 AGREE	3 NEUTRAL	4 DISAGREE	5 STRONGLY DISAGREE		
27.9	41.9	11.6	16.3	2.3	One can often feel quite lost in the lecture phase; the material is very difficult to grasp.	1.
23.3	27.9	25.6	20.9	2.3	The lecture-demonstration format produces more learning than the more formal lectures to which I have been exposed in the past.	2.
	14.0	16.3	55.8	14.0	The concepts taught by the new lecture format are irrelevant to the laboratory program.	3.
11.6	16.3	20.9	30.2	20.9	Interest in large group sessions is much greater, as compared to other courses, because the 50 minutes have been divided into different segments.	4.
20.9	30.2	20.9	23.3	4.7	In order to solve the lecture problems, a student must memorize a great deal since the concepts taught are very difficult to really understand.	5.
16.7	38.1	16.7	23.8	4.8	The format utilized by PS 101-102 holds students' attention more effectively than do those consisting of lectures only.	6.
7.0	20.9	20.9	44.2	7.0	The lecture technique makes the laboratory work more meaningful.	7.
9.5	35.7	14.3	26.2	14.3	The segment of large group instruction that is most valuable is the first part where the demonstration takes place.	8.
20.9	30.2	18.6	27.9	2.3	The lecture is too fast-paced for the student to grasp the concepts being taught.	9.

1 STRONGLY AGREE	2 AGREE	3 NEUTRAL	4 DISAGREE	5 STRONGLY DISAGREE		
	16.3	11.6	32.6	39.5	The lecture format encourages study outside of regular class meetings.	10.
20.9	25.6	11.6	32.6	9.3	Concepts are better learned when the student deals with them in the laboratory, therefore, lecture-demonstrations should be eliminated.	11.
11.9	38.1	23.8	23.8	2.4	The segment of large group instruction that is most valuable is the last part where problems are set in order to apply the information and principles.	12.
37.2	23.3	20.9	16.3	2.3	Less difficult material should be taught since at present the student is lucky if he truly understands half the material.	13.
11.6	11.6	23.3	44.2	9.3	If a student misses a large group lecture-demonstration, it is difficult to make up the work on his own.	14.
4.7	4.7	9.3	48.8	32.6	Most of the laboratory experiments are so involved that the student loses sight of the objectives, and he bogs down in manipulative techniques.	15.
20.9	34.9	20.9	11.6	11.6	The concept could be grasped more readily by stating it first and doing the demonstration last.	16.
4.7	41.9	27.9	14.0	11.6	The lecture is presented such that each concept taught builds understanding for the next in a meaningful fashion.	17.
2.3	16.3	9.3	48.8	23.3	Responding to the questions on the sheets distributed to the class creates a distraction from the content of the lecture.	18.
4.7	7.0	11.6	39.5	37.2	The laboratory experiments merely confirm what the text material has already stated and little additional knowledge is gained.	19.

1 STRONGLY AGREE	2 AGREE	3 NEUTRAL	4 DISAGREE	5 STRONGLY DISAGREE		
9.3	23.3	18.6	41.9	7.0	Student attention, that is, talking, whispering, and the like, is poorer during the demonstration portion than it is during the lecture part.	20.
2.3	27.9	16.3	27.9	25.6	The format makes it easier for the student to develop a real conceptual understanding in the course.	21.
32.6	34.9	7.0	25.6		The question sheets eliminate the necessity of students' taking notes during the lecture sessions.	22.
2.3	2.3	7.0	18.6	69.8	The lecture-demonstration method of presenting the concepts of science is so effective that the laboratory program should be eliminated.	23.
2.4	38.1	26.2	26.2	7.1	Retention of concepts and information from large group presentations is greater under the segmented format.	24.
	25.6	23.3	34.9	16.3	The format makes dry concepts like e/m, unitary charges, etc. become more real and alive.	25.
9.5	16.7	9.5	38.1	26.2	The lecture phase of Physical Science 101 should be eliminated regardless of the lecture format.	26.
9.3	51.2	14.0	25.6		The multiple choice questions that are used in the lecture sessions are effective study guides for the laboratory.	27.
32.6	44.2	14.0	7.0	2.3	The laboratory reveals the "practical side" of the physical sciences, while the lecture sessions deal mostly with abstract concepts.	28.
20.9	30.2	7.0	20.9	20.9	The present lecture format should be continued.	29.
7.0	27.9	20.9	30.2	14.0	The lecture technique, together with the multiple choice questions, has helped the student to develop a more "scientific approach" to problem solving in the laboratory.	30.

1 STRONGLY AGREE	2 AGREE	3 NEUTRAL	4 DISAGREE	5 STRONGLY DISAGREE		
14.3	47.6	11.9	16.7	9.5	The laboratory experiences are meaningful in terms of the basic knowledge of science that every informed citizen requires.	31.
	7.0	11.6	23.3	58.1	As a substitute for the laboratory program, the instructor should demonstrate the concepts and the students should record the data as the instructor performs the experiment.	32.